CURRICULUM AND DETAILED SYLLABI

FOR

B. TECH DEGREE PROGRAMME

IN

ELECTRICAL AND COMPUTER ENGINEERING

SEMESTERS III & IV

2022 SCHEME

(AUTONOMOUS)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY
(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)
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MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

B. TECH DEGREE PROGRAMME

IN

ELECTRICAL AND COMPUTER ENGINEERING

CURRICULUM AND DETAILED SECOND YEAR SYLLABUS

Items	Board of Studies (BOS)	Academic Council (AC)
Date of Approval	22-02-2023	20-03-2023

Sd/-

Head of Department
Chairman, Board of Studies

Sd/-

Principal
Chairman, Academic Council

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

Vision and Mission of the Institution

Vision:

To be an Institution moulding globally competent professionals as epitomes of Noble Values.

Mission:

To transform the Youth as technically competent, ethically sound and socially committed professionals, by providing a vibrant learning ambience for the welfare of humanity.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Vision and Mission of the Department

Vision:

To be a Centre of Excellence in Electrical & Electronics Engineering Education, Research and Application of knowledge to benefit the society at large.

Mission:

To mould quality Electrical Engineers, fostering creativity and innovation to address global issues.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Graduates will succeed as Engineering Professionals in Industry or as Entrepreneurs in Electrical and Computer Engineering and the related disciplines and exhibit an urge for innovation.

PEO2: Graduates will be able to adapt to the advances in Technology by acquiring knowledge and skills manifested through continuous learning and higher qualifications.

PEO3: Graduates will be serving community as socially committed individuals, exhibiting professional ethics in addressing the technical and engineering challenges.

PROGRAMME OUTCOMES (POs)

Engineering graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: To apply the knowledge in Electrical Engineering and Computer Engineering for the design, development testing and operation of Power and Energy Systems in the areas of Generation, Transmission, Conversion, Distribution and Utilization systems.

PSO2: To apply the knowledge in Electrical Engineering and Computer Engineering for the design, development and operation of Industrial systems in the areas of Automation, Control, Energy Management and Economic operation.

CURRICULUM

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

B.Tech. Programme in Electrical and Computer Engineering

For the students admitted from Academic Year 2022-23

SEMESTER III						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	BSC	MA0U20G	Discrete Mathematical Structures	3-1-0	4	4
B	PCC	EL2U20A	Circuits and Networks	2-2-0	4	4
C	PCC	EL2U20B	Data Structures	3-1-0	4	4
D	PCC	EL2U20C	Instrumentation Systems	3-1-0	4	4
E 1/2	HSC	HS0U20A	Professional Ethics	2-0-0	2	2
	ESC	ES0U20A	Design Engineering	2-0-0	2	2
F	MNC	NC0U20A	Constitution of India	2-0-0	2	---
S	PCC	EL2U28A	Data Structures Lab	0-0-3	3	2
T	PCC	EL2U28B	Measurements and Instrumentation Lab	0-0-3	3	2
R/M	VAC		Remedial/Minor Course	3-1-0	4	4
TOTAL					**26/30**	**22/26**

SEMESTER IV						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	BSC	MA0U20C	Probability, Random Processes and Numerical Methods	3-1-0	4	4
B	PCC	EL2U20D	Computer Organization and Architecture	3-1-0	4	4
C	PCC	EL2U20E	Object Oriented Programming using JAVA	3-1-0	4	4
D	PCC	EL2U20F	Digital Electronics	3-1-0	4	4
E (1/2)	ESC	ES0U20A	Design Engineering	2-0-0	2	2
	HSC	HS0U20A	Professional Ethics	2-0-0	2	2
F	MNC	NC0U20C	Universal Human Values	2-0-0	2	--
S	PCC	EL2U28C	Object Oriented Programming Lab (in Java)	0-0-3	3	2
T	PCC	EL2U28D	Digital Electronics Lab	0-0-3	3	2
R/M/ H	VAC		Remedial/Minor/Honors Course	3-1-0	4	4
TOTAL					**26/30**	**22/26**

B.Tech (MINOR)

Semester	BASKET I Electric Vehicle Technology				BASKET II Power Systems				BASKET III Embedded Systems & IOT				BASKET IV Architectural Lighting and Electrical System Design			
	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit
S3	EL0M20I	Electric Machine Fundamentals	3-1-0	4	EL0M20J	Introduction to Power Engineering	3-1-0	4	EL0M20K	Arduino Platform Interface & C Programming	4-0-0	4	EL0M20L	Basics of Illumination Science and Lighting Design	4-0-0	4
S4	EL0M20M	Drives and Control	3-1-0	4	EL0M20N	Energy Systems	4-0-0	4	EL0M20P	Micro Controllers & Embedded Systems	4-0-0	4	EL0M20Q	Electric Power Supply and Distribution Systems	4-0-0	4

B.Tech (HONOURS)

Semester	GROUP I Specialization: Control and Autonomous Systems				GROUP II Specialization: Machine Learning				GROUP III Specialization: Smart Grids				GROUP IV Specialization: Electric Vehicle Systems			
	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit
S4	EL2H20A	Automatic Control Systems	3-1-0	4	EL2H20B	Basics of Machine Learning	3-1-0	4	EL2H20C	Network Communication in Smart Grid	3-1-0	4	EL2H20D	Analysis of Electrical Machines	3-1-0	4

SEMESTER III

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0U20G	DISCRETE MATHEMATICAL STRUCTURES	BSC	3	1	0	4	2022

i) PRE-REQUISITE: MA0U10B: Vector Calculus, Differential Equations and Transforms.

ii) COURSE OVERVIEW: The purpose of this course is to create awareness in students about the basic terminologies used in advanced courses in Computer Science and develop rigorous logical thinking for solving different kinds of problems in Computer Science. This course helps the learner to apply the theory and applications of elementary Counting Principles, Propositional Logic, Predicate Logic, Lattices, Generating Functions, Recurrence Relations and Algebraic Structures and fundamental concepts in Graph Theory eventually in practical applications.

iii) COURSE OUTCOMES:

After the completion of the course, the student will be able to:

CO1	Use the truth tables, deductive reasoning and inference theory on Propositional Logic check the validity of predicates in Propositional and Quantified Propositional Logic	Apply
CO2	Classify binary relations into various types and illustrate an application for Partially Ordered Sets and Complete Lattices	Apply
CO3	Describe the fundamentals of abstract algebraic systems - Semigroups, Monoids, Groups, Homomorphism and Isomorphism of Monoids and Groups	Understand
CO4	Classify graphs, trees, Planar graphs and their properties. also explain vertices and their properties, types of paths.	Apply
CO5	Explain the Vertex Color problem in graphs and illustrate an example application for vertex coloring	Apply

iv) SYLLABUS

Mathematical logic - Tautology, Contradiction. Logical Equivalence - The Laws of Logic, The Principle of duality, Logical Implication - Rules of Inference, The use of Quantifiers– Logical equivalences and implications for quantified statement, Implications, Negation.

Linear recurrence relations with constant coefficients – homogeneous, non-homogeneous Solution. Principles of counting.

Binary Relation and Functions. - Relations, Equivalence Relations and partitions. Partial Order relations, partially ordered Set - Lattice, Properties of Lattice.

Algebraic Systems-Semi group and monoid-cyclic monoid, Homomorphism and Isomorphism. Group- subgroup, symmetric group, The direct product of two groups, Group Homomorphism-Cyclic Group-Right cosets and Lagrange’s Theorem.

Introduction to Graphs, Definition, incidence and degree, sub graphs walks, paths, circuits, Isomorphism, Connectedness, Eulerian and Hamiltonian graphs, Travelling salesman problem, Fleury's algorithm

Matrix representation of graphs, Trees, basic properties of trees, Binary trees, Spanning and Minimal spanning tree, Dijkstra, prims and Kruskal algorithms

Connectivity, Cut set and Cut vertices, Fundamental circuits, Planar graphs and their properties, Planarity of graphs, Kurtowski's two graphs, Euler's formula, Coloring-Chromatic number, Chromatic polynomial, Matchings, Coverings, Four color problem and Five color problem. Greedy colouring algorithm.

v) (a) TEXT BOOKS

1) Ralph P Grimaldi, B V Ramana, "Discrete and Combinatorial Mathematics (An Applied Introduction)", 5th Edition, Pearson.
2) Narsingh Deo, "Graph theory", PHI, 1979.

(b) REFERENCES

1) Kenneth H. Rosen, "Discrete Mathematics and Its Applications with Combinatorics and Graph Theory", 7th Edition, MGH, 2011.
2) Trembly J.P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata Mc Graw Hill Pub. Co. Ltd., New Delhi, 2003.
3) Bernard Kolman, Robert C. Busby, Sharan Cutler Ross, "Discrete Mathematical Structures", Pearson Education Pvt Ltd., New Delhi, 2003.
4) Douglas B. West, "Introduction to Graph Theory", Prentice Hall India Ltd., 2001.
5) J.A. Bondy and U.S.R. Murty, "Graph theory with Applications", Elsevier Science Publishing Co.., Inc, 1982.
6) Robin J. Wilson, "Introduction to Graph Theory", Longman Group Ltd., 2010.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Mathematical logic**, Basic Connectives and Truth Table Statements, Tautology, Contradiction Logical Equivalence, The Laws of Logic, The Principle of duality, Substitution Rules, The implication, The Contrapositive, the Converse, the Inverse. Logical Implication, Rules of Inference, The use of Quantifiers, Open Statement, Quantifier, Negation **Linear Recurrence Relations** with Constant Coefficients of order one and two-Homogeneous Solution Non homogeneous Solution. Pigeonhole principle, Principle of inclusion and exclusion, derangements.	**12**

II	**Binary Relation**-Reflexive Relations, Symmetric Relations, Transitive relations, Antisymmetric Relations-Partial Order relations Equivalence Relation, Equivalence Classes Partitions, Irreflexive Relations. Partially ordered Set, Hasse Diagram. Maximal-Minimal Element, Least Upper bound, Greatest Lower Bound, **Lattice**- Dual Lattice, sub lattice, Properties of glb and lub. Properties of Lattice, Special Lattice, Complete Lattice, Bounded Lattice, Complemented Lattice, Distributive Lattice.	**12**
III	**Algebraic Systems**-Binary operations on a set and its properties Semi group, Monoid, Sub semigroup and sub monoid Cyclic monoid Homomorphism and Isomorphism of Semigroup, Monoids and Groups, Elementary Properties, Subgroup, Symmetric group on three Symbols.The direct Product of two Groups-Group Homomorphism, Isomorphism, Cyclic group, Right coset, Left coset, Lagrange's Theorem.	**12**
IV	**Concepts of Graphs and Trees**: Definition, incidence and degree, sub graphs walks, paths, circuits, Isomorphism, Connectedness, Eulerian and Hamiltonian graphs, Travelling salesman problem, Fleury's algorithm. Matrix representation of graphs, adjacency and incidence matrix Trees, basic properties of trees, Binary trees Spanning and Minimal spanning tree, Graph theoretical algorithms: Dijkstra, prims and Kruskal.	**12**
V	**Connectivity and Planar Graphs** Vertex Connectivity, Edge Connectivity, Cut set and Cut vertices, Fundamental circuits, Planar graphs and their properties: Planarity of graphs, Kurtowski's two graphs, Euler's formula, **Coloring**- Chromatic number, Chromatic polynomial, Matchings, Coverings, Four color problem and Five color problem. Greedy colouring algorithm.	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U20A	CIRCUITS AND NETWORKS	PCC	2	2	0	4	2022

i) PRE-REQUISITE: MA0U10B: Vector Calculus, Differential Equation and Transforms, ES0U10D: Introduction to Electrical and Electronics Engineering.

ii) COURSE OVERVIEW: The goal of this course is to expose students to the fundamental concepts of AC and DC circuits, enhance the problem-solving skills by using various techniques to solve different types of circuits. Time Domain analysis will help students to understand the transient and the steady-state response of R, L, C circuits. The course also aims to introduce two port network modelling and network functions.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Apply circuit theorems to simplify and obtain responses in complex DC and AC electric networks.	Apply
CO2	Solve DC and AC circuits to obtain the complete response to various excitations.	Apply
CO3	Solve dynamic circuits by applying transformation to s-domain.	Apply
CO4	Solve series /parallel resonant circuits.	Apply
CO5	Develop two-port network representation using network parameters.	Apply

iv) SYLLABUS

Network theorems - DC and AC steady state analysis. Time domain analysis of dynamic circuits -steady state and transient response analysis - Introduction to Laplace Transform - Application of Laplace transform in series and parallel circuits with step and sinusoidal responses. Coupled circuits - Dot convention - Analysis of simple coupled circuits, Resonance in series and parallel circuits. Two port network - network parameters - interrelationship of network parameters - driving point and transfer immittance function.

v) (a) TEXT BOOKS

1) Hayt and Kemmerly, “Engineering Circuit Analysis”, McGraw Hill Education, New Delhi, 9th Edition, 2019.

2) Ravish R. Singh, “Network Analysis and Synthesis”, McGraw-Hill Education, 2013.

3) Sudhakar and Shyam Mohan, “Circuits and Networks: Analysis and Synthesis”, McGraw Hill Education, 5th Edition, 2015.

4) F. F. Kuo, “Network Analysis and Synthesis”, John Wiley Inc Publications, 1966.

(b) REFERENCES

1) Joseph A. Edminister and Mahmood Nahvi, "Electric Circuits", McGraw Hill, 7th Edition, 2017.
2) A. Chakrabarti, "Circuit Theory Analysis and Synthesis", Dhanpat Rai & Co., 7th Revised Edition, 2018.
3) Choudhury Roy D., "Networks and Systems", New Age International Pvt. Ltd. Publishers, 2nd Edition, 2013.
4) Van Valkenberg, "Network Analysis", Prentice Hall India Learning Private Limited, 3rd Edition, 2011.
5) Dr. B.R. Gupta, "Network Analysis and Synthesis", S. Chand & Company Ltd, 3rd Edition, 2013.
6) C. A. Desoer, E. S. Kuh, "Basic Circuit Theory", McGraw-Hill, New York, 1969.
7) James W. Nilsson and Susan A. Riedel, "Electric Circuits", Pearson Education Publications, 9th Edition, 2011.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Review of circuit elements, fundamental laws, AC representation. Circuit theorems: Thevenin theorem, Norton's theorem, Superposition theorem, Maximum Power transfer Theorem, Reciprocity theorem. DC and Sinusoidal steady state analysis of circuits with dependent and independent sources.	**12**
II	Time domain analysis of first and second order dynamic circuits: Formulation of dynamic equations of RL, RC and RLC networks with dc excitation and initial conditions and complete solution using Laplace Transforms - Time constant - Complete solution of RL, RC and RLC circuits with sinusoidal excitation using Laplace Transforms - Damping ratio -Over damped, under damped, critically damped and undamped RLC networks.	**12**
III	Transformed circuits in s-domain: Transform impedance/admittance of R, L and C - Mesh analysis and node analysis of transformed circuits in s-domain. Transfer Function representation - Poles and zeros.	**12**
IV	Analysis of Coupled Circuits: Dot polarity convention -Sinusoidal steady state analysis of coupled circuits - Linear Transformer as a coupled circuit - Analysis of coupled circuits in s-domain. Resonance in Series and Parallel RLC circuits: Quality factor - Bandwidth -Impedance Vs Frequency, Admittance Vs Frequency, Phase angle Vs frequency for series resonant circuit.	**12**
V	Two port networks: Driving point and transfer functions - Z, Y, h and T parameters - Conditions for symmetry & reciprocity - relationship between parameter sets interconnections of two port networks (series, parallel and cascade) - T-pi transformation.	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U20B	DATA STRUCTURES	PCC	3	1	0	4	2022

i) PRE-REQUISITE: ES0U10E Programming in C.

ii) COURSE OVERVIEW:

This course aims to introduce the various data structures, their organization, and operations. It covers abstract concepts for data organization and manipulation using data structures such as stacks, queues, linked lists, binary trees, heaps, and graphs. It helps the learner to apply appropriate data structures and associated algorithms for solving real world problems efficiently.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Design an algorithm for a computational task and determine the time/space complexities.	Apply
CO2	Identify suitable data structure (array or linked list) to represent a data item required to be processed to solve a given computational problem and write an algorithm to find the solution of the computational problem.	Apply
CO3	Design an algorithm to find the solution of a computational problem by selecting an appropriate data structure (binary tree/graph) to represent a data item to be processed.	Apply
CO4	Apply appropriate Hash Function to store a given dataset and enable efficient access of data in the given set.	Apply
CO5	Make use of appropriate sorting algorithms based on specific circumstances.	Apply

iv) SYLLABUS

Introduction: Basic Concepts of Data Structures, Algorithms, Performance Analysis, Asymptotic Notation, Complexity Calculation of Simple Algorithms.

Arrays and Searching: Sparse matrix, Stacks and Queues, Linear Search and Binary Search.

Linked List and Memory Management: Operations on Linked List, Types of Linked Lists, Stacks and Queues, Memory allocation and deallocation -First-fit, Best-fit and Worst-fit.

Trees and Graphs: Binary Trees, Binary Search Trees, Graph Representations, Depth First Search and Breadth First Search, Applications of Graphs.

Sorting and Hashing: Selection Sort, Insertion Sort, Quick Sort, Merge Sort and Heap Sort, Hashing Techniques, Collision Resolution, Overflow handling, Hashing functions.

v) (a) TEXT BOOKS

1) Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, "Fundamentals of Data Structures in C", 2nd Edition, Universities Press, 2007.

(b) REFERENCES

1) Samanta D., "Classic Data Structures", 2nd Edition, Prentice Hall India Learning Private Limited, 2009.
2) Richard F. Gilberg, Behrouz A. Forouzan, "Data Structures: A Pseudocode Approach with C", 2nd Edition, Cengage Learning, 2005.
3) Aho A. V., J. E. Hopcroft and J. D. Ullman, "Data Structures and Algorithms", Pearson Publication, 1982.
4) Tremblay J. P. and P. G. Sorenson, "Introduction to Data Structures with Applications", Tata McGraw Hill, 1984.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction: Basic Concepts of Data Structures, System Life Cycle, Algorithms, Performance Analysis, Space Complexity, Time Complexity, Asymptotic Notation, Complexity Calculation of Simple Algorithms.	8
II	Arrays and Searching: Polynomial representation using Arrays, Sparse matrix, Stacks, Queues-Circular Queues, Priority Queues, Double Ended Queues, Evaluation of Expressions, Linear Search and Binary Search.	14
III	Linked List and Memory Management: Self-Referential Structures, Dynamic Memory Allocation, Operations on Linked List-Singly Linked List, Doubly Linked List, Circular Linked List. Stacks and Queues using Linked List, Polynomial representation using Linked List, Memory allocation and deallocation-First-fit, Best-fit and Worst-fit allocation schemes.	14
IV	Trees and Graphs: Trees, Binary Trees-Tree Operations, Binary Tree Representation, Tree Traversals, Binary Search Trees- Binary Search Tree Operations, Graphs, Representation of Graphs, Depth First Search and Breadth First Search on Graphs, Applications of Graphs.	14
V	Sorting and Hashing: Sorting Techniques – Selection Sort, Insertion Sort, Quick Sort, Merge Sort and Heap Sort, Hashing, Hashing Techniques, Collision Resolution, Overflow handling, Hashing functions – Mid square, Division, Folding, Digit Analysis.	10
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U20C	INSTRUMENTATION SYSTEMS	PCC	3	1	0	4	2022

i) PRE-REQUISITE: ES0U10D Basics of Electrical and Electronics Engineering.

ii) COURSE OVERVIEW: This course deals with the construction and principle of operation of basic analog and digital instruments used for measurement of current, voltage, power, energy etc. It provides a detailed study of resistance, inductance and capacitance measuring methods. The course includes an elaborate discussion about potentiometers. It introduces students to the operation of various transducers to measure the physical quantities.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Compare the different types of measuring instruments, their construction, operation and characteristics.	Understand
CO2	Explain the resistance, inductance and capacitance measuring methods.	Understand
CO3	Illustrate the construction and working of wattmeters, energy meters and methods of power measurement.	Understand
CO4	Explain the working of various DC potentiometers and digital meters.	Understand
CO5	Summarise the construction and working of various transducers to measure the physical quantities.	Understand

iv) SYLLABUS

General principles of measurements, classification of meters, ammeters and voltmeters, moving coil, moving iron meters.

Measurement of resistance - measurement of insulation resistance, earth resistance, DC bridges, AC bridges.

High voltage and high current measurements, Measurement of power and energy - dynamometer type wattmeter, induction type 1-phase energy meter.

DC potentiometers, digital measurement of electrical quantities.

Instruments for Measurement of Displacement, Level, Force and Torque, Strain, Pressure.

v) (a) TEXT BOOKS

1) A. K. Sawhney, “Electrical and Electronic Measurements and Instrumentation”, 17th Edition (Reprint 2004), Dhanpat Rai & Co. Pvt. Ltd., 2004.
2) C. S. Rangan, G. R. Sarma, V. S. V. Mani, “Instrumentation: Devices and Systems”, 2nd Edition (32nd Reprint), McGraw Hill Education (India), 2014.
3) Bela G. Liptak, “Process Measurement Instrument Engineers Handbook”, Revised Edition, Chilton Book Company, 1982.

(b) REFERENCES

1) D.V. S. Murty, “Transducers and Instrumentation”, 2nd Edition, PHI, 2009.

2) A. K. Ghosh, "Introduction to Measurements and Instrumentation", 2nd Edition, PHI, 2007.
3) B.C.Nakra and K.K.Choudhry, "Instrumentation Measurement and Analysis", 3rd Edition, McGraw Hill Education (India) Pvt. Ltd. 2009.
4) Ernest O. Doeblin and Dhanesh N Manik, "Measurement Systems Application and Design", 5th Edition, McGraw Hill, 2007.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**General principles of measurements:** Classification of meters - operating forces - essentials of indicating instruments - deflecting, damping, controlling torques. Errors in measurement and analysis, Significance of IS standards. **Ammeters and Voltmeters:** Moving coil, Moving iron - constructional details and operating principles, shunts and multipliers – extension of range.	**12**
II	**Measurement of resistance:** Measurement of insulation resistance - loss of charge method, measurement of earth resistance - fall of potential method and earth tester. **DC Bridges:** Wheatstone bridge, Kelvin double bridge. **AC Bridges:** Maxwell bridge, Schering bridge and Wien's bridge.	**12**
III	**Measurement of power and energy:** Dynamometer type wattmeter – construction and working - 3-phase power measurement - three wattmeter method, two wattmeter method and single wattmeter method, Induction type 1-phase energy meter – construction and working. **Digital Measurement of Electrical Quantities:** Concept of digital measurement, block diagram, study of digital voltmeter, frequency meter, electronic energy meter, electronic multimeter, DSO.	**12**
IV	**DC potentiometers:** General Principles - Slide wire and Vernier potentiometer - Calibration of ammeter, voltmeter and wattmeter. **Transducers:** Definition of Transducers, Classifications of transducers- based on principle, primary & secondary transducers, active & passive transducers, analog and digital transducers, transducers & inverse transducers, summary of factors influencing the choice of transducers/instruments.	**12**
V	**Applications of Transducers:** LVDT, piezoelectric force transducer, Load cell, strain gauge- bridge configuration for four strain gauges, Strain gauge Circuits – Wheatstone bridge circuit, Applications. RTD, thermistors, thermocouple. Ultrasonic and Electromagnetic flowmeters.	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
HS0U20A	PROFESSIONAL ETHICS	HSC	2	0	0	2	2022

i) PRE-REQUISITE: Nil.

ii) COURSE OVERVIEW: The goal of this course is to create awareness among the students on ethics and human values.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Infer the core values that shape the ethical behaviour of a professional.	Understand
CO2	Apply philosophical concepts discussed in the course to personal and contemporary issues.	Apply
CO3	Explain the role and responsibility of engineer in technological development without compromising personal ethics and legal ethics.	Understand
CO4	Solve moral and ethical problems through exploration and assessment by established experiments.	Apply
CO5	Demonstrate the concept of Corporate Social Responsibility, and explore its relevance to ethical business activity	Understand
CO6	Apply the knowledge of human values and social values to contemporary ethical values and global issues.	Apply

iv) SYLLABUS

Morals, values and Ethics – Integrity- Academic Integrity-Work Ethics- Service Learning Civic Virtue- Respect for others- Living peacefully- Caring and Sharing- Honestly- Courage Cooperation commitment- Empathy-Self Confidence -Social Expectations.

Senses of Engineering Ethics - Variety of moral issues- Types of inquiry- Moral dilemmas – Moral Autonomy – Kohlberg's theory- Gilligan's theory- Consensus and Controversy Profession and Professionalism- Models of professional Roles - Theories about right action – Self-Interest-Customs and Religion- Uses of Ethical Theories.

Engineering as Experimentation – Engineers as responsible Experimenters- Codes of Ethics Plagiarism- A balanced outlook on law - Challenges case study- Bhopal gas tragedy.

Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining Confidentiality- Role of confidentiality in moral Integrity-Conflicts of interest- Occupational crime - Professional rights - Employee right - IPR Discrimination.

Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics - Role in Technological Development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and Advisors-Moral leadership.

v) (a) TEXT BOOKS

1) M Govindarajan, S Natarajan and V S Senthil Kumar, “Engineering Ethics”, PHI Learning Private Ltd, New Delhi, 2012.
2) R S Naagarazan, “A text book on professional ethics and human values”, New Age International (P) limited, New Delhi, 2006.

(b) REFERENCES

1) Mike W Martin and Roland Schinzinger, “Ethics in Engineering”, 4th Edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi, 2014.
2) Charles D Fledder mann, “Engineering Ethics”, Pearson Education/ Prentice Hall of India, New Jersey, 2004.
3) Charles E Harris, Michael S Protchard and Michael J Rabins, “Engineering Ethics - Concepts and cases”, Wadsworth Thompson Learning, United states, 2005.
4) http://www.slideword.org/slidestag.aspx/human-values-and-Professional-ethics.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Morals, values and Ethics, Integrity, Academic Integrity, Work Ethics Service Learning, Civic Virtue, Respect for others, living peacefully Caring and Sharing, Honesty, Courage, Co-operation commitment Empathy, Self Confidence, Social Expectations	6
II	Senses of Engineering Ethics, Variety of moral issues, Types of Inquiry Moral dilemmas, Moral Autonomy, Kohlberg’s theory, Gilligan’s theory, Consensus and Controversy, Profession& Professionalism, Models of professional roles, Theories about right action-Self-Interest-Customs and Religion, Uses of Ethical Theories.	6
III	Engineering as Experimentation, Engineers as responsible Experimenters-Codes of Ethics, Plagiarism, A balanced outlook on law Challenger case study, Bhopal gas tragedy.	6
IV	Collegiality and loyalty, Managing conflict, Respect for authority Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Conflicts of interest-Occupational crime, Professional rights, Employee right, IPR, Discrimination	6
V	Multinational Corporations, Environmental Ethics, Business Ethics, Computer Ethics-Role in Technological Development, Moral leadership Engineers as Managers, Consulting Engineers, Engineers as Expert witnesses and advisors.	6
	Total hours	**30**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
NC0U20A	CONSTITUTION OF INDIA	MNC	2	0	0	---	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

The study of the Constitution of India enables the students to

1) Understand the fundamental rights and duties and directive principles.
2) Understand the functions of Executive, Legislature and Judiciary of the Union and the States.
3) Understand the relation between the Union and the States.
4) Provides the student the knowledge and strength to face the society and people.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the historic background of the constitution of India and its features.	Understand
CO2	Describe the fundamental rights, duties and directive principles of state policy.	Understand
CO3	Discuss the machinery of executive, legislature and judiciary of the Union and the States.	Understand
CO4	Explain the relation between the Union and the States.	Understand
CO5	Demonstrate national and patriotic spirit as responsible citizens of the country.	Apply

iv) SYLLABUS

Constitution of India: Definition, historical background, features, preamble, territory, citizenship. State, fundamental rights, directive Principles, fundamental duties. The machinery of the union government, machinery of the state governments. Statutory institutions, miscellaneous provisions, amendments to constitution.

v) (a) TEXT BOOKS

1) M. Laxmikanth, Indian Polity, McGraw Hill Education India, 6th Edition, 2019.
2) D. D. Basu, Introduction to the Constitution of India, Lexis Nexis, New Delhi, 24th Edition, 2019.
3) P. M. Bhakshi, The Constitution of India, Universal Law, 14th Edition, 2017.

(b) REFERENCES

1) Ministry of Law and Justice, The Constitution of India, Govt. of India, New Delhi, 2019.
2) J. N. Pandey, The Constitutional Law of India, Central Law agency, Allahabad, 51th Edition, 2019.

3) M. V. Pylee, India's Constitution, S. Chand and Company, New Delhi, 16th Edition, 2016.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Definition of constitution, historical back ground, salient features of the constitution. Preamble of the constitution, union and its territory. Meaning of citizenship, types, termination of citizenship.	**4**
II	Definition of state, fundamental rights, general nature, classification, right to equality, right to freedom, right against exploitation. Right to freedom of religion, cultural and educational rights, right to constitutional remedies. Protection in respect of conviction for offences. Directive principles of state policy, classification of directives, fundamental duties.	**7**
III	The Union Executive, the President, the Vice President, the Council of Ministers, the Prime Minister, Attorney-General, functions. The Parliament, composition, Rajya Sabha, Lok Sabha, qualification and disqualification of membership, functions of parliament. Union judiciary, the supreme court, jurisdiction, appeal by special leave.	**7**
IV	The State executive, the Governor, the council of ministers, the Chief minister, advocate general, union Territories. The State Legislature, composition, qualification and disqualification of membership, functions. The state judiciary, the high court, jurisdiction, writs jurisdiction.	**6**
V	Relations between the Union and the States, legislative relation, administrative relation, financial Relations, Inter State council, finance commission. Emergency provision, freedom of trade commerce and inter course, comptroller and auditor general of India, public Services, public service commission, administrative Tribunals. Official language, elections, special provisions relating to certain classes, amendments to constitution.	**6**
	Total hours	**30**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U28A	DATA STRUCTURES LAB	PCC	0	0	3	2	2022

i) PRE-REQUISITE: ES0U10E: Programming in C

ii) COURSE OVERVIEW: The aim of this course is to give hands-on experience in creating and using different Data Structures. It also covers various applications of linear and nonlinear Data Structures. This course helps the learners to select appropriate data structures to solve computational problems.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Develop a time/space efficient program using arrays/linked lists/trees/graphs to provide necessary functionalities meeting a given set of user requirements	Apply
CO2	Develop a time/space efficient program to sort a list of records based on a given key in the record	Apply
CO3	Make use of a given Data Structure to determine its space complexity and time complexities of operations on it	Apply
CO4	Design and implement an efficient data structure to represent given data	Apply
CO5	Develop a time/space efficient program to convert an arithmetic expression from one notation to another	Apply

iv) LIST OF EXPERIMENTS

- Implementation of Polynomials and Sparse matrices using arrays.
- Implementation of Stack, Queues, Priority Queues, DEQUEUE and Circular Queues using arrays
- Application problems using stacks: Conversion of expression from one notation to another notation.
- Implementation of various linked list operations.
- Implementation of stack, queue and their applications using linked list.
- Implementation of trees using linked list
- Representation of polynomials using linked list, addition, and multiplication of polynomials.
- Implementation of binary trees using linked lists and arrays- creations, insertion, deletion and traversal.
- Implementation of binary search trees – creation, insertion, deletion, search
- Any application programs using trees: Implementation of sorting algorithms – bubble, insertion, selection, quick, merge sort and heap sort.
- Implementation of searching algorithms – linear search, binary search.

- Representation of graphs and computing various parameters (in degree, out degree etc.) - adjacency list, adjacency matrix.
- Implementation of BFS and DFS for each graph representations

v) REFERENCES

1) Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, "Fundamentals of Data Structures in C", 2nd Edition, Universities Press, 2007.
2) Samanta D., "Classic Data Structures", 2nd Edition, Prentice Hall India Learning Private Limited, 2009.
3) Richard F. Gilberg, Behrouz A. Forouzan, "Data Structures: A Pseudocode Approach with C", 2nd Edition, Cengage Learning, 2005.
4) Aho A. V., J. E. Hopcroft and J. D. Ullman, "Data Structures and Algorithms", Pearson Publication, 1982.
5) Tremblay J. P. and P. G. Sorenson, "Introduction to Data Structures with Applications", Tata McGraw Hill, 1984.

vi) COURSE PLAN

Expt. No.	List of exercises/Experiments	No. of hours
I	Implementation of Polynomials and Sparse matrices using arrays	**3**
II	Implementation of Stack, Queues, Priority Queues, DEQUEUE and Circular Queues using arrays	**3**
III	Application problems using stacks: Conversion of expression from one notation to another notation.	**3**
IV	Implementation of various linked list operations.	**3**
V	Implementation of stack, queue and their applications using linked list.	**3**
VI	Implementation of trees using linked list	**3**
VII	Representation of polynomials using linked list, addition, and multiplication of polynomials.	**3**
VIII	mplementation of binary trees using linked lists and arrays	**3**
IX	Implementation of binary search trees – creation, insertion, deletion, search	**3**
X	Any application programs using trees	**3**
XI	Implementation of sorting algorithms – bubble, insertion, selection, quick, merge sort and heap sort	**6**
XII	Implementation of searching algorithms – linear search, binary search	**3**
XIII	Representation of graphs and computing various parameters (in degree, out degree etc.) - adjacency list, adjacency matrix.	**3**
XIV	Implementation of BFS and DFS for each graph representations.	**3**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	15 marks
CA Exams (1 number)	:	30 marks
Assignment/Project/Case study etc.	:	30 marks
Total	:	**75 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	2 ½ hours

ix) END SEMESTER EXAMINATION PATTERN

a)	Preliminary work	:	15 marks
b)	Implementing the work/Conducting the experiment	:	20 marks
c)	Performance, result and inference (usage of equipment and troubleshooting):	:	15 marks
d)	Viva voce	:	20 marks
e)	Record	:	5 marks
	Total	**:**	**75 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U28B	MEASUREMENTS AND INSTRUMENTATION LAB	PCC	0	0	3	2	2022

i) PRE-REQUISITE: ES0U10D: Basics of Electrical and Electronics Engineering

ii) COURSE OVERVIEW: The main objective of the course is to expose the students to hands-on experience of various measuring devices and measurements, standardization and calibration of meters, characteristics of transducers.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Experimentally calibrate energy meter, ammeter and voltmeter using various methods.	Apply
CO2	Experimentally measure Power and Energy in single and three phase circuits.	Apply
CO3	Extend the range of the ammeter and voltmeter and measure its resistance.	Understand
CO4	Make use of AC circuits to find the unknown capacitance and frequency	Apply
CO5	Develop the characteristics of various transducers by conducting suitable experiments.	Apply

iv) LIST OF EXPERIMENTS

- Calibration of single- phase energy meter by direct loading.
- Calibration of single- phase energy meter by phantom loading at various power factors.
- Measurement of energy using electronic energy meter.
- Measurement of unknown capacitance and unknown frequency in an AC circuit - 2 session
- Three phase power measurement using one wattmeter and two wattmeter method.
- Characteristics of Thermistor, RTD – 2 sessions.
- Characteristics of LVDT and Load cell – 2 sessions.
- Determination of B-H curve of various specimen.
- Calibration of ammeter using Slide wire potentiometer.
- Calibration of voltmeter using Vernier dial potentiometer.
- Measurement of voltmeter and ammeter resistances using Wheatstone's bridge and Kelvin's double bridge and extension of range of voltmeter and ammeter – 2 sessions.

v) REFERENCES

1) Sawhney A.K., "A course in Electrical and Electronic Measurements & instrumentation", Dhanpat Rai, 10th Edition, 1994.
2) Golding E.W., "Electrical Measurements & Measuring Instruments", AH Wheeler & Company, 5th Edition, 1993.
3) J. B. Gupta, "A course in Electrical & Electronic Measurement & Instrumentation", S K Kataria & Sons, 2008.

vi) COURSE PLAN

Expt.. No.	Contents	No. of hours
I	Calibration of single- phase energy meter by direct loading.	3
II	Calibration of single- phase energy meter by phantom loading at various power factors.	3
III	Measurement of energy using an electronic energy meter.	3
IV	Measurement of unknown capacitance using Schering bridge.	3
V	Measurement of unknown frequency using Wein's bridge.	3
VI	3 phase power measurement using one wattmeter and two wattmeter method.	3
VII	Characteristics of Thermistor.	3
VIII	Characteristics of RTD.	3
IX	Characteristics of LVDT.	3
X	Characteristics of Load cell.	3
XI	Calibration of ammeter using Slide wire potentiometer.	3
XII	Calibration of voltmeter using Vernier dial potentiometer.	3
XIII	Measurement of voltmeter resistances and extension of range using Wheatstone's bridge	3
XIV	Astable and Monostable circuit using 555 IC.	3
	Total Hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	15 marks
CA Exams (1 number)	:	30 marks
Assignment/Project/Case study etc.	:	30 marks
Total	:	**75 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	2 ½ hours

ix) END SEMESTER EXAMINATION PATTERN

f)	Preliminary work	:	15 marks
g)	Implementing the work/Conducting the experiment	:	20 marks
h)	Performance, result and inference (usage of equipment and troubleshooting):	:	15 marks
i)	Viva voce	:	20 marks
j)	Record	:	5 marks
	Total	**:**	**75 marks**

B.TECH S3 MINORS

Basket	Course Code	Course Name	L-T-P	Credits
I	EL0M20I	Electric Machine Fundamentals	3-1-0	4
II	EL0M20J	Introduction to Power Engineering	3-1-0	4
III	EL0M20K	Arduino Platform Interface & C Programming	4-0-0	4
IV	EL0M20L	Basics of Illumination Science and Lighting Design	4-0-0	4

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M20I	ELECTRIC MACHINE FUNDAMENTALS	VAC	3	1	0	4	2022

i) PRE-REQUISITE: PH0U10A: Engineering Physics A, ES0U10D: Basics of Electrical and Electronics Engineering.

ii) COURSE OVERVIEW: The goal of this course is to expose students to the fundamental concepts of DC machines, induction motors and synchronous machines including constructional details, principle of operation, performance and applications. It introduces students to cognitive learning and develops problem solving skills.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the principle of operation and characteristics of DC generators.	Understand
CO2	Select suitable motor for various applications based on speed and torque requirements and compare different types of DC motors.	Apply
CO3	Develop the equivalent circuit and determine the efficiency of transformers	Apply
CO4	Describe principle of operation and different types of three phase and single-phase Induction machines.	Understand
CO5	Discuss the principle of operation of alternators and synchronous motors and to compute regulation of alternators.	Understand

iv) SYLLABUS

DC generators: principle of operation -emf equation-types of excitations - armature reaction, OCC.

Principle of operation of DC motors - torque and speed equations- characteristics- applications of DC shunt, series and compound motors - starters - losses and efficiency – load test.

Transformers – principle of operation – emf equation- phasor diagram- losses and efficiency – OC and SC tests - equivalent circuits - maximum efficiency – all day efficiency – auto transformers.

Three phase induction motors- types - principle of operation – torque slip characteristics- no load and blocked rotor tests - Circle diagram - methods of starting.

Single phase motors- principle of operation - resistance split phase motor – capacitor start motor- stepper motors, universal motors. Synchronous machines: construction– emf equation of alternator – regulation of alternator by emf method - synchronous motors- methods of starting- V curves, synchronous condenser.

v) (a) TEXT BOOKS

1) Bhimbra P. S., “Electric Machines”, Khanna Publishers, 2nd Edition, 2017.

2) Fitzgerald A. E., Kingsley C. and Umans S., "Electric Machinery", McGraw Hill, 6th Edition, 2003.
3) Theodore Wilde, "Electrical Machines, Drives and Power System", Pearson Ed. Asia, 6th Edition, 2013.
4) Kothari D. P., Nagrath I. J., "Electric Machines", Tata McGraw Hill, 5th Edition, 2017.

(b) REFERENCES

1) Gupta J. B., "Theory and Performance of Electrical Machines", S K Kataria & Sons, 14th Edition, 2013.
2) Deshpande M. V., "Electrical Machines", Prentice Hall India, New Delhi, Eastern Economy Edition, 2011.
3) S.K. Bhattacharya, "Electrical Machines", 4th Edition, Tata McGraw-Hill Publishing Company Limited, 2017.
4) M.G. Say, "Performance and Design of Direct Current Machines", CBS publishers, New Delhi, 1993.
5) Ashfaq Husain, Haroon Ashfaq, "Electric Machines", 3rd Edition, Dhanpat Rai and Co., 2016.
6) Clayton A. E. and Hancock N. N., "The Performance and Design of Direct Current Machines", 3rd Edition, CBS Publishers & Distributors, New Delhi, 2004.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**DC Machines**- Principles of electromechanical energy conversion, **DC generators**: principle of operation -emf equation-types of excitations. Separately excited, shunt and series excited DC generators, compound generators. Concept of armature reaction, OCC - simple numerical problems.	**12**
II	**DC motors:** Principle of operation-torque and speed equations-characteristics of DC motors- applications of DC shunt, series and compound motors - concept of starters - losses and efficiency – load test- simple numerical problems.	**12**
III	**Transformers** – principle of operation – emf equation- phasor diagram-losses and efficiency – OC and SC tests - equivalent circuits - efficiency calculations- maximum efficiency – all day efficiency – auto transformers - simple numerical problems	**12**
IV	**Three phase induction motors**- slip ring and squirrel cage types - principle of operation – rotating magnetic field- torque slip characteristics- no load and blocked rotor tests - Circle diagram - methods of starting – star-delta starting, auto transformer starting.	**12**
V	**Single phase motors**- principle of operation of single-phase induction motors – resistance split phase motor – capacitor start motor- stepper motors, universal motors. **Synchronous machines**: construction– emf equation of alternator – regulation of alternator by emf method. Principles of operation of synchronous motors- methods of starting- V curves, synchronous condenser.	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M20J	INTRODUCTION TO POWER ENGINEERING	VAC	3	1	0	4	2022

i) PRE-REQUISITE: ES0U10D: Basics of Electrical and Electronics Engineering.

ii) COURSE OVERVIEW: This course introduces various conventional energy sources. This course also introduces the design of transmission system and distributions system. It also introduces the economics of power generation.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Illustrate various conventional sources of energy generation.	Understand
CO2	Analyse the economics of power generation and power factor improvement.	Analyse
CO3	Design mechanical parameters of a transmission system.	Apply
CO4	Design electrical parameters of a transmission system.	Apply
CO5	Classify different types of ac and dc distribution systems.	Understand

iv) SYLLABUS

Conventional sources: Hydroelectric Power Plants, Steam Power Plants, Diesel Power Plant, Gas Turbine Power Plant, Nuclear Power Plants.

Economics of power generation, Power factor improvement, economics of power factor improvement.

Transmission system - Main components of overhead lines, Corona, Sag.

Electrical design of transmission line - Inductance and capacitance of a single-phase transmission line. and three-phase transmission lines – transposition of lines.

Distribution system - Types of DC distributors, Types of AC distributors, Smart Grid.

v) (a) TEXT BOOKS

1) D P Kothari and I Nagrath, "Power System Engineering," 2nd Edition, Tata McGraw Hills, 2008.

2) Wadhwa, “Electrical Power system”, Wiley Eastern Ltd. 2005.

(b) REFERENCES

1) A.Chakrabarti, ML.Soni, P.V.Gupta, V .S.Bhatnagar, “A text book of Power system Engineering” DhanpatRai, 2000.
2) Grainer J.J, Stevenson W.D, “Power system Analysis”, McGraw Hill.
3) I.J.Nagarath& D.P. Kothari, “Power System Engineering”, TMH Publication.
4) A Stuart Borlase, “Smart Grids, Infrastructure, Technology and Solutions”, CRC Press, 2013.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction and history of power generation, Hydel power plant - Schematic, components and turbines, Steam power plant – Schematic, components and turbines, Schematic and various turbines with diesel and GT power generation, Nuclear power generation.	**12**
II	Important terms associated with power generation such as load factor, load curve, etc,. Significance of power factor in power system, Methods of power factor improvement, Numerical problems on the economics of generation, capacitor value evaluation and economics of power factor improvement	**12**
III	Introduction to transmission systems, Mechanical design of transmission lines- line supports and conductors, Types of insulators, String Efficiency, Methods of improving string efficiency, Numerical problems, Corona - Critical disruptive voltage: Visual Critical Voltage – corona loss, Factor affecting corona and corona loss, Numerical problems on corona, Sag in transmission lines	**12**
IV	Introduction to constants of transmission line, Derivation of inductance and capacitance of a single-phase transmission line, Derivation of Inductance and capacitance of a three-phase transmission line with symmetrical and unsymmetrical spacing, transposition of lines. Numerical problems on inductance, capacitance of transmission lines.	**12**
V	Introduction to distribution system, DC distribution system – various types, Numerical Examples of DC distribution system, AC distribution system – various types, Numerical Examples of DC distribution system. Introduction to smart grid	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M20K	ARDUINO PLATFORM INTERFACE & C PROGRAMMING	VAC	4	0	0	4	2022

i) PRE-REQUISITE: ES0U10E: Programming in C

ii) COURSE OVERVIEW: The goal of this course is to expose the students to learn how the Arduino platform works in terms of the physical board and libraries and the IDE (Integrated Development Environment). The course will cover programming the Arduino using C code and accessing the pins on the board via the software to control external devices. This course also provides an Introduction to the shields used to extend the capabilities of an Arduino based system.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the composition of the Arduino development board and Arduino IDE.	Understand
CO2	Discuss the basic Embedded C programming used in Arduino.	Understand
CO3	Describe the Debugging process and wiring of various electrical circuits on Breadboard.	Apply
CO4	Interpret the Interfacing of various sensors and actuators.	Understand
CO5	Explain the shields used to extend the capabilities of an Arduino based system.	Understand

iv) SYLLABUS

Arduino platform – Arduino Board, Direct programming, Arduino Schematics, Arduino IDE, Compiling Code, Arduino Shields and library, Arduino basic set up

C Programming – Variables, Operators, Conditionals, Loops, Functions, Global Variables.

Debugging, Debug Environments, Debug via Serial, UART Protocol, UART Synchronization, UART Parity and stop , Serial on Arduino, Reading from Serial, Electrical circuits - Electrical properties/

Sensors- Resistive Sensors- Actuators - Analog Actuators-Pulse Width Modulation - Making Sounds Arduino libraries - EEPROM-Masking – I2C Communication.

Arduino Shields – Ethernet Shield – Ethernet library – Client examples – Ethernet server – WiFi Shield.

(a) TEXT BOOKS

1) Banzi Massimo, “Getting Started with Arduino: The Open Source”, Shroff Publishers and Distributors Pvt. Ltd. ,3rd Edition, 2015.
2) Ashwin Pajankar, “ARDUINO Made Simple”, BPB Publication, 1st Edition, January 2018.

3) Michael Margolis, "Arduino Cookbook", O'Reily Publication, 2nd Edition, December 2011.

(b) REFERENCES

1) Jeremy Blum, "Exploring Arduino: Tools and Techniques for Engineering Wizardry", Wiley Publications, 1st Edition, 2013.
2) John Nussey, "Arduino for Dummies", 2nd Edition, Kindle.
3) Mark Geddes, "Arduino Project Handbook: 25 practical projects to get you started",1st Edition, 2016.

v) COURSE PLAN

Module	Contents	No. of hours
I	Arduino platform – Arduino Board, Direct programming, Arduino Schematics, Arduino IDE, Compiling Code, Arduino Shields and library, Arduino basic set up	**12**
II	C Programming – Variables, Operators, Conditionals, Loops, Functions, Global Variables. Arduino tool chain, Cross compilation, Arduino sketches, Classes, Sketch structure, Pins, Input and output, Blink example	**12**
III	Debugging, Debug Environments, Debug via Serial, UART Protocol, UART Synchronization, UART Parity and stop, Serial on Arduino, Reading from Serial Electrical circuits- Electrical properties -Ohm's Law-Electrical Components-Diodes –Switches, Potentiometers, Push Button -Wiring	**12**
IV	Sensors- Resistive Sensors- Actuators - Analog Actuators-Pulse Width Modulation - Making Sounds Arduino libraries - EEPROM-Masking – I2C Communication – I2C Transactions – Sending bits – Wire library – Master Communication – Slave operation.	**12**
V	Arduino Shields – Ethernet Shield – Ethernet library – Client examples – Ethernet server – WiFi Shield.	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M20L	BASICS OF ILLUMINATION SCIENCE AND LIGHTING DESIGN	VAC	4	0	0	4	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: The main goal of this course is to introduce basics of illumination technology and lighting design aspects to students. Also enable them to understand lighting design considerations for interior and exterior applications. This course will impart knowledge about energy efficient lighting and get detailed insight of indoor and outdoor illumination system components and its controls.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Compare different types of lighting schemes; different artificial light sources.	Understand
CO2	Apply Laws of Illumination to calculate the illuminance level at a point.	Apply
CO3	Select lamps and luminaires for specific application.	Apply
CO4	Design interior and exterior lighting systems.	Apply
CO5	Select suitable control methods for lighting and demonstrate various features of aesthetic lighting.	Apply

iv) SYLLABUS

Light, sight & colour - Sources of light - Methods of artificial lighting - Lighting schemes - Lighting systems - Quality of lighting - Good Practices in Lighting

Measurement of light - Lamp efficiency - Concept of polar curve - Laws of illumination - Lighting calculations - Photometric data sheets - National Lighting Code 2010

The balance of lighting in indoor and outdoor workplaces – Daylight - Task lighting - Glare - Specular reflection - Sunlight shading - Light sources - Introduction to LED Lighting

Design of Interior and Outdoor lighting- Indian Standards - Selection of appropriate lamps - Calculation and Layout of luminaires.

Features of Interior Lighting - Lighting Control - Daylight sensors and occupancy sensors - Features of Aesthetic Lighting - Computer Aided Lighting design.

v) (a) TEXT BOOKS

1) D.C. Pritchard, “Lighting”, Routledge, 6th Edition, 2014

2) Jack L. Lindsey, FIES, Scott C. Dunning, "Applied Illumination Engineering", Fairmont Press, 3rd Edition, 2015.

(b) REFERENCES

1) M. K. Giridharan, "Electrical Systems Design", I K International Publishers, New Delhi, 2nd Edition, 2016.
2) Rüdiger Ganslandt, Harald Hofmann, "Handbook of Lighting", Erco Edition, 1997.
3) John Matthews, "Introduction to the Design and Analysis of Building Electrical Systems", Springer, 1993.
4) "SLL Lighting Handbook", CIBSE, 2018.
5) M.A. Cayless, "Lamps and Lighting", Routledge, 1996.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Light, sight & colour:** Sources of light - Day light, artificial light sources - energy radiation, visible spectrum of radiation. Incandescence, dependence of light output on temperature. Perception of light and colour - optical system of human eye - eye as visual processor. Quality of lighting- visual comfort, visual performance, safety, shadow, glare, reflection, colour rendering, colour appearance and stroboscopic effect **Methods of artificial lighting:** Lighting systems- direct, indirect, semi direct, semi indirect, Lighting schemes-ambient, task, accent lighting. General and localised- Artificial lighting as substitute to natural light. Good Practices in Lighting.	**11**
II	**Measurement of light:** Luminous flux, Luminous intensity, Lumen, Illuminance, Luminance, Candle power- M.H.C.P, M.S.C.P - Lamp efficiency. Concept of polar curve - Laws of illumination - Inverse square law and Lambert's Cosine law. Lighting calculations- Point by point method and Average Lumen method. Photometric data sheets- Finding Lux using Lux meters - Indian standard recommendation and standard practices for illumination levels in various areas – National Lighting Code 2010.	**11**
III	**Balance of lighting in indoor and outdoor workplaces:** Daylight- Room brightness- Task lighting - Glare - Specular reflection - Balance of daylight and electrical light- Colour appearance of lamps - Sunlight shading. **Light sources:** Different types of lamps and its evolution - Incandescent lamp - Fluorescent Lamp, Compact Fluorescent Lamp (CFL). Sodium Vapour lamp, Metal halide Lamps, Argon Neon lamps for signboards. Introduction to LED Lighting.	**10**

IV	**Design of Interior Lighting:** Interior Lighting Design Standards - Maintenance factor, Uniformity ratio, Direct ratio, Coefficients of utilisation and factors affecting it - Illumination required for various work planes, Space to mounting height ratio (SHR) - DLOR and ULOR - Selection of lamp and luminance - Selection of utilisation factor, reflection factor and maintenance factor - Calculation of wattage of each lamp and no of lamps needed - Layout of luminaires. **Design of Outdoor Lighting:** Street Lighting design- Flood lighting- Beam angle- Selection of lamp and projector	**15**
V	**Special features of Interior Lighting:** Entrance, corridors, industrial buildings. Introduction to Lighting Controls - Methods of control, Selection of Lighting Controls - Dimmers for various lamps - Daylight sensors and occupancy sensors. **Special Features of Aesthetic Lighting:** Monument and statue lighting, Sports lighting, Hospital lighting, Auditorium lighting, Facade Lighting, Retail Lighting. **Computer Aided Lighting design:** Role of computers in design - Softwares used for lighting design.	**13**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

SEMESTER IV

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0U20C	PROBABILITY, RANDOM PROCESSES AND NUMERICAL METHODS	BSC	3	1	0	4	2022

i) **PRE-REQUISITE:** MA0U10B: Vector Calculus, Differential Equations and Transforms.

ii) **COURSE OVERVIEW**: This course introduces students to the modern theory of probability and statistics, covering important models of random variables and analysis of random processes using appropriate time and frequency domain tools. A brief course in numerical methods familiarizes students with some basic numerical techniques for finding roots of equations, evaluating definite integrals solving systems of linear equations and solving ordinary differential equations which are especially useful when analytical solutions are hard to find.

iii) **COURSE OUTCOMES**

After the completion of the course the student will be able to:

CO1	Identify the different discrete random experiments and find the probabilities of their occurrence.	Apply
CO2	Identify the different continuous random experiments and find the probabilities of their occurrence.	Apply
CO3	Examine random processes using autocorrelation, power spectrum and Poisson process model as appropriate.	Apply
CO4	Find roots of equations, definite integrals and interpolating polynomials on given numerical data using standard numerical techniques.	Apply
CO5	Apply standard numerical techniques for solving systems of equations, fitting curves on given numerical data and solving ordinary differential equations.	Apply

iv) **SYLLABUS**

Discrete random variables and their probability distributions, Binomial distribution, Poisson distribution, Discrete bivariate distributions, Expectation - multiple random variables.

Continuous random variables and their probability distributions - Uniform, exponential and normal distributions, Continuous bivariate distributions, Expectation-multiple random variables, i.i.d random variables and Central limit theorem.

Random processes and its classification, wide sense stationary (WSS) processes, power spectral density of WSS processes, Poisson process.

Roots of equations- Newton-Raphson, regula falsi methods. Interpolation-finite differences, Newton’s forward and backward formula, Newton’s divided difference method, Lagrange’s method. Numerical integration.

Solution of linear systems - Gauss-Siedal and Jacobi iteration methods. Curve fitting-method of least squares, Solution of ordinary differential equations-Euler and Classical Runge-Kutta method of second and fourth order, Adams- Moulton predictor-correction method.

v) (a) TEXT BOOKS

1) Jay L. Devore, Probability and Statistics for Engineering and the Sciences,8th Edition, Cengage, 2012.
2) Oliver C. Ibe, Fundamentals of Applied Probability and Random Processes, Elsevier, 2005.
3) Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2016.

(b) REFERENCES

1) Hossein Pishro-Nik, "Introduction to Probability, Statistics and Random Processes, Kappa Research", 2014 (Also available online at www.probabilitycourse.com).
2) V. Sundarapandian, "Probability, Statistics and Queueing theory", PHI Learning, 2009.
3) Gubner, "Probability and Random Processes for Electrical and Computer Engineers", Cambridge University Press, 2006.
4) B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 36th Edition, 2010.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Discrete random variables and probability distributions, expected value, mean and variance (discrete). Binomial distribution - mean, variance, Poisson distribution - mean, variance, Poisson approximation to binomial, Discrete bivariate distributions, marginal distributions, Independence of random variables (discrete), Expected values.	**12**
II	Continuous random variables and probability distributions, expected value, mean and variance (continuous). Uniform, exponential and normal distributions, mean and variance of these distributions, Continuous bivariate distributions, marginal distributions, Independent random variables, Expected values, Central limit theorem.	**12**
III	Random process -definition and classification, mean, autocorrelation, WSS processes its autocorrelation function and properties, Power spectral density. Poisson process, inter-distribution of arrival time, combination of independent Poisson processes (merging) and subdivision (splitting) of Poisson processes.	**12**
IV	Errors in numerical computation-round-off, truncation and relative error, Solution of equations – Newton-Raphson method and Regula-Falsi method. Interpolation - finite differences - Numerical Integration - Trapezoidal rule and Simpson's 1/3rd rule with proof (derivation of other methods/ formulae not required in this module).	**12**

V	Solution of linear systems-Gauss-Siedal method, Jacobi iteration method Curve-fitting-fitting straight lines and parabolas to pairs of data points using method of least squares. Linear Correlation-Basic ideas of Multiple regression. Solution of ODE-Euler, Modified Euler and Classical Runge - Kutta methods of second and fourth order, Adams-Moulton predictor-corrector methods.	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U20D	COMPUTER ORGANIZATION AND ARCHITECTURE	PCC	3	1	0	4	2022

i) PRE-REQUISITE: Nil.

ii) COURSE OVERVIEW: The aim of this course is to enable students to understand the fundamental architecture of a digital computer. Study of Computer Organization and Architecture is essential to understand the hardware behind the code and its execution at physical level by interacting with existing memory and I/O structure. It helps the learners to understand the fundamentals about computer system design so that they can extend the features of computer organization to detect and solve problems occurring in computer architecture.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Infer the relevance of basic components, I/O organization and pipelining schemes in a digital computer.	Understand
CO2	Explain the types of memory systems and mapping functions used in memory systems.	Understand
CO3	Demonstrate the control signals required for the execution of a given instruction.	Understand
CO4	Illustrate the design of Arithmetic Logic Unit and explain the usage of registers in it, the implementation aspects of arithmetic algorithms in a digital computer.	Understand
CO5	Develop the control logic for a given arithmetic problem.	Apply

iv) SYLLABUS

Fundamental building blocks and functional units of a computer. Memory locations and addresses. Execution phases of an instruction. Register transfer logic: inter register transfer – arithmetic, logic and shift micro-operations.
Processor logic design: - Design of arithmetic circuit, logic circuit, arithmetic logic unit, shifter, accumulator.
Arithmetic Algorithms. Pipelining: Basic principles, classification of pipeline processors, instruction and arithmetic pipelines, hazard detection and resolution.
Design of the processing unit – how arithmetic and logic operations are performed. Design of the control unit – hardwired and microprogrammed control.
I/O organization – interrupts, DMA, different interface standards. Memory Subsystem – different types. Virtual Lab using simulation software.

v) (a) TEXT BOOKS

1) Hamacher C., Z. Vranesic and S. Zaky, "Computer Organization", 5th Edition, McGraw Hill, 2011.
2) M. Morris Mano, "Digital Logic & Computer Design", 4th Edition, Pearson Education, 2013.
3) M. Morris Mano, "Computer System Architecture", 3rd Edition, Pearson Education, 2007.

(b) REFERENCES

1) Robert Bausiere, Francis Labrique, Guy Seguier Patterson D.A. and J. L. Hennessy, "Computer Organization and Design", 5th Edition, Morgan Kaufmann Publishers, 2013.
2) William Stallings, "Computer Organization and Architecture: Designing for Performance", Pearson, 9th Edition, 2013.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Basic Structure of computers – functional units - basic operational concepts - bus structures. Memory locations and addresses - memory operations, Instructions and instruction sequencing, addressing modes. Basic processing unit – fundamental concepts – instruction cycle – execution of a complete instruction -single bus and multiple bus organization.	**12**
II	Register transfer logic: inter register transfer – arithmetic, logic and shift micro-operations. Processor logic design: - processor organization – Arithmetic logic unit - design of arithmetic circuit - design of logic circuit – Design of arithmetic logic unit - status register – design of shifter - processor unit – design of accumulator.	**12**
III	Arithmetic algorithms: Algorithms for multiplication and division (restoring method) of binary numbers. Array multiplier, Booth's multiplication algorithm. Pipelining: Basic principles, classification of pipeline processors, instruction and arithmetic pipelines (Design examples not required), hazard detection and resolution.	**12**
IV	Control Logic Design: Control organization – Hardwired control-microprogram control – control of processor unit – Microprogram sequencer, micro programmed CPU organization -horizontal and vertical micro instructions.	**11**
V	I/O organization: accessing of I/O devices – interrupts, interrupt hardware - Direct memory access. Memory system: basic concepts – semiconductor RAMs. Memory system considerations – ROMs, Content addressable memory, cache memories - mapping functions. Virtual Lab using simulation software: Design of ALU, Memory, CPU	**13**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U20E	OBJECT ORIENTED PROGRAMMING USING JAVA	PCC	3	1	0	4	2022

i) PRE-REQUISITE: ES0U10E: Programming in C.

ii) COURSE OVERVIEW: The purpose of this course is to enable learners to solve problems by breaking it down to object level while designing software and to implement it using Java. This course covers Object Oriented Principles, Object Oriented Programming in Java, Inheritance, Exception handling, Event handling, multithreaded programming and working with window-based graphics. This course helps the learners to develop Desktop GUI Applications, Mobile applications, Enterprise Applications, Scientific Applications and Web based Applications.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Develop Java programs using the object-oriented concepts - classes, objects, constructors, data hiding, inheritance and polymorphism	Apply
CO 2	Utilise datatypes, operators, control statements, built in packages & interfaces, Input/ Output Streams and Files in Java to develop programs.	Apply
CO 3	Illustrate how robust programs can be written in Java using exception handling mechanism.	Understand
CO 4	Develop application programs in Java using multithreading and database connectivity.	Apply
CO 5	Develop Graphical User Interface based application programs by utilizing event handling features and Swing in Java.	Apply

iv) SYLLABUS

Basic concepts of Object-Oriented Programming, Application Programming interface, Simple Java Program, Java Virtual Machine, Primitive Data types.

Core Java Fundamentals, Object Oriented Programming in Java, Introduction to Methods, Inheritance.

Packages and Interfaces, Managing errors and Exceptions, Managing Input/Output Files.

Java Library Array List class, Accessing a Collection via an Iterator, Event handling Multithreaded Programming.

Graphical User Interface and Database support of Java - Event Handling in Swings, Swing Layout Managers, Exploring Swings, Creating and Executing Queries.

v) (a) TEXT BOOKS

1) Herbert Schildt, Java: The Complete Reference, 8th Edition, Tata McGraw Hill, 2011.
2) Balagurusamy E., Programming JAVA a Primer, 5th Edition, McGraw Hill, 2014.
3) Paul Deitel, Harvey Deitel, Java How to Program, Early Objects 11th Edition, Pearson, 2018.

(b) REFERENCES

1) Y. Daniel Liang, Introduction to Java Programming, 7th Edition, Pearson, 2013.
2) Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press, 2008.
3) Flanagan D., Java in A Nutshell, 5th Edition, O'Reilly, 2005.
4) Barclay K., J. Savage, Object Oriented Design with UML and Java, Elsevier, 2004.
5) Sierra K., Head First Java, 2nd Edition, O'Reilly, 2005.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction:** Basic concepts of Object-Oriented Programming- Objects and classes- Data Abstraction and Encapsulation, Inheritance, Polymorphism. Benefits of OOP- Application. Introduction to Java- Java Features, Difference between Java and C++. Java Environment- Developer Kit. Application Programming interface – Runtime Environment. Simple Java Program, Java Program Structure, Java Tokens, Java Statements. Implementing A Java program- creating, compiling and running. Java Virtual Machine, Java compiler, Java applet, Java Buzzwords Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class.	**12**
II	**Core Java Fundamentals:** Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence. Control Statements - Selection Statements, Iteration Statements and Jump Statements. Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Object Reference, Introduction to Methods, Constructors, this Keyword, Method Overloading, Nesting of Methods	**13**

	Inheritance- Extending a class, Overriding methods, Final variables and methods, Final classes, Finalizer methods, Abstract methods and classes. Methods with Varags, Visibility Control.	
III	**More features of Java:** Packages and Interfaces- Defining interfaces, Extending Interfaces, Implementing and accessing interfaces. Packages- Using system packages, Creating, Accessing and using a Package, adding a class to a package, hiding classes Managing errors and Exceptions- Types of errors, Exceptions, Multiple catch statements, Using Finally statement, Throwing exceptions. Using exceptions for debugging. Managing Input/Output Files – Concept of streams, Stream classes, Working with files, Random Access Files, Interactive Input and Output.	**12**
IV	**Advanced features of Java:** Java Library - String Handling – String Constructors, String Length, Special String Operations - Character Extraction, String Comparison, Searching Strings, Modifying Strings, using valueOf(), Comparison of String Buffer and String. Collections framework - Collections overview, Collections Interfaces- Collection Interface, List Interface. Collections Class – Array List class. Accessing a Collection via an Iterator. Event handling - Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Model. Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads	**11**
V	**Graphical User Interface and Database support of Java:** Swings fundamentals - Swing Key Features, Model View Controller (MVC), Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings – JFrame, JLabel, The Swing Buttons, JTextField. Java DataBase Connectivity (JDBC) - JDBC overview, Creating and Executing Queries – create table, delete, insert, select.	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U20F	DIGITAL ELECTRONICS	PCC	3	1	0	4	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: The Goal of this course is to expose the students to acquire the basic knowledge of digital logic levels and application of knowledge to understand the Digital Electronic Circuits. Students will be able to analyse, design and Implement Combinational and Sequential Circuits. This course also gives an introduction to students on designing Digital circuits using VHDL.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Classify various number systems, binary codes and formulate digital functions using Boolean algebra.	Apply
CO2	Construct various Combinational logic circuits.	Apply
CO3	Model various Sequential logic circuits.	Apply
CO4	Compare the operation of various analog to digital and digital to analog conversion circuits.	Understand
CO5	Explain the basic concepts of Programmable Logic devices and VHDL.	Understand

iv) SYLLABUS

Introduction to various number representations –Signed numbers- representation, addition and subtraction, Fixed point and floating-point representation. Error detection and correction, A/D and D/A converter,Comparison of CMOS and TTL performance of Logic gates

Digital Logic Families -Logic Gates-Boolean Algebra - De Morgan's Theorem - Karnaugh Map.

Combinational Logic Design - Half Adder and Full Adder, Half Subtractor and Full Subtractor, Full Adder, Parity Generators, Encoder, decoder, Multiplexer, Demultiplexer.

Sequential Circuits- Counters-Asynchronous and synchronous, Ring and Johnson counters - Mealy/Moore models state diagram, state table.

Programmable Logic Devices - ROM, PLA, PAL, FPGA - VHDL Coding.

v) (a) TEXT BOOKS

1) Thomas L. Floyd, "Digital Fundamentals", Pearson Education, 10th Edition, 2011.
2) Roth C. H., Kimney L. L., "Fundamentals of Logic Design", Cengage Learning, 7th Edition 2013.
3) Mano M. M., "Logic and Computer Design Fundamentals", Pearson Education, 4th Edition, 2008.
4) Salivahanan S., Arivazhagan S., "Digital Electronics", Vikas Publishers, 5th Edition 2018.
5) Roy Chaudari, "Linear Integrated Circuits", New Age International Publications,5th Edition,2018

(b) REFERENCES

1) Ronald J. Tossi, Neal S. Widmer and Gregory L. Moss, "Digital Systems: Principles and Applications", Pearson Education, 10th Edition, 2011.
2) John F. Wakerly, "Digital Design: Principles and Practices", Pearson, 4th Edition ,2005.
3) Anand Kumar A., "Fundamentals of Digital Circuits", Prentice Hall of India, 4th Edition, 2016.
4) Donald P. Leach, Albert Paul Malvino, "Digital Principles and Applications", Tata Mc Graw Hill, 8th Edition, 2014.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Number Systems and Codes: Binary, Octal and hexadecimal conversions- ASCII code, Excess -3 code, Gray code, BCD, Error detection codes-Parity method. Signed numbers-representation, addition and subtraction, Fixed point and floating-point representation. Logic gates, Universal gates, TTL and CMOS logic families-Internal diagram of TTL NAND gate and CMOS NOR gate. Comparison of CMOS and TTL performance	**11**
II	Boolean Laws and theorems, Sum of Products method, Product of Sum method – K map representation and simplification (up to four variables) - Pairs, Quads, Octets, don't care conditions. Combinational circuits: Adders -Full adder and half adder, Subtractors- half subtractor and full subtractor, 4-bit parallel binary adder/subtractor, Carry Look ahead adders.	**13**
III	Comparators, Parity generators and checkers, Encoders, Decoders, BCD to seven segment decoder, Code converters, Multiplexers, Demultiplexers, Architecture of Arithmetic Logic Units (Block schematic only).	**11**
IV	Flip-Flops - SR, JK, D and T, JK Master Slave Flip-flop, Preset and clear inputs, Conversion of flip-flops. Registers -SISO, SIPO, PISO, PIPO. Up/Down Counters: Asynchronous Counters – Modulus of a counter – Mod-N counters, Ring counter, Johnson Counter, Synchronous counters- Design of Synchronous counters.	**13**
V	State Machines: State transition diagram, Moore and Mealy Machines, Digital to Analog converter , Analog to Digital Converter Programmable Logic Devices - PAL, PLA, FPGA (basic concepts) Introduction to Verilog- Implementation of logic gates and combinational circuits	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U20A	DESIGN ENGINEERING	ESC	2	0	0	2	2022

i) PRE-REQUISITE: Nil.

ii) COURSE OVERVIEW: The goal of this course is to expose the students to the fundamental principles of design engineering. Students are expected to apply design thinking in learning, which is very important and relevant for today. The course also focuses on familiarizing the students with the aesthetics, ergonomics and sustainability factors in designs and practice professional ethics while designing.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Demonstrate the different stages involved in design engineering process	Understand
CO2	Compose a problem statement with design objectives taking into account the customer requirements, design constraints and functionality.	Create
CO3	Develop innovative solutions to the Design problem through brainstorming and ideation.	Apply
CO4	Identify the concepts of Biomimicry, Aesthetics and Ergonomic factors in designs to add more value to it.	Apply
CO5	Apply the Design communication tools to model an idea.	Apply
CO6	Apply different segments of knowledge in engineering in order to develop innovative, reliable, sustainable and economically viable designs.	Apply

iv) SYLLABUS

Introduction to engineering design. Generate a design through the Design Process stages.

Design Thinking Approach, Design Thinking Process Stages: empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent- Convergent Questioning.

Ideation in Design Thinking - Brainstorming sessions. Design Engineering Concepts. Application of Biomimicry, Aesthetics and Ergonomics in Design. Design for X – Quality, Reliability and Sustainability.

Design Communication, Data Representation, Communicating Designs Orally, Graphically and in Writing. Modelling, Prototyping and Proof of Concept.

Value Engineering, Concurrent and Reverse Engineering. Expediency, Economics and Environment in Design Engineering. Design Rights. Ethics in Design.

v) (a) TEXT BOOKS

1) Yousef Haik, Sangarappillai Sivaloganathan, Tamer M. Shahin, "Engineering Design Process", 3rd Edition, Cengage Learning, 2017.
2) Linda C. Schmidt, George Dieter, "Engineering Design", McGraw Hill Education; 4th Edition, 2017.
3) Pavan Soni, "Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-Solving", Penguin Random House India Private Limited, 2022.
4) Voland, G., "Engineering by Design", Pearson India, 2nd Edition, 2014.

(b) REFERENCES

1) Clive L Dym, Engineering Design: "A Project Based Introduction", 4th Edition, John Wiley & Sons, New York 2009.
2) Tim Brown, "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation," Harper Business; Revised, Updated Edition, 2019.
3) Don Norman, "The Design of Everyday Things", Basic Books; 2nd Edition, 2013.
4) Dominique Forest, "Art of Things: Product Design Since 1945", Abbeville Press Inc.,U.S.; Special Edition, 2014.
5) Javier Abarca, Al Bedard, et al, "Introductory Engineering Design – A Projects-Based Approach", 3rd Edition, Regents of the University of Colorado, 2000.
6) Nigel Cross, "Design Thinking: Understanding How Designers Think and Work", Berg Publishers, 2011, 1st Edition, ISBN: 978-1847886361.
7) Pahl, G., Beitz, W., Feldhusen, J., Grote, K. H., "Engineering Design: A Systematic Approach", Springer 2007, 3rd Edition, ISBN 978-1-84628-319-2.
8) George Dieter, "Engineering Design: A Materials and Processing Approach", McGraw-Hill Education / Asia; 3rd Edition, 2000.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Design Process: - Defining a Design Process-: Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.	3
	Practical Exercise: Need Identification. How to define a Problem Statement. Present an idea using the stages of Design Process.	3
II	Design Thinking Approach: -Introduction to Design Thinking, Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning. Empathize – User Persona, Day in the Life Technique, identify customer requirements using Morphological Chart and set design objectives. Define - Identifying and formulating a Problem Statement -Fish Bone Diagram	4

	Practical Exercise: User Persona Chart. Morphological Chart.	**2**
III	Ideate - Brainstorming sessions, and ideation using Random word technique, SCAMPER. Design Engineering Concepts: Modular Design and Life Cycle Design Approaches. Application of Biomimicry, Aesthetics and Ergonomics in Design. Design for X – Quality, Reliability and Sustainability.	**4**
	Practical Exercise: Brainstorming, 6-3-5 technique, Random Word Technique.	**2**
IV	Design Communication: - Data Representation, Communicating Designs Orally, Graphically and in Writing. Modelling, Prototyping and Proof of Concept. Awareness of Basic tools of Design like – Autodesk, CATIA, MATLAB.	**3**
	Practical Exercise: Communicating Designs Graphically.	**4**
V	Value Engineering, Concurrent Engineering, and Reverse Engineering in Design. Expediency, Economics and Environment in Design Engineering: - Design for Production, Use, and Sustainability. Engineering Economics in Design. Design Rights. Ethics in Design.	**3**
	Practical Exercise: Case Studies.	**2**
	Total hours	**30**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
NC0U20C	UNVERSAL HUMAN VALUES	MNC	2	0	0	-	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

The objectives of the course are:

1. To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS'.
2. To facilitate the development of a Holistic perspective among students towards life and profession leading towards a value-based living.
3. To help the students to have ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with nature.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain more of themselves and their surroundings (family, society, nature).	Understand
CO2	Show more responsibility in life to handle problems with sustainable solutions keeping human relationships and human nature in mind.	Understand
CO3	Demonstrate more Commitment towards human values, human relationship and human society.	Understand
CO4	Apply what they have learnt about Harmony to their real life.	Apply

iv) SYLLABUS

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

Purpose and motivation for the course, recapitulation from Universal Human Values-I

Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration

Continuous Happiness and Prosperity- A look at basic Human Aspirations

Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority

Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario

Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

(Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking)

Module 2: Understanding Harmony in the Human Being - Harmony in Myself!

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'

Understanding the needs of Self ('I') and 'Body' - happiness and physical facility

Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)

Understanding the characteristics and activities of 'I' and harmony in 'I'

Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail

Programs to ensure Sanyam and Health.

(Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease)

Module 3: Understanding Harmony in the Family and Society- Harmony in Human Relationship

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness;

Trust and Respect as the foundational values of relationship

Understanding the meaning of Trust; Difference between intention and competence

Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship

Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals

Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

(Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives)

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

Understanding the harmony in the Nature

Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature

Understanding Existence as Co-existence of mutually interacting units in all pervasive space

Holistic perception of harmony at all levels of existence.

Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

Natural acceptance of human values

Definitiveness of Ethical Human Conduct

Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order

Competence in professional ethics:

a. Ability to utilize the professional competence for augmenting universal human order

b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems,

c. Ability to identify and develop appropriate technologies and management patterns for above production systems.

Case studies of typical holistic technologies, management models and production systems

Strategy for transition from the present state to Universal Human Order

a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers.

b. At the level of society: as mutually enriching institutions and organizations Sum up.

(Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg.To discuss the conduct as an engineer or scientist etc.).

v) (a) TEXT BOOKS

1) Gaur P.R, Asthana R, Bagaria G.P, "Human Values and Professional Ethics", (2nd revised Edition) Excel Books, New Delhi, 2019
2) Tripathi A. N, "Human Values", New Age Intl. Publishers, New Delhi, 2004.

(b) REFERENCES

1) Gaur R.R, Sangal R, Bagaria G P, "A Foundation Course in Human Values and Professional Ethics (Teacher Manual)", Excel Books, 1st Edition, 2013.
2) Nagaraj A, Jeevan Vidya Prakashan, Amarkantak, "Jeevan Vidya: Ek Parichaya", 1999.
3) Mohandas K Gandhi, "The story of my Experiments with Truth", Fingerprint, 2009.
4) Cecile Andrews, "Slow is Beautiful", New Society Publishers, 2006.
5) Kumarappa J C, "Economy of Permanence", Sarva Seva Sangh Prakashan, 2017.

vi) MODE OF CONDUCT OF COURSE

Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.

Tutorial hours are to be used for practice sessions. In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration. Scenarios may be used to initiate discussion. Depending on the nature of topics, worksheets, home assignment and/or activity are included.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses.

This course is to be taught by faculty from every teaching department, including HSS faculty.

Teacher preparation with a minimum exposure to at least one 8-day FDP on Universal Human Values is deemed essential.

vii) COURSE PLAN

Each Lecture hour and Tutorial hour can be structured as given below for the efficient delivery of the course content.

MODULE	CONTENT	No.of Hours (L/T)
1	Understanding Value Education	L1
	Self-Exploration as the process for Value Education	L2
	Sharing about oneself	T1
	Understanding Happiness and Prosperity-the Basic Human Aspirations	L3
	Right Understanding, Relationship, Physical Facility	L4
	Exploring Human Consciousness	T2
	Happiness and Prosperity- Current Scenario	L5
	Method to Fulfill the Basic Human Aspirations	L6
	Exploring Natural Acceptance	T3
2	Understanding Human Being as the Co-existence of the Self and Body	L7
	Distinguishing between the needs of the Self and the Body	L8
	Exploring the difference of needs of the Self and the Body	T4
	The Body as an Instrument of the Self	L9
	Understanding Harmony in the Self	L10
	Exploring Sources of Imagination in the Self	T5
	Harmony of the Self with the Body	L11
	Programme to ensure Self-Regulation and Health	L12
	Exploring Harmony of Self with the Body	T6
3	Harmony in the Family-the Basic unit of Human Interaction	L13
	Values in the Human-to-Human Relationship	L14
	'Trust' – the foundation Value in Relationship	L15
	Exploring the feeling of Trust	T7
	'Respect'- as the Right Evaluation	L16
	Exploring the feeling of Respect	T8
	Understanding Harmony in the Society	L17
	Vision for the Universal Human Order	L18
	Exploring Systems to fulfill Human Goal	T9
4	Understanding Harmony in the Nature	L19
	Interconnectedness, self-regulation and Mutual Fulfillment among the four orders of Nature	L20
	Exploring the four orders of Nature	T10
	Realizing Existence as Co-Existence at all Levels	L21
	The Holistic Perception of Harmony in Existence	L22
	Exploring Co-Existence in Existence	T11
5	Natural Acceptance of Human Values	L23
	Definitiveness of (Ethical) Human Conduct	L24

	Exploring Ethical Human Conduct	T12
	A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order	L25
	Competence in Professional Ethics	L26
	Exploring Humanistic Models in Education	T13
	Holistic Technologies, Production Systems and Management-Models - Typical Case Studies	L27
	Strategies for Transition towards Value –based Life and Profession	L28
	Exploring Steps of Transition towards Universal Human Order	T14

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	15 marks
Assignment/Project/Case study etc.	:	20 marks Self-Assessment - 5 marks Peer Assessment - 5 Marks Peer Assessment can be done on group-wise basis by dividing the class into suitable groups
Total	:	**50 marks** Two Continuous Assessment Tests of 15 marks each, average of which can be taken as final marks. Tests may be conducted as written examination/quiz/viva –voce.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2U28C	OBJECT ORIENTED PROGRAMMING LAB (IN JAVA)	PCC	0	0	3	2	2022

i) PRE-REQUISITE: ES0U10E: Programming in C.

ii) COURSE OVERVIEW: The aim of the course is to provide hands-on experience to the learners on various object-oriented concepts in Java Programming. This course helps the learners to enhance the capability to design and implement various Java applications for real world problems.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Apply the Object-Oriented concepts - constructors, inheritance, method overloading & overriding and polymorphism in Java	Apply
CO2	Develop programs in Java which use datatypes, operators, control statements, built in packages & interfaces, Input/Output streams and Files	Apply
CO3	Develop robust application programs in Java using exception handling	Apply
CO4	Develop application programs in Java using multithreading and database connectivity	Apply
CO5	Develop Graphical User Interface based application programs by utilizing event handling features and Swing in Java	Apply

iv) SYLLABUS

Classes-Objects, Constructors, Data Types, Operators, Control statements, Polymorphism, Interfaces, I/O, File operations, Multithreading, Exception Handling, GUI based application programs-Swing, Database Connectivity, Searching, Sorting.

v) REFERENCES

1) Herbert Schildt, “Java: The Complete Reference”, 8th Edition, Tata McGraw Hill, 2011.
2) Balagurusamy E., “Programming JAVA a Primer”, 5th Edition, McGraw Hill, 2014.
3) Sierra K., “Head First Java”, 2nd Edition, O'Reilly, 2005.
4) Y. Daniel Liang, “Introduction to Java Programming”, 7th Edition, Pearson, 2013.
5) Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press, 2008.
6) Flanagan D., Java in a Nutshell, 5th Edition, O'Reilly, 2005.

vi) COURSE PLAN

Experiment No.	List of exercises/Experiments	No. of hours
I	Basic programs using datatypes, operators, and control statements in Java.	**6**
II	Object Oriented Programming Concepts: Problem on the use of constructors, inheritance, method overloading & overriding, polymorphism	**6**
III	File Handling: Problems on performing I/O operations using streams and files	**9**
IV	Exception handling and multi-threading applications.	**6**
V	Graphics Programming and database connectivity	**9**
VI	Standard Searching and Sorting Algorithms using data structures and algorithms	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

(a) Attendance	:	15 marks
(b) Continuous Assessment	:	30 marks
(c) Internal Test	:	30 marks
Total	**:**	**75 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	2 ½ hours

ix) END SEMESTER EXAMINATION PATTERN

a) Preliminary work	:	15 marks
b) Implementing the work/Conducting the experiment	:	20 marks
c) Performance, result and inference (usage of equipment and troubleshooting):	:	15 marks
d) Viva voce	:	20 marks
e) Record	:	5 marks
Total	**:**	**75 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EEL2U28D	DIGITAL ELECTRONICS LAB	PCC	0	0	3	2	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

The goal of this course is to impart practical experience to students by exposing them to various digital ICs, the building block of digital circuits. The course is designed to expose the students to perform analysis and design of various combinational and sequential logic circuits.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Construct digital functions using Boolean Algebra and verify experimentally.	Apply
CO2	Develop combinational logic circuits.	Apply
CO3	Model sequential logic circuits.	Apply
CO4	Develop VHDL programs for combinational circuits	Apply

iv) LIST OF EXPERIMENTS

- Familiarization of Logic circuit
- Realization of SOP and POS using gates
- Design and realization of various combinational circuits – 5 sessions
- Design and realization of various sequential circuits – 6 sessions
- Simulation using VHDL

v) REFERENCES

1) Thomas L. Floyd, “Digital Fundamentals”, Pearson Education, 10th Edition, 2011.
2) Mano M. M., “Logic and Computer Design Fundamentals”, Pearson Education, 4th Edition, 2008.
3) Salivahanan S., Arivazhagan S., “Digital Electronics”, Vikas Publishers, 5th Edition 2018.
4) Roth C. H. and Kimney L. L., “Fundamentals of Logic Design”, Cengage Learning, 7th Edition 2013.

vi) COURSE PLAN

Expt. No.	List of exercises/Experiments	No. of hours
I	Verification & Realisation of De Morgan's theorem.	3
II	Realisation of SOP & POS functions after K-map reduction.	3
III	Half adder & Full adder using gates.	3
IV	4-bit adder/subtractor & BCD adder using IC 7483.	3
V	Realisation of 2-bit comparator using gates and study of four-bit comparator IC 7485.	3
VI	BCD to decimal decoder and BCD to 7-segment decoder & display.	3
VII	Study of multiplexer IC and realization of combinational circuits using multiplexers.	3
VIII	Realization of RS, T, D & JK flip flops using gates.	3
IX	Study of flip flop ICs (7474 & 7476).	3
X	Realisation of ripple up and down counters and modulo-N counter using Flip Flops	3
XI	Study of counter ICs (7490, 7493).	3
XII	Design of synchronous up, down & modulo-N counters.	3
XIII	Realization of 4-bit serial IN serial OUT registers using flip flops.	3
XIV	Study of shift register IC 7495, ring counter and Johnson counter.	3
XV	VHDL implementation of full adder, 4-bit magnitude comparator	3
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

(a) Attendance	:	15 marks
(b) Continuous Assessment	:	30 marks
(c) Internal Test	:	30 marks
Total	**:**	**75 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	2 ½ hours

ix) END SEMESTER EXAMINATION PATTERN

a) Preliminary work	:	15 marks
b) Implementing the work/Conducting the experiment	:	20 marks
c) Performance, result and inference (usage of equipment and troubleshooting):	:	15 marks
d) Viva voce	:	20 marks
e) Record	:	5 marks
Total	**:**	**75 marks**

B.TECH S4 MINORS

Basket	Course Code	Course Name	L-T-P	Credits
I	EL0M20M	Drives and Control	3-1-0	4
II	EL0M20N	Energy Systems	4-0-0	4
III	EL0M20P	Microcontrollers & Embedded Systems	4-0-0	4
IV	EL0M20Q	Electric Power Supply and Distribution Systems	4-0-0	4

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M20M	DRIVES AND CONTROL	VAC	3	1	0	4	2022

i) PRE-REQUISITE: EL0M20A Electrical Machine Fundamentals

ii) COURSE OVERVIEW: The goal of this course is to impart knowledge about the DC and AC motor drives and its applications.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Illustrate the various drive mechanisms and methods.	Understand
CO2	Apply power electronic converters to control the speed of DC motors and induction motors.	Apply
CO3	Develop the motor control schemes for a specific application.	Apply
CO4	Illustrate the various speed control techniques of induction motors.	Understand
CO5	Distinguish different speed control methods of synchronous motor drives	Understand

iv) SYLLABUS

Electrical Drives, Advantages of Electric drives, Choice of Electric Drives and Losses. Dynamics of Electric drives, Rating and Heating of motors: Heating effects, heating and cooling curves, classes of duty, load equalization, environmental factors.

DC motor drives, Basic characteristics, Operating modes, Single phase and three phase-controlled rectifier fed DC drives, Chopper drives. Methods of breaking, speed control of DC motors.

Induction motor drives, types of three phase induction motors, voltage control, current control, slip power recovery schemes, closed loop control and vector control.

Synchronous motors- Speed torque characteristics and torque angle characteristics. Self-control modes. load commutated CSI fed synchronous motor.

Permanent Magnet motors, BLDC and PMSM drive configuration, Speed and torque control in BLDC and PMSM, Sensorless control of PMBLDCM Drive.

v) (a) TEXT BOOKS

1) G. K. Dubey, “Fundamentals of Electric Drives”, Narosa publishers, second Edition, 2001.
2) R. Krishnan, “Permanent Magnet Synchronous and Brushless DC motor Drives”, CRC Press, 2009.

(b) REFERENCES

1) Bimal K.Bose, "Power Electronics and Motor Drives", Academic press, An Imprint of Elsevier, 2006.
2) Vedam Subrahmanyam, "Electric Drives Concepts and Applications", MC Graw Hill Education, 2nd Edition, 2011, New Delhi.
3) Ned Mohan, Tore M Undeland, William P Robbins, "Power electronics converters applications and design", John Wiley and Sons Inc.,3rd Edition
4) Muhammad H.Rashid, "Power Electronics, Devices, Circuits and Applications", Pearson, 3rd Edition, 2014.
5) R Krishnan, "Electric Motor Drives: Modelling, Analysis, and Control", Prentice Hall, 2001.
6) S.V. Dishore, "Control of Electric Drives", Lakshmi Publications,1st Edition, 2019

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Electric Drives:** Electrical Drives, Advantages of Electric drives, Parts of Electrical Drives, Electric Motors, Selection of motors, Power Modulators, Sources, Control unit, Choice of Electric Drives and Losses. Dynamics of Electric drives: Types of loads, Multi quadrant operations, motor dynamics steady state stability and transient stability. Rating and Heating of motors: Heating effects, heating and cooling curves, classes of duty, load equalization, environmental factors.	**12**
II	**DC motor drives:** Basic characteristics, Operating modes, Single phase and three phase-controlled rectifier fed DC drives, Chopper drives, Rheostatic and regenerative braking. Speed control of DC series and shunt motors -Armature and field control, Ward-Leonard control system, closed loop speed control for separately excited dc motor.	**13**
III	**AC motor drives:** Induction motor drives,stator voltage control, stator impedance control, V/f control, rotor voltage control – Slip power recovery- Concepts of Static Kramer drives and Static Scherbius drive, Current control method. Need for harmonic filter, Closed loop control. Introduction to vector control scheme.	**12**
IV	**Synchronous motor drives:** Synchronous motors- Speed torque characteristics and torque angle characteristics. Fixed and variable frequency operation modes, Self-control modes. load commutated CSI fed synchronous motor.	**11**
V	**Permanent magnet motor drives:** Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM, Sensorless control of PMBLDCM Drive	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M20N	ENERGY SYSTEMS	VAC	4	0	0	4	2022

i) PRE-REQUISITE: ES0U10D: Basics of Electrical and Electronics Engineering

ii) COURSE OVERVIEW: This course provides an intensive introduction to the AC system, AC system losses and power factor correction, operation and control of power system, solar and wind energy systems, and energy storage techniques with an emphasis on their technology and applications.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Describe the concepts of AC system and electric power generation.	Understand
CO2	Explain the concepts of transmission and distribution systems, economic operation, and control of the power system.	Understand
CO3	Apply power factor correction methods.	Apply
CO4	Explain solar and wind energy systems and associated power electronic converters.	Understand
CO5	Explain various energy storage techniques, harmonics in power systems and EVs.	Understand

iv) SYLLABUS

AC system fundamentals, power generation, transmission and distribution, load dispatch, automatic generation control, automatic voltage regulator, power factor and reactive power, power factor improvement, solar and wind power systems, converters for solar and wind power systems, energy storage, electric vehicles, harmonics in the power system.

v) (a) TEXT BOOKS

1) Nagrath I. J. and Kothari D. P., “Power System Engineering”, McGraw-Hill; 3rd Edition, 2019.
2) Wadhwa C. L., “Electrical Power Systems”, New Age International (P) Limited Publishers, 7th Edition, 2017.
3) Gupta B.R., “Power System Analysis and Design”, S. Chand Publishing, 7th Edition, 1998.
4) D P Kothari, K C Singal, Rakesh Panjan, “Renewable Energy Sources and Emerging Technologies”, PHI, 2nd Edition, 2011.
5) Robert A. Huggins, “Energy Storage”, Springer, 2010.

(b) REFERENCES

1) Gilbert M. Masters, “Renewable and Efficient Electric Power Systems”, Wiley – Interscience Publication, 2004.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Review of AC system fundamentals, Indian power sector, the structure of power system, Sources of energy and various power generation schemes, Power system economics and tariff. Distributed Generation and smart grid- Introduction.	**12**
II	Transmission and Distribution, Comparison of AC and DC transmission, Components of overhead transmission lines. Representation of power system components - Single line diagram, reactance diagram and per-unit system, Characteristics and performance of transmission lines. Corona, skin effect, Ferranti effect, proximity effect, transposition of conductors, bundled conductors, sag.	**12**
III	Economic Dispatch Neglecting Losses, Optimum Load Dispatch Including Transmission Losses, automatic generation control, automatic voltage control. Concept of power factor and reactive power, causes and effects of low power factor, advantages of improved power factor, power factor improvement through a capacitor, synchronous condenser. Active Shunt Compensators, Static Compensators and Flexible A.C. Transmission System.	**12**
IV	Solar energy systems, wind energy conversion systems. Components of HAWT. Converters for grid-connected PV and wind energy systems- Half-bridge inverter, full-bridge inverter, sine PWM inverter. Maximum power point tracking in PV inverters.	**11**
V	**Energy Storage**- Battery storage, Thermal Storage, Compressed air storage, pumped hydro storage, fuel cells, Flywheel - Supercapacitors, Solar electrolytic hydrogen production. Electric and hybrid electric vehicles. Power quality issues- Problem of harmonics in power system, sources of harmonics, performance measures, harmonic mitigation.	**13**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M20P	MICROCONTROLLERS & EMBEDDED SYSTEMS	VAC	4	0	0	4	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: This course is designed to introduce microcontroller assembly language programming. Students will be taught the basic use of an assembly as well as embedded C programming environment to control peripheral devices. Students will also understand the interfacing of various peripheral elements with microcontroller to design an automated system. The course prepares the student with a set of concepts common to many different embedded systems.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the architecture of a 8051 microcontroller	Understand
CO2	Develop assembly language and Embedded C program for 8051 microcontroller.	Apply
CO3	Construct embedded C program for serial port communication and time delay using timers/counters of 8051.	Apply
CO4	Construct interrupt programming in embedded C and demonstrate interfacing of different peripheral devices with 8051.	Apply
CO5	Explain the general characteristics of embedded system and also classify the system with its life cycle development.	Understand

iv) SYLLABUS

Types of microcontrollers, Applications of microcontrollers, Architecture of Intel 8051 microcontroller, Assembly language Programming and instruction set of 8051, addressing modes, 8051 programming in C.

8051 Timer/Counter programming in embedded C, 8051 serial port programming in embedded C, Introduction of Keil Software to simulate Assembly and embedded C programs.

8051 Interrupt programming in embedded C, Interfacing: LCD, seven segment display, DIP switches, ADC & DAC, Motor control.

Overview of Embedded Systems, Application domain of embedded systems, Categories of embedded systems, Design and Development life cycle model, Introduction to ARM processors (Basic concepts only).

v) (a) TEXT BOOKS

1) Muhammad Ali Maidu and Janice Gillespie, “The 8051 Microcontroller and Embedded Systems – using assembly and C”, Pearson, 2nd Edition, 2007.

2) Kenneth J. Ayala, "The 8051 Microcontroller", 3rd Edition, Thomson/Cengage Learning, 2007.
3) Craig Steiner, "Microcontroller: Architecture Assembly", Publisher: WP Publishers / Microsoft Press, 2007.

(b) REFERENCES

1) Manish K Patel, "The 8051 Microcontroller Based Embedded Systems", McGraw Hill, July 2017, ISBN: 978-93-329-0125-4.
2) Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, January 2011.
3) K.Uma Rao & Andhe Pallavi, "The 8051 microcontrollers, architecture and programming and applications", Pearson, January 2010.
4) Ajay V. Deshmukh, "Microcontrollers and application", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
5) D. Karuna Sagar, "Microcontroller", Publisher: Alpha Science International Ltd Released: 2010-12.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Types of microcontrollers:** Overview of the 8051 family, Selection of microcontrollers, Applications of microcontrollers, Architecture of Intel 8051 microcontroller, PSW and Flag Bits, 8051 Register Banks and Stack, Internal Memory Organization of 8051, IO Port Usage in 8051, Types of Special Function Registers and their uses in 8051, Pins of 8051.	**12**
II	**Assembly programming of 8051:** Instruction set of 8051, Introduction to 8051 assembly programming, Data types and Assembler directives, 8051 Addressing Modes, simple Assembly programs. **8051 programming in C**: Data types and time delay in 8051C, I/O programming in 8051C, Logic operations in 8051 C, Data conversion program in 8051 C.	**12**
III	**8051 Timer/Counter programming in embedded C:** Programming 8051 timers, Counter programming, Programming timers 0 and 1 in 8051 C. **8051 serial port programming in embedded C:** Basics of serial communication, 8051 connections to RS232, serial port programming in 8051 C. Introduction of **Keil** Software to simulate Assembly and embedded C programs.	**12**
IV	**8051 Interrupt programming in embedded C:** 8051 interrupts, Programming timer, external hardware and serial communication interrupt, Interrupt priority in 8051/52, Interrupt programming in C. **Interfacing:** LCD, seven segment display, DIP switches, ADC & DAC. **Motor control:** Relays and opto isolators, stepper motor interfacing, DC motor interfacing and PWM using 8051	**12**

V	**Overview of Embedded Systems** - Application domain of embedded systems, features and characteristics, overview of embedded system architecture; recent trends in embedded systems, Categories of embedded systems-Hard and soft, Design and Development life cycle model - Embedded system design process – Challenges in Embedded system design, Introduction to ARM processors (Basic concepts only).	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M20Q	ELECTRIC POWER SUPPLY AND DISTRIBUTION SYSTEMS	VAC	4	0	0	4	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: The aim of this course is to provide a comprehensive understanding of the various components, characteristics, and technologies involved in electrical power generation, transmission, distribution, and management.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Compare the efficiency and reliability of various electrical power generation and transmission methods and technologies.	Understand
CO2	Discuss load flow analysis, state estimation, short circuit analysis, and harmonic analysis in power systems.	Understand
CO3	Explain generation control and dispatch, load control, power system protection and stability analysis.	Understand
CO4	Discuss the characteristics and benefits of distributed energy resources, types of microgrids, their control and protection and integration with the main grid.	Understand
CO5	Describe smart grid technologies, renewable energy sources integration, energy storage systems and future trends in electrical power supply systems.	Understand

iv) SYLLABUS

Introduction to Electric Power Supply Systems, Overview of electrical power systems, Electrical power generation methods and technologies, AC/DC transmission and distribution systems

Power System Analysis: Load flow analysis, State estimation, Short circuit analysis, Harmonic analysis

Power System Control and Protection, Generation control and dispatch, Load control, Power system protection, Power system stability analysis

Distributed Energy Resources and Microgrids, Overview of distributed energy resources, Types of microgrids and their applications, Control, and protection of microgrids, Integration of microgrids with the grid

Emerging Technologies in Electric Power Supply Systems, Smart grid technologies, Renewable energy sources and their integration into power systems, Energy storage systems and their applications. Future trends and developments in electrical power supply systems.

v) (a) TEXT BOOKS

1) Ned Mohan, "Electric Power Systems: A first Course", Wiley India, 2012.
2) J. Duncan Glover, Thomas Overbye, Mulukutla S. Sarma, "Power System Analysis and Design", 4th Edition, Thomson learning, 2008.
3) V.K. Mehta and Rohit Mehta, "Principles of Electric Power Systems", 3rd Edition, S. Chand Publications, 2005.
4) James L. Kirtley, "Electric Power Principles: Sources, Conversion, Distribution and Use", 2nd Edition, Wiley Publication, 2020.

(b) REFERENCES

1) Ned Mohan, "Electric Power Systems: A First Course", John Wiley and Sons Inc., 2012.
2) F C Chan, "Electric Power Distribution Systems", 3rd Edition, McGraw Hill, 1994.
3) K.R. Padiyar, "Power System Dynamics: Stability and control", Anshan Ltd., 2004.
4) Turan Gonen, "Electric Power Distribution Engineering", 3rd Edition, CRC Press, 2014.
5) James Momoh, "Smart Grid: Fundamentals of Design and Analysis", Wiley- IEEE Press, 2012.
6) "Handbook on Microgrids for power quality", Asian Development bank.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Overview of electrical power systems**: Types of electrical power systems, components of power systems, power system characteristics. Electrical power generation methods and technologies: Conventional power generation (thermal, hydro, nuclear), renewable energy sources (solar, wind, geothermal). AC/DC transmission and distribution systems: Advantages and disadvantages of AC and DC transmission, high voltage AC and DC transmission, sub-transmission, and distribution systems	**10**
II	**Load flow analysis:** Load flow equations, Newton-Raphson method, Gauss-Seidel method, Decoupled load flow method, fast decoupled load flow method. **State estimation:** State estimation theory, weighted least squares state estimation, Kalman filtering. **Short circuit analysis:** Symmetrical components, sequence impedance, fault analysis, symmetrical fault analysis, unsymmetrical fault analysis. Harmonic analysis: Harmonic sources, harmonics in power systems, power system harmonics standards, harmonic mitigation techniques.	**12**
III	**Generation control and dispatch:** Power system control, power system stability, generation control and dispatch, economic dispatch. Load control: Load control techniques, direct load control, indirect load control, real-time pricing.	**12**

	Power system protection: Principles of power system protection, protection zones, relay types, protection coordination. Power system stability analysis: Transient stability analysis, steady-state stability analysis, dynamic stability analysis.	
IV	**Overview of distributed energy resources:** Characteristics of distributed energy resources, benefits and challenges of distributed energy resources. Types of microgrids and their applications: Types of microgrids, microgrid topologies, microgrid control and protection, microgrid planning and design. Control and protection of microgrids: Microgrid control, microgrid protection, microgrid stability, microgrid reliability. Integration of microgrids with the grid: Integration of microgrids with the main grid, microgrid interconnection, microgrid power quality, microgrid market integration.	**13**
V	**Smart grid technologies:** Smart grid concepts, communication technologies for the smart grid, smart grid applications, smart grid security. Renewable energy sources and their integration into power systems: Renewable energy sources and their impact on power systems, integration of renewable energy sources into power systems, grid integration of renewable energy sources, grid codes for renewable energy sources. Energy storage systems and their applications: Energy storage systems, applications of energy storage systems, energy storage system design and analysis, energy storage system control and management. Future trends and developments in electrical power supply systems: Future trends in electrical power supply systems, energy systems integration, energy systems optimization, energy systems automation.	**13**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

B.TECH S4 HONOURS

Group	Course Code	Course Name	L-T-P	Credits
I	EL2H20A	Automatic Control Systems	3-1-0	4
II	EL2H20B	Basics of Machine Learning	3-1-0	4
III	EL2H20C	Network Communications in Smart Grid	3-1-0	4
IV	EL2H20D	Analysis of Electrical Machines	3-1-0	4

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2H20A	AUTOMATIC CONTROL SYSTEMS	VAC	3	1	0	4	2022

i) PRE-REQUISITE: MA0U10B: Vector Calculus, Differential Equations and Transforms.

ii) COURSE OVERVIEW: This course introduces fundamental concepts in control theory to the students to enable them to model various components a control system using transfer function and state space model. The course also presents the concept of time response and frequency response of the systems. This course discusses the stability analysis of systems using different time domain and frequency domain methods. It thus helps the students to get an overview of the basic concepts in control systems and enables them to apply these control principles in various areas of industry.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Develop a mathematical model of various electromechanical systems.	Apply
CO2	Apply Laplace transform to determine the time response of various control systems.	Apply
CO3	Apply Laplace transform to determine the frequency response of various control systems.	Apply
CO4	Make use of time and frequency domain techniques to determine the stability of a system.	Apply
CO5	Make use of state space techniques to determine the performance of the system	Apply

iv) SYLLABUS

Feedback Control Systems, Mechanical and Electromechanical systems, block diagram representation, signal flow graph, characteristic equation.

Time domain analysis of control systems, step responses of first and second order systems, Error Analysis and Stability, Time response for various pole locations - stability of feedback systems - Routh's stability criterion, Root locus technique.

Frequency Domain Analysis, Polar plot, Bode Plot, Nyquist stability criterion.

State space analysis of systems, State Space representation Electrical network/ Mechanical systems, State transition matrix, Computation of state transition matrix, Controllability and Observability.

v) (a) TEXT BOOKS

1) Nagarath I. J. and Gopal M., "Control System Engineering", 5th Edition, New Age International Publishers.
2) Ogata K, "Modern Control Engineering", 5th Edition, Prentice Hall, 2010.
3) Nise N. S, "Control Systems Engineering", 6th Edition, Wiley, 2010.
4) R. C. Dorf and Bishop R. H, "Modern Control Systems", 12th Edition, Prentice Hall, 2011.

(b) REFERENCES

1) Kuo B. C, "Automatic Control Systems", 7th Edition, Prentice Hall Inc., 1995.
2) Desai M. D., "Control System Components", Prentice Hall of India, 2008
3) Gopal M., "Control Systems: Principles and Design", 4th Edition, McGraw Hill Education, 2012.
4) Imthias Ahamed T. P, "Control Systems", Phasor Books, 2016.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Feedback Control Systems**: Terminology and basic structure of Open loop and Closed loop control systems- Examples of Automatic control systems (block diagram representations only). Transfer function approach to feed back control systems- Mechanical and Electromechanical systems: Force – voltage, force–current analogy. Block Diagram Reduction Techniques, Signal flow graph- Mason's gain formula, Characteristic Equation.	**15**
II	**Performance Analysis of Control Systems:** Time domain analysis of control systems: Transient and steady state responses- Impulse and Step responses of first and second order systems Time domain specifications. Error analysis: Steady state error analysis - static error coefficient of Type 0, 1, 2 systems. Dynamic error coefficients. Introduction to software tools (MATLAB/SIMULINK) to analyze the control system.	**15**
III	**Stability Analysis:** Concept of stability-BIBO stability and Asymptotic stability- Time response for various pole locations- stability of feedback systems. Application of Routh's stability criterion to control system analysis- Relative stability. Root locus technique: General rules for constructing Root loci – stability from root loci - Effect of addition of poles and zeros on Root locus.	**15**
IV	**Frequency domain analysis**: Frequency domain specifications - correlation between time domain and frequency domain responses.	**15**

	Polar plot: Concepts of gain margin and phase margin- stability analysis. Bode Plot: Construction of Bode plots - gain margin and phase margin- Stability analysis based on Bode plot. Nyquist stability criterion (criterion only).	
V	**State space analysis of systems**: Introduction to state concept- state equation of linear continuous time data systems, Matrix representation of State equations, Phase variable and canonical forms of state representation. State Space representation: Electrical network/ Mechanical systems, Relationship between state equation and transfer function, Eigen values & Eigen vectors, State transition matrix- Properties of state transition matrix- Computation of state transition matrix using Laplace transform and Cayley Hamilton method Controllability and Observability.	**15**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2H20B	BASICS OF MACHINE LEARNING	VAC	3	1	0	4	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW: The goal of this course to introduce the fundamental concepts of various optimization techniques and machine learning algorithms.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the basic concepts of Machine Learning and Neural Networks.	Understand
CO2	Explain the basic concepts of various optimization techniques.	Understand
CO3	Apply supervised and unsupervised machine learning algorithms.	Apply

iv) SYLLABUS

Machine Learning - Examples, Learning Associations, Classification, Regression, Supervised Learning, Unsupervised Learning, Reinforcement Learning.
Least-squares and linear programming, Convex sets, convex optimization problems, quasi-convex optimization, linear optimization, quadratic optimization, Unconstrained minimization.
Feed Forward Networks, Backpropagation Algorithm, Fundamentals of Deep Learning, Basic Deep Learning Architectures.
Linear regression and Linear Classification, Feature selection, Dimensionality Reduction, SVM, Clustering.
Machine Learning Applications.

v) (a) TEXT BOOKS

1) Kalyanmoy Deb, "Optimization for Engineering Design Algorithms and Examples", Prentice Hall of India, New Delhi, 2004.
2) Bishop C. M., "Pattern Recognition and Machine Learning", Springer, 2010.
3) Mueller A. C. & Guido S., "Introduction to Machine Learning with Python", O'REILLY' Publishers, 2016.
4) Buduma N. & Locascio N., "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", O'REILLY' Publishers, 2017.

(b) REFERENCES

1) Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning", Cambridge University Press, 2017.

2) Simon Haykin, "Neural networks and learning machines", 3rd Edition. Pearson Education India, 2010.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction:** What Is Machine Learning? Examples of Machine Learning Applications, Learning Associations, Classification, Regression, Supervised Learning, Unsupervised Learning, Reinforcement Learning.	**12**
II	**Mathematical optimization:** least-squares and linear programming, Convex sets - optimization problem in standard form, convex optimization problems, quasi-convex optimization, linear optimization, quadratic optimization, generalized inequality constraints, Unconstrained minimization- gradient descent method, steepest descent method, Newton's method.	**12**
III	**Neural Networks**: Introduction, Feed Forward Networks, Backpropagation Algorithm, Fundamentals of Deep Learning, Basic Deep Learning Architectures.	**12**
IV	**Supervised and Unsupervised Learning**: Linear regression and Linear Classification, Feature selection, Dimensionality Reduction – Support Vector Machines, Hyper parameter tuning regularization – Artificial Neural Networks – Clustering.	**12**
V	**Machine Learning Applications**: Machine Learning applied to 1D, ECGEditionEG, time-series, 2D data (images) – applications of Deep Learning to 3D (videos).	**12**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2H20C	NETWORK COMMUNICATION IN SMART GRID	VAC	3	1	0	4	2022

i) PRE-REQUISITE: POWER SYSTEM I and II

ii) COURSE OVERVIEW: This course provides an in-depth study of network communications in smart grid systems. Students will learn about the communication requirements, challenges, and technologies in the context of smart grid components as well as the integration of Internet of Things and cloud computing. Students will gain knowledge and skills in analysing communication technologies, protocols, and standards for smart grid. The course also focuses on the application of big data analytics and machine learning in smart grid.

iii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Discuss the concept of smart grid and its components, communication requirements and challenges, and communication	Understand
CO2	Explain the wireless communication technologies, wireless sensor networks and their applications, and security and reliability issues in wireless communications for smart grid.	Understand
CO3	Choose the power line communication technologies, channel characteristics and noise mitigation techniques based on the applications of power line communications in smart grid.	Apply
CO4	Explain the applications of IoT in smart grid, IoT communication technologies, protocols, and standards, and security and privacy challenges in IoT-based smart grid.	Understand
CO5	Discuss the benefits of cloud computing for smart grid, big data analytics and machine learning in smart grid, and case studies of cloud-based smart grid applications, including fault detection and prediction.	Understand

iv) SYLLABUS

Overview of the smart grid and its components, Communication requirements and challenges in smart grid, Communication technologies and standards for smart grid.

Wireless communication technologies for smart grid, Wireless sensor networks and their applications in smart grid**,** Security and reliability issues in wireless communications for smart grid.

Power line communication technologies for smart grid, Channel characteristics and noise mitigation techniques for power line communications, Applications of power line communications in smart grid.

Overview of IoT and its applications in smart grid**,** Security and privacy challenges in IoT-based smart grid, Cloud computing and its benefits for smart grid**,** Big data analytics and machine learning in smart grid**.**

v) (a) TEXT BOOKS

1) Hussein Mouftah, Melike Erol-Kantarci, "Smart Grid Networking, Data Management, and Business Models", 1st Edition, Wiley, 2016.
2) Lutz Lampe, Andrea M. Tonello, Theo G. Swart, "Power Line Communications: Principles, Standards and Applications from Multimedia to Smart Grid", 2nd Edition, Wiley, 2016.
3) Hwaiyu Geng (Editor), "Internet of Things and Data Analytics Handbook", Wiley, 2017.
4) Mostapha Zbakh, Pierre Manneback, Chunming Rong, Mohamad Essaaidi, "Cloud Computing and Big Data: Technologies, Applications and Security", Wiley, 2019.

(b) REFERENCES

1) Chen-Ching Liu, Stephen McArthur, Seung-Jae Lee, “Smart Grid Handbook”, 3 Volume Set, 3rd Edition, Wiley, 2016.
2) Mohammad Ilyas and Imad Mahgoub, “Handbook of Sensor Networks: Compact Wireless and Wired Sensing Systems”, 1st Edition, CRC Press, 2004.
3) Janaka B. Ekanayake, Nick Jenkins, Kithsiri M. Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, 2nd Edition, Wiley, 2012.
4) James Momoh, “Smart Grid: Fundamentals of Design and Analysis”, 2nd Edition, Wiley, 2012.
5) Arun K. Somani, Ganesh Chandra Deka, “Big Data Analytics Tools and Technology for Effective Planning”, 1st Edition, Chapman and Hall/CRC, 2017.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Smart Grid and Communications:** Components of the smart grid: generation, transmission, distribution, and end-use, Smart grid benefits, Challenges of smart grid deployment. Types of communications in smart grid, Communication requirements in smart grid, Communication challenges in smart grid, Impact of communication on smart grid performance. Communication technologies for smart grid - wired and wireless, including PLC, Wi-Fi, Zigbee, LTE, etc. Communication standards for smart grid - IEC, IEEE, ANSI, etc. Architecture of smart grid communication and standards in smart grid.	**12**
II	**Wireless Communications in Smart Grid:** Overview of wireless communication technologies for smart grid - Zigbee, Wi-Fi, LTE, etc. Comparison - range, data rate, power consumption, and cost. Applications - home energy management, demand response, and distribution automation. Overview of wireless sensor networks (WSNs) and their characteristics, Applications of WSNs in smart grid - fault detection	**12**

	and isolation, load monitoring, and environmental monitoring, WSN topology design and deployment in smart grid. Overview of wireless communication security and reliability challenges in smart grid. Authentication, authorization, and access control in wireless communication for smart grid. Techniques for reliability improvement in wireless communication: error control, redundancy, and diversity.	
III	**Power Line Communications in Smart Grid:** Overview of power line communication (PLC) technologies for smart grid - narrowband, broadband, and G.hn. Characteristics - attenuation, noise, and interference. Comparison of PLC technologies. Channel characteristics and noise mitigation techniques for power line communications, Channel modeling and characterization for power line communication. Techniques for noise mitigation in power line communication: adaptive equalization, channel estimation, and error correction. Power line communication over different types of power lines: medium voltage, low voltage, and home wiring, Applications of power line communications in smart grid.	**12**
IV	**Internet of Things (IoT) in Smart Grid:** Definition and evolution of the IoT, Applications of IoT in smart grid - energy management, demand response, and grid control. Benefits and challenges of IoT in smart grid deployment. IoT communication technologies, protocols, and standards for smart grid. Bluetooth Low Energy, Zigbee, and LoRaWAN. IoT communication protocols - MQTT, CoAP, and AMQP. Standardization of IoT communication in smart grid - IETF, IEEE, and OASIS Overview of security and privacy challenges in IoT-based smart grid: data confidentiality, integrity, and availability. Techniques for IoT security in smart grid, Privacy protection in IoT-based smart grid - data anonymization, aggregation, and sharing policies.	**11**
V	**Cloud Computing and Big Data Analytics in Smart Grid:** Introduction to cloud computing and its components - Cloud-based services and applications for smart grid, Benefits of cloud computing for smart grid, Cloud-based smart grid architectures. Case studies of cloud-based smart grid applications: utility-scale solar forecasting, smart home energy management, and peak demand reduction. Introduction to big data analytics and machine learning in smart grid - Data sources in smart grid, Data management and processing in smart grid, Big data analytics techniques in smart grid, Machine learning algorithms in smart grid - regression, clustering, classification, and deep learning.	**13**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL2H20D	ANALYSIS OF ELECTRICAL MACHINES	VAC	3	1	0	4	2022

i) PRE-REQUISITE: Nil

ii) COURSE OVERVIEW:

Goal of this course is to expose the students to analyse electrical machine behaviour based on the voltage and torque equations of the machine and its transformation using different methods. This course also provides the concept of generalized machine theory and its application in DC generator/ motor, Synchronous motor and three phase Induction motor. This course also imparts knowledge about the analysis of transient and steady state behaviour of rotating machines.

iii) COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Develop the generalized model of electrical machines.	Apply
CO2	Outline the general equations for voltage and torque of rotating machines.	Understand
CO3	Apply the generalized theory to learn the steady state and transient behaviour of DC machines.	Apply
CO4	Construct the primitive machine model of AC machines to study its steady state behaviour.	Apply
CO5	Interpret the principle of operation of single-phase Induction Motor.	Understand

iv) SYLLABUS

Unified approach to the analysis of electrical machine performance - basic two pole model of rotating machines- per unit system.

Primitive machine - transformer and rotational voltages in the armature voltage and torque equations resistance, inductance and torque matrix.

Transformations - passive linear transformation in machines- Park's transformation- invariance of power.

DC Machines- Application of generalized theory to separately excited, shunt and series machines- Steady state and transient analysis, transfer functions.

Synchronous Machines: synchronous machine reactance and time constants-Primitive machine model, Balanced steady state analysis-power angle curves.

Induction Machines- Primitive machine representation- Steady State Operation- Equivalent circuit. Single phase induction motor- Voltage and Torque equations.

v) (a) TEXT BOOKS

1) Bhimbra P. S., “Generalized Theory of Electrical Machines”, Khanna Publishers, 6th Edition, Delhi 2017.

2) Charles V. Johnes, "Unified Theory of Electrical Machines", New York, Plenum Press, 2nd Edition 1985.
3) Bernad Adkins, Ronald G. Harley, "General theory of AC Machines", London, Springer Publications, 2013.
4) Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, "Analysis of Electrical Machines and Drive Systems", John Wiley & Sons, 3rd Edition 2013.

(b) REFERENCES

1) Charles Concordia, "Synchronous Machines - Theory and Performance", John Wiley and Sons Incorporate, New York, 1988.
2) Say M. G., "Introduction to Unified Theory of Electrical Machines", Pitman Publishing, 4th Edition 1978.
3) Alexander S Langsdorf M. N., "Theory of Alternating Current Machinery", Tata McGraw Hill, 2nd Edition, 2001.
4) NPTEL: http://nptel.ac.in/courses/108106023/

vi) COURSE PLAN

Module	Contents	No. of hours
I	Unified approach to the analysis of electrical machine performance – conventions- - basic two pole model of rotating machines- DC compound and shunt machines with interpoles, single phase series machine, three phase induction machine-per unit system –Transformer with movable secondary, transformer and rotational voltages in the armature -Primitive machine - voltage and torque equations-resistance, inductance and torque matrix.	**12**
II	Transformations - passive linear transformation in machines-transformation from a displaced brush axis-transformation from three phase to two phase and from rotating axes to stationary axes-Clark's and Park's transformation- invariance of power - Restrictions of the Generalized theory of machines	**12**
III	DC Machines: Application of generalized theory to separately excited DC generator: steady state and transient analysis, Separately excited DC motor- steady state and transient analysis, Transfer function of separately excited DC generator and motor- DC shunt and series motors: Steady state analysis and characteristics.	**13**
IV	Synchronous Machines: synchronous machine reactance and time constants-Primitive machine model, Balanced steady state analysis-power angle curves, phasor diagram of salient pole and cylindrical rotor synchronous machines.	**11**
V	Induction Machines: Primitive machine representation- Transformation-Steady state operation-Equivalent circuit.	**12**

	Single phase induction motor- Revolving Field Theory- Equivalent circuit- Voltage and Torque equations -Cross field theory-Comparison between single phase and polyphase induction motor.	
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours