CURRICULUM AND DETAILED SYLLABI

FOR

B. TECH DEGREE PROGRAMME

IN

ELECTRICAL AND COMPUTER ENGINEERING

SEMESTERS III & IV

2023 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	01-04-2024	---

Head of Department
Chairman, Board of Studies

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 2023-24

SEMESTER III						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P-J**	**Hours**	**Credit**
A	BSC	23MAL20B	Discrete Mathematical Structures	3-1-0-0	4	4
B	PCC	23ELL20A	Instrumentation Systems	3-1-0-0	4	4
C	PCC	23ELL20B	Data Structures	3-1-0-0	4	4
D	PCC	23EEL20C	Electrical Circuit Analysis	3-1-0-0	4	4
E	ESC	23ESL00A	Design Engineering	2-0-0-0	2	2
G	MNC	23NCL20A	Professional Ethics	2-0-0-0	2	—
S	PCC	23ELP20A	Data Structures Lab	0-0-3-0	3	2
T	PCC	23ELP20B	Instrumentation Lab	0-0-3-0	3	2
R/M	VAC	23ELP20B	Remedial/Minor Course	3-0-0-0/ 2-1-0-0	3	3
TOTAL					**26/29**	**22/25**

SEMESTER IV						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P-J**	**Hours**	**Credit**
A	BSC	23MAL20B	Probability, Random Processes and Numerical Methods	3-1-0-0	4	4
B	PCC	23ELL20D	Computer Organization and Architecture	3-1-0-0	4	4
C	PCC	23ELL20E	Object Oriented Programming using JAVA	3-0-3-0	6	5
D	PCC	23ELL20F	Digital Electronics and Logic Design	3-1-0-0	4	4
E	HSC	23HSL20A	Universal Human Values - II	3-0-0-0	3	3
G	MNC	23NCL20B	Industrial Safety Engineering	2-1-0-0	3	—
S	PCC	23ELP20C	Digital Electronics and Logic Design Lab	0-0-3-0	3	2
R/M/H	VAC		Remedial/Minor/Honors Course	3-0-0-0/ 2-1-0-0	3	3
TOTAL					**27/30**	**22/25**

B.Tech (MINORS): Same basket for one department

Semester	BASKET I				BASKET II				BASKET III				BASKET IV			
	Embedded Systems for Industrial Applications				Architectural Lighting and Electrical System Design				Clean and Sustainable Energy				Electric Vehicle Systems			
	Course Code	Course	L-T-P	Credit	Course Code	Course	L-T-P	Credit	Course Code	Course	L-T-P	Credit	Course Code	Course	L-T-P	Credit
S3	23EEL2MA	Micro Controllers and Embedded Systems	3-0-0-0	3	23EEL2MC	Basics of Illumination Science and Lighting Design	3-0-0-0	3	23EEL2ME	Sustainable Energy Systems	3-0-0-0	3	23EEL2MG	Electric Machinery	3-0-0-0	3
S4	23EEL2MB	Hardware Interfacing using Arduino-C Platform	3-0-0-0	3	23EEL2MD	Electric Power Supply and Distribution Systems	3-0-0-0	3	23EEL2MF	Renewable Energy in Power Grids	3-0-0-0	3	23EEL2MH	Power Electronics and Energy Storage Devices	3-0-0-0	3

B.Tech (HONOURS)

Semester	GROUP I				GROUP II				GROUP III			
	Specialization: Control and Autonomous Systems				Specialization: Machine Learning				Specialization: Smart Grids			
	Course Code	Course	L-T-P-J	Credit	Course Code	Course	L-T-P-J	Credit	Course Code	Course	L-T-P-J	Credit
S4	23ELL2HB	Automatic Control Systems	2-1-0-0	3	23ELL2HD	Basics of Machine Learning	2-1-0-0	3	23ELL2HF	Network Communication in Smart Grid	2-1-0-0	3

** **Honours Group IV of EEE** can be opted by the students of Electrical and Computer Engineering

SEMESTER III

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL20A	INSTRUMENTATION SYSTEMS	PCC	3	1	0	0	4	2023

i) PRE-REQUISITE: 23ESL10J Basics of Electrical Engineering A , 23ESL10L Basics of 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	Model transistor amplifiers, Op Amp circuits and multivibrator circuits.	Apply
CO2	Compare the different types of measuring instruments, their construction, operation and characteristics.	Understand
CO3	Explain the resistance, inductance and capacitance measuring methods.	Understand
CO4	Illustrate the construction and working of wattmeters, energy meters and methods of power measurement.	Understand
CO5	Explain the working of various DC potentiometers and digital meters.	Understand
CO6	Summarize the construction and working of various transducers to measure the physical quantities.	Understand

iv) SYLLABUS

BJT and JFET- construction, working and characteristics and amplifiers,

Operational Amplifiers - Analysis of fundamental differential Amplifiers, Inverting and Non-Inverting Amplifiers, Open loop and Closed loop Configurations, Concept of virtual short. OP-AMP Circuits, Timer 555 IC - Internal diagram of 555 IC, Astable and Mono-stable multivibrators using 555 IC.

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) Boylestad R. L. and Nashelsky L., "Electronic Devices and Circuit Theory", Pearson Education, 10th Edition, 2009.
3) C. S. Rangan, G. R. Sarma, V. S. V. Mani, "Instrumentation: Devices and Systems", 2nd Edition (32nd Reprint), McGraw Hill Education (India), 2014.
4) Bela G. Liptak, "Process Measurement Instrument Engineers Handbook", Revised Edition, Chilton Book Company, 1982.
5) Roy D. C. and Jain S. B., "Linear Integrated Circuits", New Age International, 3rd Edition, 2010.

(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.
5) Bell D. A., "Electronic Devices and Circuits", Prentice Hall of India, 2007.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Transistor Amplifiers:** BJT, JFET- construction working and characteristics, CE Amplifier, CS Amplifier - Design **OpAmp IC:** Fundamental differential amplifier - Modes of operation, Properties of ideal and practical Op-amp, Open loop and Closed loop Configurations-Concept of virtual short. Negative feedback in Op-amps. Inverting and non- inverting amplifier circuits. Summing and difference amplifiers, Instrumentation amplifier, Differentiator and Integrator circuits-practical circuits – Design –Comparators: Zero crossing and voltage level detectors. **Timer 555 IC:** Internal diagram of 555IC – Astable and Monostable multi-vibrators using 555 IC.	**12**
II	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**

III	**DC Bridges:** Wheatstone bridge, Kelvin double bridge. **AC Bridges:** Maxwell bridge, Schering bridge and Wien's bridge. Measurement of insulation resistance and - earth resistance **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.	**12**
IV	**DC potentiometers:** General Principles - Slide wire and Vernier potentiometer - Calibration of ammeter, voltmeter and wattmeter. **Digital Measurement of Electrical Quantities:** Concept of digital measurement, block diagram, study of digital voltmeter, frequency meter, electronic energy meter, electronic multimeter, DSO.	**12**
V	**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. **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	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**50 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	40	60	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL20B	DATA STRUCTURES	PCC	3	1	0	0	4	2023

i) PRE-REQUISITE: 23ESB10D Problem Solving and 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	Explain the fundamental concepts of data structures, algorithms, and performance analysis, alongside demonstrating the ability to articulate arrays, searching techniques, linked lists, memory management, trees, and graphs.	Understand
CO2	Apply arrays, stacks, queues, and searching algorithms effectively to solve real-world problems, demonstrating proficiency in algorithmic problem-solving.	Apply
CO3	Apply a 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
CO4	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
CO5	Make use of appropriate sorting algorithms and appropriate Hash Function to store a given dataset and enable efficient access of data in the given set 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. **(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.

v) 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**

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

vii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	40	60	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL20C	Electric Circuit Analysis	PCC	3	1	0	0	4	2023

i) **PRE-REQUISITE:** 23MAl10B: Vector Calculus, Differential Equation and Transforms, 23ESL10J Basics of Electrical Engineering A

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 modeling 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 magnetically coupled circuits and 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.	**14**
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.	**10**
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.	**11**
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.	**13**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 Marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	40	60	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELP20A	DATA STRUCTURES LAB	PCC	0	0	3	0	2	2023

i) PRE-REQUISITE: 23ESB10D: Problem Solving and 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 using Arrays	**3**
III	Implementation of Queues using Arrays	**3**
IV	Application problems using stacks: Conversion of expression from one notation to another notation.	**3**
V	Implementation of Singly linked list operations.	**3**
VI	Implementation of Doubly linked list operations.	**3**
VII	Implementation of Stack using linked list.	**3**
VIII	Implementation of Queue using linked list.	**3**
IX	Implementation of trees using linked list	**3**
X	Representation of polynomials using linked list, addition, and multiplication of polynomials.	**3**
XI	Implementation of binary search trees.	**6**
XII	Implementation of sorting algorithms.	**3**
XIII	Implementation of searching algorithms – linear search, binary search	**3**
XIV	Implementation of BFS and DFS for each graph representation.	**3**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

(a) Attendance	:	5 marks
(b) Continuous Assessment	:	55 marks
(c) Final Assessment	:	40 marks
Total	**:**	**100 marks**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELP20B	INSTRUMENTATION LAB	PCC	0	0	3	0	2	2023

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	Develop and test various circuits using OpAmp and 555 timer IC	Apply
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

- Basic Op-amp circuits
- Astable and Monostable Multivibrator circuits.
- 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	Op Amp Circuits: Inverting and Non inverting Amplifiers , Summer, Integrator and differentiator.	3
II	Astable and Monostable circuit using 555 IC.	3
III	Calibration of single- phase energy meter by direct loading.	3
IV	Calibration of single- phase energy meter by phantom loading at various power factors.	3
V	Measurement of energy using an electronic energy meter.	3
VI	Measurement of unknown capacitance using Schering bridge.	3
VII	Measurement of unknown frequency using Wein's bridge.	3
VIII	3 phase power measurement using one wattmeter and two wattmeter method.	3
IX	Characteristics of Thermistor	3
X	Characteristics of RTD	3
XI	Characteristics of LVDT.	3
XII	Characteristics of Load cell.	3
XIII	Calibration of ammeter using Slide wire potentiometer.	3
XIV	Calibration of voltmeter using Vernier dial potentiometer.	3
XV	Measurement of voltmeter resistances and extension of range using Wheatstone's bridge	3
XIV	Measurement of voltmeter resistances and extension of range using Wheatstone's bridge	3
		45

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

vi) CONTINUOUS ASSESSMENT EVALUATION PATTERN

(a) Attendance	:	5 marks
(b) Continuous Assessment	:	55 marks
(c) Final Assessment	:	40 marks
Total	**:**	**100 marks**

B.TECH S3 MINORS

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M20I	ELECTRIC MACHINE FUNDAMENTALS	VAC	3	1	0	4	2023

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**

i) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 arks**

ii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	40	60	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M20J	INTRODUCTION TO POWER ENGINEERING	VAC	3	1	0	4	2023

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	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**41 arks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	40	60	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	2023

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	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**42 arks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	40	60	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
23EEL2MC	BASICS OF ILLUMINATION SCIENCE AND LIGHTING DESIGN	VAC	3	0	0	3	2023

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.	9
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.	9
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.	9

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	**10**
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.	**8**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	10 marks
Total	:	**40 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	40	60	3 hours

SEMESTER IV

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
23ELL20D	COMPUTER ORGANIZATION AND ARCHITECTURE	PCC	3	1	0	4	2023

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.

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.	**13**
	Total hours	**60**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	40	60	3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
	OBJECT ORIENTED PROGRAMMING USING JAVA	PCC	3	1	3	0	5	2023

i) PRE-REQUISITE: Nil

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:

CO1	Develop simple Java programs using the object-oriented concepts - classes, objects, constructors, data hiding, inheritance and polymorphism	Apply
CO2	Utilize data types, operators, control statements, built in packages & interfaces, Input/ Output Streams and Files in Java to develop programs.	Apply
CO3	Illustrate how robust programs can be written in Java using exception handling mechanisms.	Understand
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

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. Introduction to Java- Java Buzzword, Difference between Java and C++ Java Development Kit, Application Programming interface. Simple Java Program, Java Program Structure, Java Tokens, Java Statements. Implementing A Java program- creating, compiling and running. Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class.	**9**
	Laboratory Experiments : JDK installation, creating, compiling and running a simple java program using primitive data types, literals, type conversion and casting. Programs using arrays and vectors.	**2**

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. Introduction to Methods, Constructors, this Keyword, Method Overloading, Nesting of Methods. Overriding methods, Final variables and methods, Final classes, Finalizer methods, Abstract methods and classes. Methods with Varags.	**9**
	Laboratory Experiments : Programs based on operators and control statements. Programs based on inheritance and polymorphism.	**2**
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. Managing Input/Output Files – Concept of streams, Stream classes, Working with files, Random Access Files, Interactive Input and Output.	**9**
	Laboratory Experiments : Implementation of user defined package.Programs using exception handling mechanisms.	**2**
IV	Java Library - String Handling – String Constructors, String Length, Special String Operations - Character Extraction, Modifying Strings, using valueOf(). Collections framework - Collections overview, Collections Interfaces. 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.	**9**
	Laboratory Experiments : Programs using multithreading.Programs using data connectivity.	**6**

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, JTextField. Java DataBase Connectivity (JDBC) - JDBC overview, Creating and Executing Queries – create table, delete, insert, select.	**9**
	Laboratory Experiments : Programs on Graphical User Interface. Programs using event handling features and swing	**8**
	Total hours	**75**

Sl.No	**Laboratory Program/Experiment**	**No of Hours**
1	JDK installation, creating, compiling and running a simple java program using primitive data types, literals, type conversion and casting.	2
2	Programs using arrays and vectors.	2
3	Programs based on operators and control statements.	2
4	Programs based on inheritance and polymorphism.	2
5	Implementation of user defined package.	2
6	Programs using exception handling mechanisms.	2
7	Programs using multithreading.	2
8	Programs using data connectivity.	4
9	Programs on Graphical User Interface	4
10	Programs using event handling features and swing	4
	TOTAL	**30**

vi) ASSESSMENT PATTERN

Continuous Assessment

Attendance	5 marks
Assignment / Project Work	15 marks
Assessment through Tests	20 marks
Assessment of Lab Work	10 marks
Lab Exam	10 marks
Total Continuous Assessment	**60 marks**
End Semester Examination	**40 marks**
TOTAL	**100 marks**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules (approx.)

END SEMESTER EXAMINATION

Maximum Marks: 40

Exam Duration: 2 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELL20F	DIGITAL ELECTRONICS AND LOGIC DESIGN	PCC	3	1	0	0	4	2023

i) 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.

ii) 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	Develop Sequential circuits using PLDs.	Apply
CO5	Model Combinational and Sequential logic circuits using HDL.	Apply

iii) 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 - HDL coding

iv) (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.

v) COURSE PLAN

Module	Contents	No. of hours
I	Number system and codes: Binary, octal, hexadecimal and decimal number systems - their inter conversion and arithmetic, BCD number system. Gray code, excess–3 code, code conversion, ASCII, EBCDIC codes, Error detection codes. Binary addition and subtraction, signed and unsigned binary numbers arithmetic, 1's and 2's complement representation.	**10**
II	Boolean Algebra and Logic gates- Theorems and properties of Boolean Algebra, Canonical and standard forms, Digital logic gates, Gate level minimization – Four variable K map, don't care conditions, Hardware Description Language.	**13**
III	Combinational Logic: Combinational Circuits- Binary Adder – Subtractor, Decimal Adder, Magnitude Comparators, Decoders, Encoders, Multiplexers, De multiplexers, Code Converters, HDL model of combinational circuits	**13**
IV	Synchronous Sequential Logic: Sequential circuits, Storage elements – Latches and Flip Flops, Conversion of Flip Flops. Registers and Counters: Shift registers, Ripple Counters, Synchronous Counters, HDL model of Sequential circuits	**13**
V	State machines – Mealy and Moore, Programmable logic devices, Case study using PLD	**10**
	Total hours	**60**

vi) ASSESSMENT PATTERN

Continuous Assessment	
Attendance	5 marks
Assignments	15 marks
Assessment through Tests	20 marks
Total Continuous Assessment	**40 marks**
End Semester Examination	**60 marks**
TOTAL	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
23ELP20C	Digital Electronics and Logic Design Lab	PCC	0	0	3	2	2023

i) COURSE OVERVIEW:

The main objective of this course is to impart practical experience to students by exposing them to various digital ICs and 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.

COURSE OUTCOMES

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

CO 1	Construct digital functions using Boolean Algebra and verify experimentally.	Apply
CO 2	Develop combinational logic circuits.	Apply
CO 3	Model sequential logic circuits.	Apply
CO 4	Develop Verilog programs for combinational/ sequential circuits	Apply

iii) SYLLABUS

- 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

iv) 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.

COURSE PLAN

12 experiments are mandatory

Experiment No	List of exercises/experiments	No of hours
1	Verification & Realisation of De Morgan's theorem.	**3**
2	Realisation of SOP & POS functions after K-map reduction.	**3**
3	Half adder & Full adder using gates.	**3**
4	4-bit adder/subtractor & BCD adder using IC 7483.	**3**
5	Realisation of 2-bit comparator using gates and study of four-bit comparator IC 7485.	**3**
6	BCD to decimal decoder and BCD to 7-segment decoder & display.	**3**
7	Study of multiplexer IC and realization of combinational circuits using multiplexers.	**3**
8	Realization of RS, T, D & JK flip flops.	**3**
9	Study of flip flop ICs (7474 & 7476).	**3**
10	Realisation of ripple up and down counters and modulo-N counter using Flip Flops.	**3**
11	Study of counter ICs (7490, 7493).	**3**
12	Design of synchronous up, down & modulo-N counters.	**3**
13	Realization of 4-bit serial IN serial OUT registers using flip flops.	**3**
14	Study of shift register IC 7495, Ring counter and Johnson counter.	**3**
15	Pattern detection using state (Mealy and Moore) machines.	**3**
16	HDL implementation of Combinational/Sequential circuits.	**3**
	Total hours	**48**

VII) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance : 15 marks

CA Exam (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	2½ 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 : (Same as Electrical & Electrical Engineering)

Basket	Course Code	Course Name	L-T-P	Credits
I	EL0M20E	Drives and Control	3-1-0	4
II	EL0M20F	Energy Systems	4-0-0	4
III	EL0M20G	Microcontrollers & Embedded Systems	4-0-0	4
IV	EL0M20H	Electric Power Supply and Distribution Systems	4-0-0	4

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
EL0M20E	DRIVES AND CONTROL	VAC	3	1	0	0	4	2023

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	J	Credit	Year of Introduction
23EEL2ME	SUSTAINABLE ENERGY SYSTEMS	VAC	3	0	0	0	3	2023

i) PRE-REQUISITE: Nil.

ii) COURSE OVERVIEW: The aim of this course is to introduce the students about current and potential future energy systems, extraction, conversion and applications, with emphasis on meeting regional and global energy needs in a sustainable manner and also have an increased awareness on issues in the areas of sustainability.

iii) COURSE OUTCOMES

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

CO1	Explain the concept and need of sustainability.	Understand
CO2	Explain the classification of energy sources, potentials, achievements and applications.	Understand
CO3	Illustrate the production of energy from solar and wind.	Understand
CO4	Compare biomass, tidal, ocean, geothermal, hydro energy sources and also the different types of fuel cells.	Understand
CO5	Explain the concept of various types of energy storage systems.	Understand

iv) SYLLABUS

Energy Fundamentals- Sustainability, Need and concept of sustainability, Social, environmental and economic sustainability concepts.

General classification of energy- Conventional and non-conventional.

Solar and Wind Energy- Applications- Merits and demerits-Global uptake and future possibilities of solar and wind energy.

Production of ocean, geothermal and hydro energy –Energy conversion- Global uptake and future possibilities of ocean, geothermal and hydro energy.

Energy production from biomass and wastes-Biomass resources- Biomass conversion technologies- Fuel cells- types and applications.

Energy Storage and Conservation - Characteristics and uses of Energy Storage System-Energy Conservation Methods-Case Studies.

v) (a) TEXT BOOKS

1) Boyle, Godfrey, “Renewable Energy”, 3rd Edition, Oxford University Press, 2012.
2) Bansal N. K., Kleemann M., Michael Meliss, “Renewable Energy Sources & Conversion Technology”, Tata McGraw Hill publishing Company, New Delhi 1990.
3) Rai G. D., “Non-conventional Energy Sources”, Khanna Publishers, 2011.

(b) REFERENCES

1) Gary L. Johnson, “Wind Energy System”, Prentice Hall Inc, 1995.

2) Earnest J., Wizelius T., "Wind Power Plants and Project Development", PHI Learning Pvt Ltd, 2nd Edition, 2015.
3) Rai G. D., "Solar Energy Utilization", Khanna Publishers, 1995.
4) Sayigh A. A. M., "Solar Energy Engineering", Academic Press, 1977.
5) Abbasi S. A., Abbasi N., "Renewable Energy Sources and Their Environmental Impact", Prentice Hall of India, 2001.
6) Khan B. H., "Non-Conventional Energy Resources", Tata McGraw Hill, 2009.
7) Sawhney G. S., "Non-Conventional Energy Resources", PHI Learning, 2012.
8) Allen D. T., Shonnard D. R., "Sustainability Engineering: Concepts, Design and Case Studies", Pearson; Illustrated Edition, 2011.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction and Energy Fundamentals**- Sustainability, Need and concept of sustainability, Social, environmental and economic sustainability concepts, Sustainable development, Challenges for sustainable development-Increasing energy demand and climate change. **General classification of energy**- Conventional and non-conventional, Environmental aspects of energy utilization, Energy planning, Renewable energy sources, potentials, achievements and applications	**9**
II	**Solar Energy**- Solar radiation, Solar thermal systems- Collectors- Flat plate and concentrating collectors, Solar pond, Solar cookers, Solar thermal electric power plant, Solar photovoltaic conversion, Merits and limitations of solar energy **Wind Energy** – Availability of wind energy, Site characteristics, Wind turbine types, Wind power plants, Merits and limitations of wind energy Carbon footprint, global uptake and future possibilities for solar and wind energy	**9**
III	**Production of ocean, geothermal and hydro energy**-Ocean thermal electrical conversion, Tidal energy conversion Geothermal energy conversion -Hydropower, Positive and negative attributes of hydropower- Electricity from hydropower - Small hydro power plants. Carbon footprint, global uptake and future possibilities for ocean, geothermal and hydropower.	**9**
IV	**Energy production from biomass and wastes**-Biomass resources, Biomass conversion technologies- direct combustion, pyrolysis, biomass gasification, Biogas production, Bioethanol, Biodiesel, Hydrogen as fuel, Storage of hydrogen, Carbon footprint, global uptake and future possibilities for bioenergy. **Fuel cells**-types and applications.	**9**
V	**Energy Storage and Conservation** - Characteristics & uses of Energy Storage System- Flywheel storage, Compressed air storage, Pumped Hydro Energy Storage-Energy Conservation Methods. **Case Studies** – Sustainability assessment of conventional energy systems, Sustainability assessment of alternative energy systems.	**9**

	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	10 marks
Total	:	**40 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	40	60	3 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EL0M20G	MICROCONTROLLERS & EMBEDDED SYSTEMS	VAC	4	0	0	4	2023

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
EL0M20H	ELECTRIC POWER SUPPLY AND DISTRIBUTION SYSTEMS	VAC	4	0	0	4	2023

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	23ELL2HB	Automatic Control Systems	2-1-0-0	3
II	23ELL2HB	Basics of Machine Learning	2-1-0-0	3
III	23EEL2HF	Network Communication in Smart Grid	2-1-0-0	3
IV	23EEL2HD	Modelling and Analysis of Electrical Machines	2-1-0-0	3

Course Code	Course Name	Category	L-T-P-J	Credit	Year of Introduction
23ELL2HB	AUTOMATIC CONTROL SYSTEMS	VAC	2-1-0-0	3	2023

i) PRE-REQUISITE: 23MAL10B 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 in a control system using transfer function and state space model. It helps the students to get an overview of the basic concepts in control systems and enables them to apply the control principles in various areas of industry.

iii) COURSE OUTCOMES

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

CO1	Explain the various concepts of linear control systems.	Understand
CO2	Develop a mathematical model of various electromechanical systems.	Apply
CO3	Apply Laplace transform to determine the time response and 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) Gopal M., "Control Systems: Principles and Design", 4th Edition, McGraw Hill Education, 2012.
3) 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 in feedback control systems - Mechanical and Electromechanical systems: Force-voltage, force-current analogy. Block Diagram Reduction Techniques, Signal flow graph - Mason's gain formula, Characteristic Equation.	**9**
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.	**9**
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.	**9**
IV	**Frequency domain analysis**: Frequency domain specifications - correlation between time domain and frequency domain responses. 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).	**9**

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.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	40	60	3 hours

Course Code	Course Name	Category	L-T-P-J	Credit	Year of Introduction
23ELL2HD	BASICS OF MACHINE LEARNING	VAC	2-1-0-0	3	2023

i) PRE-REQUISITE: Basics of Python

ii) COURSE OVERVIEW: The goal of this course is to introduce the fundamental concepts of Machine Learning and types of 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 Python	Understand
CO2	Explain the basic concepts of various Machine Learning Algorithms	Understand
CO3	Apply Supervised and Unsupervised Machine learning algorithms using Python Programming	Apply
CO 4	Apply various advanced Machine Learning Algorithms using Python Programming	Apply
CO 5	Apply Machine Learning Algorithms on various Applications of Machine Learning in electrical and electronics domain	Apply

iv) SYLLABUS

Machine Learning and Python – EDA and Data Preprocessing, Data Visualization, Basics of Statistics and Types of Machine Learning Algorithms.
Supervised, Unsupervised and Reinforcement learning, Principle Component Analysis. Advanced Techniques in Machine Learning: Ensemble Methods and Model Optimization, Applications of Machine Learning

v) (a) TEXT BOOKS

1. McKinney, W. (2012). Python for Data Analysis. O'Reilly Media: Sebastopol.
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. Géron, A. (2019). Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow. O'Reilly Media: Sebastopol.
5. 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 to Python and Machine Learning:** Introduction to Python: Data Types in Python, NumPy and Pandas, Data Visualization using Python, Basic Exploratory Data Analysis: EDA & Data Preprocessing, Plots and graphs: Matplotlib, Seaborn and Plotly Introduction to Machine Learning and Machine Learning Algorithms (Supervised, Unsupervised, Reinforcement learning), Statistical Learning: Basics of Applied Statistics	**9**
II	**Supervised Learning**: Introduction to Supervised Learning Algorithm: Linear Regression - Linear relationship, Assumptions of Linear regressions, Errors, Logistic Regression: Logistic function & Sigmoid Curve, Confusion matrix - Accuracy, Precision, Recall, Specificity, Model evaluation Classifiers: Naïve Bayes Classifier, KNN Classifier and Support Vector Machine (SVM)	**9**
III	**Unsupervised Learning:** Introduction to Unsupervised Learning: Clustering Concept & K-Mean Clustering - Distance measures, Types of clustering: Hierarchical Clustering: Distance calculation between data points, Cluster and dendograms formation, Cophenetic correlation Principle Component Analysis (PCA): Principal component Co variance matrix, PCA for dimensionality reduction"	9
IV	**Advanced Techniques in Machine Learning:** Decision Tree: Decision Tree Classifier Gini Index Purning, Ensemble Techniques: Bagging, Boosting, Random Forest Feature Engineering and Cross-Validation: k-fold cross-validation, stratified cross-validation Model Performance Measures & Hyperparameter tuning: Grid search, random search"	**9**
V	**Application of Machine Learning using Python:** Applications of Machine learning in various domains, Implementation of Machine Learning Algorithms using Python (Supervised and Unsupervised Learning), Case studies and real-world applications of machine learning in various domains	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**40 marks**

ix) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	40	60	3 hours

Course Code	Course Name	Category	L-T-P-J	Credit	Year of Introduction
23EEL2HF	NETWORK COMMUNICATION IN SMART GRID	VAC	2-1-0-0	3	2023

i) PRE-REQUISITE: Nil

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	Explain the concept of smart grid and its components, communication requirements and challenges.	Understand
CO2	Explain wireless sensor networks and their applications,security and reliability issues.	Understand
CO3	Choose the power line communication technologies, channel characteristics and noise mitigation techniques in smart grids.	Apply
CO4	Explain the applications, communication technologies, protocols, standards and challenges of IoT in smart grids.	Understand
CO5	Summarize the benefits of cloud computing and big data analytics in smart grids.	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**,** and big data analytics 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 deployment-benefits and challenges. Types of communications 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 - IEC, IEEE, ANSI, etc.	**9**
II	**Wireless Communications in Smart Grid:** Overview of wireless communication technologies for smart grid, Comparison - range, data rate, power consumption, and cost, Applications. Overview of wireless sensor networks (WSNs) and their characteristics, Applications of WSNs in smart grid - fault detection and isolation, load monitoring, and environmental monitoring, WSN topology design and deployment in smart grid.	**9**

	Overview of wireless communication security and reliability challenges in smart grid. Authentication, authorization, and access control in wireless communication for smart grid.	
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. PLC- Channel characteristics and noise mitigation techniques, Techniques for noise mitigation in PLC: 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 PLC in smart grid.	**9**
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.	**9**
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 in smart grid - Data sources in smart grid, Data management and processing in smart grid, Big data analytics techniques in smart grid.	**9**
	Total hours	**45**

vii) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	25 marks
Assignment/Project/Case study etc.	:	10 marks
Total	:	**40 marks**

viii) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	40	60	3 hours

Course Code	Course Name	Category	L-T-P-J	Credit	Year of Introduction
23EEL2HD	MODELLING AND ANALYSIS OF ELECTRICAL MACHINES	VAC	2-1-0-0	3	2023

ix) PRE-REQUISITE: Nil

x) 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.

xi) COURSE OUTCOMES

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

CO1	Develop the generalised model of electrical machines.	Apply
CO2	Outline the general equations for voltage and torque of rotating machines.	Understand
CO3	Apply the generalised 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

xii) 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.

xiii) (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/

xiv) 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**

xv) CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	5 marks
CA Exams (2 numbers)	:	20 marks
Assignment/Project/Case study etc.	:	15 marks
Total	:	**43 arks**

xvi) MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	40	60	3 hours