CURRICULUM
&
SYLLABUS
2023 Scheme
(Autonomous)

B.TECH
ELECTRICAL AND COMPUTER ENGINEERING

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

Mar Ivanios Vidyanagar, Nalanchira, Thiruvananthapuram – 695015

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

SECOND YEAR SYLLABUS

2023 SCHEME

Items	Board of Studies (BOS)	Academic Council (AC)
Date of Approval	01.04.2024	19.06.2024

Head of Department
Chairman, Board of Studies

Principal
Chairman, Academic Council

MAR BASELIOS COLLEGE OF ENGINEERING & TECHNOLOGY (AUTONOMOUS) ★ MAR IVANIOS VIDYANAGAR THIRUVANANTHAPURAM PIN: 695015

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

SEMESTER III						
Slot	**Category Code**	**Course Code**	**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	Electric Circuit Analysis	3-1-0-0	4	4
E	ESC	23ESL00A	Design Engineering	2-0-0-0	2	2
G	HSC	23HSL2NA	Professional Ethics	2-0-0-0	2	1*
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		Remedial/Minor Course	3-0-0-0/ 2-1-0-0	3	3
TOTAL					**26/29**	**23/26**

* Not to be considered for Grade/GPA/CGPA. Pass or Fail only.

B.Tech MINORS (Same as EEE)

Course Code	Courses	L-T-P-J	Credit
23EEL2MA	Microcontrollers 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

SEMESTER IV						
Slot	**Category Code**	**Course Code**	**Courses**	**L-T-P-J**	**Hours**	**Credit**
A	BSC	23MAL20D	Probability, Statistics and Numerical Methods	3-1-0-0	4	4
B	PCC	23ELL20D	Computer Organization and Architecture	3-1-0-0	4	4
C	PCC	23ELB20E	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	23HSL2NB	Universal Human Values - II	2-1-0-0	3	1*
G	ESC	23ESL2NC	Industrial Safety Engineering	2-1-0-0	3	1*
S	PCC	23ELP20C	Digital Electronics and Logic Design Lab	0-0-3-0	3	2
R/M/H	VAC		Remedial/Minor Course	3-0-0-0/ 2-1-0-0	3	3
TOTAL					**27/30**	**21/24**

* Not to be considered for Grade/GPA/CGPA. Pass or Fail only.

B.Tech MINORS (Same as EEE)

Course Code	Courses	L-T-P-J	Credit
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)

Group	Course Code	Course Name	L-T-P-J	Credits
I	23EEL2HB	Automatic Control Systems	2-1-0-0	3
II	23EEL2HD	Basics of Machine Learning	2-1-0-0	3
III	23EEL2HF	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

SYLLABUS

SEMESTER III

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23MAL20B	DISCRETE MATHEMATICAL STRUCTURES	BSC	3	1	0	0	4	2023

i) COURSE OVERVIEW

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

ii) COURSE OUTCOMES

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

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

iii) SYLLABUS

Mathematical logic - Tautology, Contradiction. Logical Equivalence - The Laws of Logic, The Principle of duality, Logical Implication - Rules of Inference, The use of Quantifiers– Logical equivalences and implications for quantified statement, Implications, Negation.
Linear recurrence relations with constant coefficients – homogeneous, non-homogeneous Solution. Principles of counting.
Binary Relation and Functions. - Relations, Equivalence Relations and partitions. Partial Order relations partially ordered Set - Lattice, Properties of Lattice.

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

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

Matrix representation of graphs, Trees, basic properties of trees, Binary trees, Spanning and Minimal spanning tree, Dijkstra, prims and Kruskal algorithms
Connectivity, Cut set and Cut vertices, Fundamental circuits, Planar graphs and their properties, Planarity of graphs, Kurtowski's two graphs, Euler's formula, Coloring- Chromatic number, Chromatic polynomial, Matchings, Coverings, Four color problem and Five color problem. Greedy colouring algorithm

iv) a) TEXTBOOKS

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

b) REFERENCES

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

v) COURSE PLAN

Module	Contents	No. of hours
I	Mathematical logic, Basic Connectives and Truth Table Statements, Tautology, Contradiction Logical Equivalence, The Laws of Logic, The Principle of duality, Substitution Rules, The implication, The Contrapositive, the Converse, the Inverse. Logical Implication, Rules of Inference, The use of Quantifiers, Open Statement, Quantifier, Negation Linear Recurrence Relations with Constant Coefficients of order one and two-Homogeneous Solution Nonhomogeneous Solution. Pigeonhole principle, Principle of inclusion and exclusion, derangements.	**12**
II	Binary Relation-Reflexive Relations, Symmetric Relations, Transitive relations, Antisymmetric Relations-Partial Order relations Equivalence Relation, Equivalence Classes Partitions, Irreflexive Relations. Partially ordered Set, Hasse Diagram Maximal-Minimal Element, Least Upper bound, Greatest Lower Bound. Lattice- Dual Lattice, sub lattice, Properties of glb and lub Properties of Lattice, Special Lattice, Complete Lattice, Bounded Lattice, Complemented Lattice, Distributive Lattice	**12**
III	Algebraic Systems-Binary operations on a set and its properties Semi group, Monoid, Sub semigroup and sub monoid Cyclic monoid Homomorphism and Isomorphism of Semigroup, Monoids and Groups, Elementary Properties, Subgroup, Symmetric group on three Symbols The	**12**

	direct Product of two Groups-Group Homomorphism, Isomorphism, Cyclic group, Right coset, Left coset, Lagrange's Theorem	
IV	Concepts of Graphs and Trees: Definition, incidence and degree, sub graphs walks, paths, circuits, Isomorphism, Connectedness, Eulerian and Hamiltonian graphs, Travelling salesman problem, Fleury's algorithm, Matrix representation of graphs, adjacency and incidence matrix Trees, basic properties of trees, Binary trees Spanning and Minimal spanning tree Graph theoretical algorithms: Dijkstra, prims and Kruskal algorithm)	**12**
V	Connectivity and Planar Graphs Vertex Connectivity, Edge Connectivity, Cut set and Cut vertices, Fundamental circuits, Planar graphs and their properties: Planarity of graphs, Kurtowski's two graphs, Euler's formula, Coloring- Chromatic number, Chromatic polynomial, Matchings, Coverings, Four color problem and Five color problem. Greedy colouring algorithm.	**12**
	Total	**60**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

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	J	Credit	Year of Introduction
23ELL20A	INSTRUMENTATION SYSTEMS	PCC	3	1	0	0	4	2023

i) 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.

ii) 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

iii) 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.

iv) (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.

v) 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	**12**

	wattmeter method, two wattmeter method and single wattmeter method, Induction type 1-phase energy meter – construction and working.	
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**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

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**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 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) 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.

ii) 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

iii) 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.

iv) (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) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

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**

CONTINUOUS ASSESSMENT TEST

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

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 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) 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.

ii) 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

iii) 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.

iv) (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.

v) 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**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

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**

CONTINUOUS ASSESSMENT TEST

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

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ESL00A	DESIGN ENGINEERING	ESC	2	0	0	0	2	2023

i) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental principles of design engineering. Students are required to utilize design thinking as a crucial and pertinent approach to learning, reflecting its significance and relevance in contemporary contexts. The course also focuses on familiarizing the students with the concepts of innovative idea generation and presentation along with its market viability and business model.

ii) COURSE OUTCOMES

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

CO1	Demonstrate the ability to effectively apply the principles of the design process in solving real-world engineering challenges.	Apply
CO2	Analyse user needs and frame well-defined problem statements.	Analyse
CO3	Create innovative ideas to solve real-world problems by applying the principles of Design Thinking.	Create
CO4	Explain the concepts of Modular design, Ergonomics and Aesthetics to address design challenges.	Understand
CO5	Create a pitch deck and deliver a presentation that effectively communicates an innovative idea.	Create

iii) SYLLABUS

Defining a Design Process-: Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.

Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test.

Empathize: Understanding User Needs, Define- Framing the Problem. Translating empathy findings into actionable problem statements.

Ideate: Brainstorming, Steps in Brain Storming: Divergent-Convergent Thinking and Questioning. Prototype: Inexpensive prototypes to quickly explore and iterate on ideas. Test: Gathering feedback from real users through interactions

Design Engineering Concepts: Modular Design and Life Cycle Design Approaches. Bio-mimicry, Aesthetics and Ergonomics in Design. Design for Production, Use, and Sustainability.

Product Viability and Business Model- Value Proposition, Market Opportunity, Cost-Revenue Relationship, Technology and Implementation, Competitive Analysis, Traction and Milestones.

iv) a) TEXTBOOKS

1. Yousef Haik, Sangarappillai Sivaloganathan, Tamer M. Shahin, Engineering Design Process, Third Edition, Cengage Learning, January 2017
2. Michael Lewrick, Patrick Link, Larry Leifer, Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems, Wiley Publications, June 2018
3. Michael Lewrick, Patrick Link, Larry Leifer, The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods, Wiley Publications, April 2020
4. A Osterwalder, Value Proposition Design: How to Create Products and Services Customers Want, Wiley Publications, October 2014

b) REFERENCES

1. Dr. Amitkumar Goudar, The Secrets of Design Thinking Mindset: More Tools and Techniques To Enhance Your Design Thinking Skill, Clever Fox Publishing, October 2023
2. Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-Solving, Penguin Random House India Private Limited, 2020
3. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business; Revised, Updated edition, March 2019
4. Don Norman, The Design of Everyday Things, Basic Books; 2 edition November 2013
5. Voland, G., Engineering by Design, Pearson India 2014, Second Edition, ISBN 9332535051

iv) COURSE PLAN

Module	Contents	No. of hours
I	**Design Process**: - Defining a Design Process-: Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.	3
	Practical Exercise: Need Identification Case studies. How to define a Problem Statement. Present an idea using the stages of the Design Process.	3
II	**Design Thinking Approach** - Introduction to Design Thinking. Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. **Empathize:** Understanding User Needs, Gathering meaningful insights from users.	3

	Define: Framing the Problem. Translating empathy findings into actionable problem statements. Utilizing tools such as problem statements, point-of-view statements, and user personas.	
	Practical Exercise: Analyse user needs and frame well-defined problem statements	**3**
III	**Ideate:** Brainstorming, Steps in Brain Storming: Divergent-Convergent Thinking and Questioning. **Prototype:** Low-Fidelity Prototyping: Building rough, inexpensive prototypes using materials like paper, cardboard, or digital wireframes to quickly explore and iterate on ideas. **Test:** Gathering feedback from real users through interviews, surveys, or usability tests to evaluate prototypes and refine designs.	**3**
	Practical Exercise: Design Thinking in a Team Environment. Create innovative ideas to solve real-world problems by applying the principles of Design Thinking	**3**
IV	**Design Engineering Concepts:** Modular Design and Life Cycle Design Approaches. Application of Bio-mimicry, Aesthetics and Ergonomics in Design. Design for Production, Use, and Sustainability. **Design Communication:** Communicating Designs Graphically, Communicating Designs Orally and in Writing.	**3**
	Practical Exercise: Apply the concepts of Modular design, Ergonomics and Aesthetics to address design challenges.	**3**
V	**Product Viability and Business Model:** Customer Segments, Value Proposition, Market Opportunity, Cost- Revenue Relationship, Technology and Implementation, Competitive Analysis, Traction and Milestones.	**3**
	Practical Exercise: Create a Pitch deck and make a presentation of the idea generated along with its business model.	**3**
	Total hours	**30**

v) ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Test	:	20 marks
Assignment	:	15 marks
Total	:	**40 marks**
End Semester Evaluation (Design Presentation)	:	**60 marks**

End Semester Evaluation (60 Marks)

The end semester evaluation for Design and Engineering will consist of a group presentation, with a maximum group size of 5 students. Students will be required to apply

the fundamentals of design thinking learned during the course to identify and address a problem statement. The problem statement shall be selected from the pool of problems provided by various Government departments and industries listed in initiatives such as Smart India Hackathon or Young Innovators Programme or their own solution to a potential regional real-world problem.

Mark Distribution for Design Presentation (60 Marks):

Understanding of User Needs and Problem Statement: 10 marks

Demonstrating a clear understanding of user needs and articulating a well-defined problem statement.

Creativity and Innovation in Solution Design: 10 marks

Presenting innovative and creative solutions that address the identified problem statement effectively.

Product Market Fit: 10 Marks

Evaluating the market potential and ensuring alignment between the proposed solution and market demands.

Clarity and Effectiveness of Presentation: 10 marks

Delivering a clear and engaging presentation that effectively communicates the proposed solution and its benefits.

Competitive Analysis: 10 Marks*Conducting a thorough analysis of competitors and market dynamics to inform strategic decision-making.*

Individual and Teamwork: 10 Marks

Assessing individual contributions to the presentation as well as the effectiveness of teamwork and collaboration within the group.

This evaluation format provides students with an opportunity to apply their knowledge and skills in design thinking to real-world problems, while also evaluating their ability to work effectively in teams and deliver compelling presentations.

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23HSL2NA	PROFESSIONAL ETHICS	HSC	2	0	0	0	1	2023

i) COURSE OVERVIEW

The objective of this course is to create an awareness on engineering ethics and human values. The course also aims to instill moral and social values, loyalty and also to learn to appreciate the rights of others

ii) COURSE OUTCOMES

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

CO1	Identify different skills required in personal life.	Understand
CO2	Apply well-defined techniques to cope with emotion and stress.	Apply
CO3	Solve moral and ethical problems in professional life.	Apply
CO4	Explain the core values that shape the ethical behaviour of a professional.	Understand
CO5	Solve moral and ethical problems through explorations and assessment by established experiments.	Apply
CO6	Apply the knowledge of human values and social values to contemporary ethical values and global issues	Apply

iii) SYLLABUS

Meaning and significance of life skills. Life skills identified by WHO: Self- awareness, Empathy, Decision making, problem solving, interpersonal relationship, coping with stress, coping with emotion. Self-awareness: Definition, need for self-awareness; Human Values, tools and techniques of SA: questionnaires, journaling, reflective questions, meditation, mindfulness, psychometric tests, feedback Stress Management: Stress, reasons and effects, stress diaries, the four A's of stress management, techniques, approaches: action- oriented, emotion-oriented, acceptance-oriented, resilience, Gratitude training

Coping with emotions: Identifying and managing emotions, harmful ways of dealing with emotions, PATH method and relaxation techniques

Life skills for Professionals: positive thinking, right attitude, attention to detail, having the big picture, learning skills, research skills, perseverance, setting goals and achieving them, motivation, personality development, IQ, EQ and SQ Responsibilities and Rights.– Collegiality and loyalty- Managing conflict-Respect for authority- Collective bargaining- Confidentiality-Role of confidentiality in moral integrity- conflicts of interest-occupational crime-professional rights-employee right-IPR discrimination

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

Engineering as social Experimentation- Engineering as Experimentation-Engineers as responsible Experimenters- Codes of Ethics- Plagiarism-A balanced outlook on law-Challenger case study-Bhopal gas tragedy
Global Ethical Issues- Multinational Corporations- Environmental Ethics-Business Ethics-Computer Ethics- Role in Technological Development-Engineers as Managers-Consulting Engineers- Engineers as Expert witnesses and Advisors-Moral leadership

iv) a) TEXTBOOKS

1) Remesh S., Vishnu R.G., "Life Skills for Engineers", Ridhima Publications, 1st Edition, 2016.
2) Life Skills for Engineers, Complied by ICT Academy of Kerala, McGraw Hill Education (India) Private Ltd., 2016
3) M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi,2012
4) R S Naagarazan, A textbook on professional ethics and human values, New age international (P) limited, New Delhi,2006.

b) REFERENCES

1) Barun K. Mitra, Personality Development & Soft Skills, Oxford Publishers, 3rd impression, 2017.
2) Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi,2014.
3) Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey, 2004.
4) Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics-Concepts and cases, Wadsworth Thompson Learning, United states,2005.

v) COURSE PLAN

Module	Contents	No. of hours
I	Overview of Life Skills: Meaning and significance of life skills. Life skills identified by WHO: Self- awareness, Empathy, Decision making, problem solving, interpersonal relationship, coping with stress, coping with emotion. Self-awareness: Definition, need for self-awareness; Human Values, tools and techniques of SA: questionnaires, journaling, reflective questions, meditation, mindfulness, psychometric tests, feedback. Stress Management: Stress, reasons and effects, stress diaries, the four A's of stress management, techniques, Approaches: action- oriented, emotion- oriented, acceptance- oriented, resilience, Gratitude Training, Coping with emotions: Identifying and managing emotions, harmful ways of dealing with emotions, PATH method and relaxation techniques	5
II	Life skills for Professionals: positive thinking, right attitude, attention to detail, having the big picture, learning skills, research skills, perseverance, setting goals and achieving them, motivation, personality development, IQ, EQ, and SQ Collegiality and loyalty, Managing conflict, Respect for authority Collective bargaining, Confidentiality, Role of confidentiality in moral integrity,	5

	Conflicts of interest-Occupational crime, Professional rights, Employee right, IPR, Discrimination	
III	Senses of Engineering Ethics, Variety of moral issues, Types of Inquiry-Professionalism, Models of professional roles, Theories about right action-Self-Interest-Customs and Religion, Uses of Ethical Theories	**6**
IV	Engineering as Experimentation, Engineers as responsible Experimenters-Codes of Ethics, Plagiarism, A balanced outlook on law-Case study)	**8**
V	Multinational Corporations, Environmental Ethics, Business Ethics, Computer Ethics-Role in Technological Development, Moral leadership-Engineers as Managers, Consulting Engineers, Engineers as Expert witnesses and advisors	**6**
	Total Hours	**30**

vi) ASSESSMENT PATTERN

Continuous Assessment: Group Project – 50 : 50

Continuous Assessment		
Attendance	:	5 marks
Case Study	:	30 marks
CAT	:	15 marks
(Test to be conducted for 30 marks and need to be converted to 15 Marks)		
Total Continuous Assessment	:	**50 marks**
Group Project with Presentation and Report	:	**50 marks**
TOTAL	:	**100 marks**

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) **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.

ii) **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

iii) **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.

iv) 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.

v) 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**

vi) ASSESSMENT PATTERN

Continuous Assessment : Final Assessment – 60 : 40

Continuous Assessment		
Attendance	:	5 marks
Class work/ Assessment /Viva-voce	:	55 marks
Total Continuous Assessment	:	**60 marks**
Final Assessment	:	**40 marks**
TOTAL	:	**100 marks**

vii) FINAL ASSESSMENT

- Maximum Marks : 40
- Test Duration : 2.5 hours /3 hours

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

i) 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.

ii) 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
CO2	Experimentally calibrate energy meter, ammeter and voltmeter using various methods.	Apply
CO3	Experimentally measure Power and Energy in single and three phase circuits.	Apply
CO4	Extend the range of the ammeter and voltmeter and measure its resistance.	Understand
CO5	Make use of AC circuits to find the unknown capacitance and frequency	Apply
CO6	Develop the characteristics of various transducers by conducting suitable experiments.	Apply

iii) 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.

iv) 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.

v) 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
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment : Final Assessment – 60 : 40

Continuous Assessment		
Attendance	:	5 marks
Class work/ Assessment /Viva-voce	:	55 marks
Total Continuous Assessment	:	**60 marks**
Final Assessment	:	**40 marks**
TOTAL	:	**100 marks**

vii) FINAL ASSESSMENT

- Maximum Marks : 40
- Test Duration : 2.5 hours /3 hours

B.TECH S3 MINORS

Basket	Course Code	Course Name	L-T-P-J	Credits
I	23EEL2MA	Microcontrollers and Embedded Systems	3-0-0-0	3
II	23EEL2MC	Basics of Illumination Science and Lighting Design	3-0-0-0	3
III	23EEL2ME	Sustainable Energy Systems	3-0-0-0	3
IV	23EEL2MG	Electric Machinery	3-0-0-0	3

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2MA	MICROCONTROLLERS AND EMBEDDED SYSTEMS	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The aim of this course is to introduce embedded C programs. Students will be familiarized with 8051 microcontroller and will get an overview of what an embedded system is. This course also provides a brief introduction to various open-source prototyping platforms.

ii) COURSE OUTCOMES

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

CO1	Explain the concepts of an Embedded system.	Understand
CO2	Compare Microcontroller with a Microprocessor and explain the architecture of 8051.	Understand
CO3	Develop 8051 Embedded C programs for Data Operations and Timer/Counter.	Apply
CO4	Develop 8051 Embedded C programs for Serial Communication and Interfacing.	Apply
CO5	Explain different Open-Source Prototyping platforms.	Understand

iii) SYLLABUS

Overview of Embedded Systems: Characteristics, Architecture, Categories, Design process, Challenges, Trends.

Introduction to Microprocessor and Microcontrollers, 8051 architecture.

8051 programming in C – I/O programming, programming on Data Conversions, Timer/Counter programs, 8051 embedded c serial communication programs, Interfacing of ADC, DAC, LCD, DC motor.

Introduction to different open-source prototyping platform - Arduino, Raspberry Pi, Galileo.

iv) (a) TEXT BOOKS

1) Mohammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D McKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, Pearson, 2nd Edition,2007.
2) Kenneth J. Ayala, The 8051 Microcontroller Architecture, Programming and Application, Cengage Learning, 3rd Edition,2012.
3) Raj Kamal, Microcontrollers: Architecture, Programming, Interfacing and System Design, Pearson Education, 2nd Edition, 2012.

(b) REFERENCES

1) Shibu K. V., "Introduction to Embedded Systems", 2nd Edition, McGraw Hill Education India, 2016.
2) Uday Shankar V., Mallikarjun Swamy, "The 8051 Microcontroller", McGraw Hill, 2009.
3) Dr. Uma Rao K., Dr. Andhe Pallavi, "The 8051 Microcontroller", Sanguine, 2009.
4) Steve Heath, "Embedded Systems Design", Newnes, 2nd Edition, 2002.
5) Simon Monk, "Programming Arduino: Getting started with sketches", Mc Graw Hill, 2nd Edition, 2016.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Overview of Embedded System**: Definition, Application areas, Design of embedded systems, Recent trends and challenges in embedded systems. Introduction to embedded microcontroller cores.	**8**
II	**Microprocessors and microcontroller-** Introduction, Microprocessors and Microcontrollers, RISC & CISC CPU Architectures, Harvard & Von-Neumann CPU architecture. 8051 Architecture, Memory organization, External memory interfacing, Stack.	**8**
III	**8051 Programming in C:** Data types and time delays in 8051C, I/O programming, logic operations, data conversion programs, accessing code ROM space, data serialization. **Timer / Counter Programming in 8051**: Programming 8051 Timers, Counter Programming, programming timers 0 and 1in 8051C.	**10**
IV	**8051 Serial Communication:** Basics of Serial Communication, 8051 connections to RS-232, 8051 Serial communication Programming, Programming the second serial port, Serial port programming in C. **8051 Interfacing and Applications:** Interfacing 8051 to LCD, Keyboard, parallel and serial ADC, DAC, Stepper motor interfacing, DC motor interfacing and PWM.	**11**
V	**Introduction to Open-source prototyping platforms**: Arduino, Raspberry Pi, ARM Cortex, Intel Galileo, Basic Arduino programming; Raspberry pi; Intel Galileo boards	**8**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

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**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 3 hours

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

i) 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.

ii) 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	Choose lamps and luminaires for specific applications.	Apply
CO4	Design interior and exterior lighting systems.	Apply
CO5	Choose suitable control methods for lighting and demonstrate various features of aesthetic lighting.	Apply

iii) 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.

iv) (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", ErCOEdition, 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.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Light, sight and 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 localized - Artificial lighting as substitute to natural light. Good Practices in Lighting.	**8**
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.	**8**
III	**Balance of lighting in indoor and outdoor workplaces:** Daylight- Room brightness- Task lighting - Glare - Specular reflection - Balance of daylight and electrical light- Colour appearance of lamps - Sunlight shading. **Light sources:** Different types of lamps and its evolution - Incandescent lamp - Fluorescent Lamp, Compact Fluorescent Lamp (CFL). Sodium Vapour lamp, Metal halide Lamps, Argon Neon lamps for signboards. Introduction to LED Lighting.	**10**
IV	**Design of Interior Lighting:** Interior Lighting Design Standards - Maintenance factor, Uniformity ratio, Direct ratio, Coefficients of utilisation and factors affecting it - Illumination required for various work planes, Space to mounting height ratio (SHR) - DLOR and ULOR - Selection of lamp and luminance - Selection of utilisation factor, reflection factor and maintenance factor - Calculation of wattage of each lamp and no of lamps needed - Layout of luminaires. **Design of Outdoor Lighting:** Street Lighting design- Flood lighting- Beam angle- Selection of lamp and projector	**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.	**9**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

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**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 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) 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.

ii) 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 production of energy from solar and wind.	Understand
CO4	Discuss energy sources like biomass, tides, ocean, geothermal and hydro.	Understand
CO5	Explain the concept of various types of energy storage systems.	Understand

iii) SYLLABUS

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

General classification of energy- Conventional and non-conventional, Global and Indian energy sources.

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 and Indian scenario- 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.

iv) (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.

v) 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, Global and Indian energy sources, Environmental aspects of energy utilization, Energy planning, Renewable energy sources, potentials, achievements and applications	**8**
II	**Solar Energy**- Solar radiation, Solar thermal systems-Flat plate and concentrating collectors, Solar desalination, Solar Pond, Solar dryers, 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	**8**
III	**Production of ocean, geothermal and hydro energy**-Ocean thermal electrical conversion, Tidal energy conversion Geothermal energy conversion -Hydropower- Global and Indian scenario - Positive and negative attributes of hydropower- Electricity from hydropower - Small hydroplants. Carbon footprint, global uptake and future possibilities for ocean, geothermal and hydropower.	**10**
IV	**Energy production from biomass and wastes**-Biomass resources, Biomass conversion technologies- direct combustion, pyrolysis, biomass gasification, Biogas production, Bioethanol, Biodiesel, Hydrogen as fuel, Biohydrogen production, 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, Battery Storage, Pumped Hydro Energy Storage-Energy Conservation Methods **Case Studies** – Sustainability assessment of conventional energy systems, Sustainability assessment of alternative energy systems.	**10**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

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**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2MC	ELECTRIC MACHINERY	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The goal of this course is to expose students to the fundamental concepts of DC machines, transformers, 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.

ii) COURSE OUTCOMES

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

CO1	Explain the principle of operation and characteristics of DC machines.	Understand
CO2	Apply emf equation and power flow equations to solve problems based on DC Machines.	Apply
CO3	Develop the phasor diagram and equivalent circuit of a transformer, and to calculate its losses and efficiency.	Apply
CO4	Explain the principle of operation and types of three phase and single-phase Induction motors.	Understand
CO5	Illustrate the principle of operation of alternators and synchronous motors and to compute regulation of alternators.	Understand

iii) 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 Induction motor- principle of operation - resistance split phase motor – capacitor start motor.

Synchronous machines: construction– emf equation of alternator – regulation of alternator by emf method - synchronous motors- methods of starting- V curves, synchronous condenser.

iv) (a) TEXT BOOKS

1) Bhimbra P. S., “Electric Machines”, Khanna Publishers, 2nd Edition, 2017.
2) Kothari D. P. and I. J. Nagrath, “Electrical Machines”, Tata McGraw Hill, 2004.

3) Fitzgerald A. E., Kingsley C. and Umans S., "Electric Machinery", McGraw Hill, 6th Edition, 2003.
4) Mehta V. K. and R. Mehta, "Principles of Electrical and Electronics", S. Chand & Company Ltd., 1996.

(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) Theraja B. L. and A. K. Theraja, "A Text Book of Electrical Technology", S. Chand & Company Ltd., 2008.
4) S.K. Bhattacharya, "Electrical Machines", Tata McGraw-Hill Publishing Company Limited, New Delhi.

v) COURSE PLAN

Module	Contents	No. of hours
I	**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 and load characteristics- Power flow diagram - simple numerical problems.	**8**
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 - Power flow diagram – losses and efficiency– load test- simple numerical problems.	**8**
III	**Transformers**: principle of operation – emf equation- phasor diagram- losses and efficiency – OC and SC tests - equivalent circuits - maximum efficiency –regulation- all day efficiency -simple numerical problems- auto transformers.	**8**
IV	**Three phase induction motors**: slip ring and squirrel cage types - principle of operation – rotating magnetic field- power and torque equations - torque slip characteristics - no load and blocked rotor tests - Equivalent Circuit - Circle diagram - methods of starting – star-delta starting, auto transformer starting, rotor resistance starting.	**10**
V	**Single phase Induction motor**: principle of operation of single-phase induction motors – double field revolving theory- types -resistance split phase motor – capacitor start motor- capacitor start run motor. **Synchronous machines**: construction– emf equation of alternator – phasor diagram under lagging power factor - regulation of alternator by emf method. Principle of operation of synchronous motors-methods of starting- V curves, synchronous condenser.	**11**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

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**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 3 hours

SEMESTER IV

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MAL20D	PROBABILITY, STATISTICS AND NUMERICAL METHODS	BSC	3	1	0	0	4	2023

i) COURSE OVERVIEW

This course introduces students to the modern theory of probability and statistics, covering important models of random variables and techniques of parameter estimation and hypothesis testing. A brief course in numerical methods familiarizes students with some basic numerical techniques for finding roots of equations, evaluating definite integrals solving systems of linear equations, and solving ordinary differential equations which are especially useful when analytical solutions are hard to find.

ii) COURSE OUTCOMES

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

CO1	Identify the different discrete random experiments and find the probabilities of their occurrence	Apply
CO2	Identify the different continuous random experiments and find the probabilities of their occurrence	Apply
CO3	Use statistical inference to draw conclusions concerning characteristics of a population based on attributes of samples drawn from the population	Apply
CO4	Find roots of equations, definite integrals and interpolating polynomial on given numerical data using standard numerical techniques	Apply
CO5	Apply standard numerical techniques for solving systems of equations, ordinary differential equations and for fitting curves on given numerical data	Apply

iii) SYLLABUS

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

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

Population and samples, Sampling distribution of the mean and proportion. Test of hypotheses Concerning mean and proportion. Confidence interval.

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

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

method

iv) a) TEXTBOOKS

1) Jay L. Devore, Probability and Statistics for Engineering and the Sciences, 8th edition, Cengage, 2012
2) Erwin Kreyszig, Advanced Engineering Mathematics, 10 th Edition, John Wiley & Sons, 2016.

b) REFERENCES

1) Hossein Pishro-Nik, Introduction to Probability, Statistics and Random Processes, Kappa Research, 2014 (Also available online at www.probabilitycourse.com)
2) Sheldon M. Ross, Introduction to probability and statistics for engineers and scientists, 4th edition, Elsevier, 2009.
3) T. Veera Rajan, Probability, Statistics and Random processes, Tata McGraw-Hill, 2008
4) B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36 Edition, 2010.

v) COURSE PLAN

Module	Contents	No. of hours
I	Discrete random variables and probability distributions, expected value, mean and variance (discrete) Binomial distribution-mean, variance, Poisson distribution-mean, variance, Poisson approximation to binomial- Discrete bivariate distributions, marginal distributions, Independence of random variables (discrete), Expected values	**12**
II	Continuous random variables and probability distributions, expected value, mean and variance (continuous)-Uniform, exponential and normal distributions, mean and variance of these distributions Continuous bivariate distributions, marginal distributions, Independent random variables, Expected values, Central limit theorem.	**12**
III	Population and samples, Sampling distribution of single mean and single proportion (large samples) Confidence interval for single mean and single proportions (large samples) Hypothesis testing basics, large sample test for single mean and single proportion Large sample test for equality of means and equality of proportions of two populations-t-distribution and small sample t-test for single mean and pooled t-test for equality of means	**12**
IV	Errors in numerical computation-round-off, truncation and relative error, Solution of equations – Newton-Raphson method and Regula-Falsi method. Interpolation - finite differences, Numerical integration - Trapezoidal rule and Simpson's 1/3rd rule (Proof or derivation of the formulae not required for any of the methods in this module)	**12**

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

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

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**

CONTINUOUS ASSESSMENT TEST

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

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 3 hours

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

i) 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.

ii) 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

iii) 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.

iv) (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.

v) 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**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

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**

CONTINUOUS ASSESSMENT TEST

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

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELB20E	OBJECT ORIENTED PROGRAMMING USING JAVA	PCC	3	0	3	0	5	2023

i) 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.

ii) 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

iii) 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,	9

	Using Finally statement, Throwing exceptions. Managing Input/Output Files – Concept of streams, Stream classes, Working with files, Random Access Files, Interactive Input and Output.	
	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: 30

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**

CONTINUOUS ASSESSMENT TEST

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

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23HSL2NB	UNIVERSAL HUMAN VALUES-II	HSC	2	1	0	0	3	2023

i) COURSE OVERVIEW:

The objectives of the course are:

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

ii) COURSE OUTCOMES

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

CO1	Understand themselves and their surroundings (family, society, nature)	Understand
CO2	Show more commitment towards what they have learnt about Human values, Human relationship and Human society	Understand
CO3	Apply Sustainable Solutions to Real Life problems based on the learning gained through Universal Human Values	Apply

iii) SYLLABUS

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education Purpose and motivation for the course, recapitulation from Universal Human Values-I

Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration, Continuous Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

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

Understanding Harmony in the Human Being - Harmony in Myself!

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

Understanding the needs of Self ('I') and 'Body' - happiness and physical facility Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) Understanding thecharacteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health.

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

Understanding Harmony in the Family and Society- Harmony in Human Relationship

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, Understanding the meaning of Trust; Difference between intention and competence, Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

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

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence,

Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all pervasive space Holistic perception of harmony at all levels of existence.

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

Implications of the above Holistic Understanding of Harmony on Professional Ethics, Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order Competence in professional ethics:

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

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

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

Case studies of typical holistic technologies, management models and production systems Strategy for transition from the present state to Universal Human Order

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

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

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

iv) (a) TEXT BOOKS

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

(b) REFERENCES

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

v) COURSE PLAN

Module	Contents	No. of hours
I	Understanding Value Education Self-Exploration as the process for Value Education Sharing about oneself Understanding Happiness and Prosperity-the Basic Human Aspirations Right Understanding, Relationship, Physical Facility Exploring Human Consciousness, Happiness and Prosperity - Current Scenario. Method to Fulfil the Basic Human Aspirations Exploring Natural Acceptance	9
II	Understanding Human Being as the Co-existence of the Self and Body. Distinguishing between the needs of the Self and the Body Exploring the difference of needs of the Self and the Body, The Body as an Instrument of the Self. Understanding Harmony in the Self-Exploring Sources of Imagination in the Self-Harmony of the Self with the Body. Programme to ensure Self-Regulation and Health Exploring Harmony of Self with the Body.	9
III	Harmony in the Family-the Basic unit of Human Interaction Values in the Human-to-Human Relationship. 'Trust' –the foundation Value in Relationship Exploring the feeling of Trust. 'Respect' - as the Right Evaluation Exploring the feeling of Respect Understanding Harmony in the Society Vision for the Universal Human Order. Exploring Systems to fulfil Human Goal	9
IV	Understanding Harmony in the Nature Interconnectedness, self-regulation and Mutual Fulfilment among the four orders of Nature Exploring the four orders of Nature Realizing Existence as Co-Existence at all Levels The Holistic Perception of Harmony in Existence Exploring Co-Existence in Existence	9
V	Natural Acceptance of Human Values Definitiveness of (Ethical) Human Conduct Exploring Ethical Human Conduct A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order Competence in Professional Ethics Exploring Humanistic Models in	9

	Education Holistic Technologies, Production Systems and Management-Models-Typical Case Studies Strategies for Transition towards Value –based Life and Profession Exploring Steps of Transition towards Universal Human Order.	
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment		
Continuous Assessment Test (1 No)	:	10 marks
Assignment/Project/Case study etc.	:	20 marks
Self-Assessment	:	5 marks
Peer Assessment	:	5 marks
Peer Assessment can be done on group-wise basis by dividing the class into suitable groups		
Total Continuous Assessment	**:**	**40 marks**
End Semester Examination	**:**	**60 marks**
TOTAL	**:**	**100 marks**

Assessment Pattern can be modified (if needed), subject to the approval of the Committees Concerned.

vii) END SEMESTER EXAMINATION

The End semester examination will be conducted by the faculty. The examination will be for three hours and 60 marks.

MODE OF CONDUCT OF COURSE (L-T- P: 2 – 1 - 0)

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

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

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

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

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

Course Code	Course Name	Cate-gory	L	T	P	J	Credit	Year of Introduction
23ESL2NC	INDUSTRIAL SAFETY ENGINEERING	ESC	2	1	0	0	1	2023

i) COURSE OVERVIEW

Goal of this course is to expose the students to the concepts of safety engineering and identify possible safety requirements. It introduces students to the various safety equipment and precautions. After this course, students will be able to recognize similar safety problems in real-world situations and respond accordingly.

ii) COURSE OUTCOMES

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

CO1	Explain the theories of accident causation and preventive measures of industrial accidents	Understand
CO2	Explain personal protective equipment, its selection, safety performance & indicators and importance of housekeeping.	Understand
CO3	Explain the various hazards and associated safety measures in construction industries.	Understand
CO4	Explain various hazards associated with different machines and mechanical systems.	Understand
CO5	Explain different hazard identification tools in different industries with the knowledge of different types of chemical hazards.	Understand

iii) SYLLABUS

Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, Role of management.

Personal protection in the work environment, Types of PPEs, Personal protective equipment- respiratory and non-respiratory equipment. Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Typical industrial models and methodology.

Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning & Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space –.Temporary Structures. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.

Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas welding and Arc Welding, Material Handling equipment-operation & maintenance. Hearing Conservation Program in Production industries.

Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - Hazard and Operability study (HAZOP)) –Hazardous properties of chemicals, Material Safety Data Sheets

iv) a) TEXTBOOKS

1) R.K Jain, Industrial Safety, Health and Environment management systems, Khanna Publications, 2000.
2) Paul S V, Safety management System and Documentation training Programme handbook, CBS Publication, 2000.
3) Krishnan, N.V. Safety management in Industry. Jaico Publishing House, New Delhi, 1997.

b) REFERENCES

1) AIChE/CCPS. (1992). Guidelines for Hazard Evaluation Procedures. (second edition). Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York.
2) Alan Waring. (1996). Safety management system. Chapman & Hall, England.

v) COURSE PLAN

Module	Contents	No. of hours
I	Need for safety- Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation - Safety, organization- objectives, types, functions, Role of management - supervisors, workers, unions, government and voluntary agencies in safety. Safety policy - Safety Officer-responsibilities, authority. Safety committee - need, types, advantages.	9
II	Personal protection in the work environment - Types of PPEs, Personal protective equipment-respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance - Frequency rate, severity rate, incidence rate, activity rate. Housekeeping - Responsibility of management and employees. Advantages of good housekeeping, 5 s of housekeeping. Work permit system - objectives, hot work and cold work permits.	9
III	Introduction to construction - industry and safety issues in construction. Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning & Shoring – Ladders & Scaffolds. Tunneling – Blasting, Demolition – Confined space – Temporary Structures. Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety. Relevance of ergonomics in construction safety. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.	9

IV	Machinery safeguard - Point-of-Operation, Principle of machine guarding - types of guards and devices. Safety in turning, and grinding. Welding and Cutting - Safety Precautions ofGas welding and Arc Welding. Material Handling – Classification - safety consideration - manual and mechanical handling. Handling assessments and techniques - lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenance of common elements - wire rope, chains slings, hooks, clamps. Hearing Conservation Program in Production industries.	**9**
V	Hazard and risk, Types of hazards – Classification of Fire, Types of Fire extinguishers, fire explosion and toxic gas release, Structure of hazard identification and risk assessment. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis. Hazard and Operability study (HAZOP)) – methodology, criticality analysis,corrective action and follow-up. Control of Chemical Hazards - Hazardous properties of chemicals, Material Safety Data Sheets.	**9**
	Total Hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 100: 0

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
Final Examination (Summative)	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

No. of tests: 02
Maximum Marks: 30
Test Duration: 1½ hours
Topics: 2 ½ modules

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ELP20C	DIGITAL ELECTRONICS AND LOGIC DESIGN LAB	PCC	0	0	3	0	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.

ii) 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.

iii) COURSE PLAN

12 experiments are mandatory

Expt. 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	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment : Final Assessment – 60 : 40

Continuous Assessment		
Attendance	:	5 marks
Class work/ Assessment /Viva-voce	:	55 marks
Total Continuous Assessment	:	**60 marks**
Final Assessment	:	**40 marks**
TOTAL	:	**100 marks**

vii) FINAL ASSESSMENT

- Maximum Marks : 40
- Test Duration : 2.5 hours /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	23ELL2HD	Basics of Machine Learning	2-1-0-0	3
III	23ELL2HF	Network Communication in Smart Grid	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) 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.

ii) 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

iii) 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.

iv) (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.

v) 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**:	9

	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).	
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**

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**

CONTINUOUS ASSESSMENT TEST

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

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 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) COURSE OVERVIEW: The goal of this course is to introduce the fundamental concepts of Machine Learning and types of Machine learning algorithms.

ii) 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.

v) 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**

iv) 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**

CONTINUOUS ASSESSMENT TEST

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

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 3 hours

Course Code	Course Name	Category	L-T-P-J	Credit	Year of Introduction
23ELL2HF	NETWORK COMMUNICATION IN SMART GRID	VAC	2-1-0-0	3	2023

i) 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.

ii) 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

iii) 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**.**

iv) (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.

v) 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. Overview of wireless communication security and reliability challenges in smart grid. Authentication, authorization, and access control in wireless communication for smart grid.	9
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.	9

	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.	
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**

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**

CONTINUOUS ASSESSMENT TEST

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

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 3 hours

B.TECH S4 MINORS

Basket	Course Code	Course Name	L-T-P-J	Credits
I	23EEL2MB	Hardware Interfacing using Arduino-C Platform	3-0-0-0	3
II	23EEL2MD	Electric Power Supply and Distribution Systems	3-0-0-0	3
III	23EEL2MF	Renewable Energy in Power Grids	3-0-0-0	3
IV	23EEL2MH	Power Electronics and Energy Storage Devices	3-0-0-0	3

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2MB	HARDWARE INTERFACING USING ARDUINO-C PLATFORM	VAC	3	0	0	0	3	2023

i) 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.

ii) 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	Develop basic Embedded C programming used in Arduino.	Apply
CO3	Explain the Debugging process and basics of serial communication in Arduino	Understand
CO4	Interpret the Interfacing of various sensors and actuators with Arduino	Understand
CO5	Explain the shields used to extend the capabilities of an Arduino based system.	Understand

iii) 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 - Arduino tool chain, Cross compilation, Arduino sketches, Classes, Sketch structure, Pins, Input and output, Blink example, Debugging, Debug Environments, Debug via Serial, UART Protocol, UART Synchronization, UART Parity and stop , Serial on Arduino, Reading from Serial Electrical circuits

iv) (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 setup	**9**
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	**9**
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	**10**
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.	**9**
V	Arduino Shields – Ethernet Shield – Ethernet library – Client examples – Ethernet server – WiFi Shield.	**8**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

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**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2MD	ELECTRIC POWER SUPPLY AND DISTRIBUTION SYSTEMS	VAC	3	0	0	0	3	2023

i) 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.

ii) 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	Apply load flow analysis, state estimation, short circuit analysis, stability analysis and harmonic analysis in power systems.	Apply
CO3	Explain generation control and dispatch, load control, power system protection and stability analysis.	Understand
CO4	Illustrate the characteristics and benefits of distributed energy resources, and the various aspects of microgrids.	Understand
CO5	Explain smart grid technologies and future trends in electrical power supply systems.	Understand

iii) 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, Energy storage systems and their applications. Future trends and developments in electrical power supply systems.

iv) (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.

v) 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	**8**
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. **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.	**9**

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.	**8**
V	**Smart grid technologies:** Smart grid concepts, communication technologies for the smart grid, smart grid applications, smart grid security. **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.	**8**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

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**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2MF	RENEWABLE ENERGY IN POWER GRIDS	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The goal of this course is to expose the students to the fundamental concepts of the integration of renewable energy sources to power grids. The course also intends to cover the basic concepts of various power converter circuits for renewable energy systems.

ii) COURSE OUTCOMES

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

CO1	Explain the basic concepts of Distributed Generation and Microgrids.	Understand
CO2	Illustrate the various types of Distributed Energy Resources in Microgrids.	Understand
CO3	Explain the various protection issues of microgrids and the impact of DG integration on power quality.	Understand
CO4	Illustrate the working of DC-DC converters for solar photovoltaic applications	Understand
CO5	Illustrate the working of Voltage Source inverters	Understand

iii) SYLLABUS

Distributed generation and Microgrid concept - Distributed generation, Need for integration of Distributed Energy Resources, Active distribution network, Concept of Microgrid.

Distributed energy resources - Combined heat and power systems, Wind energy conversion systems, Solar Photovoltaic systems, Small-scale hydroelectric power generation, Storage devices. Protection Issues for Microgrids – Islanding.

Impact of DG Integration on Power Quality - Introduction, Power Quality Disturbances-Power quality sensitive customers, Existing power quality improvement technologies, Impact of DG Integration.

Power Electronics interface for distributed generation – Ideal Switch, Types of Power Semiconductor Devices. DC-DC Converters – Buck, Boost and Buck-Boost topologies.

Switched Mode Inverters - Single phase half bridge, full bridge and three phase bridge Voltage Source Inverters, AC-AC Converters - Grid integrated wind energy conversion systems, single phase and three phase AC voltage controllers.

iv) (a) TEXT BOOKS

1) Ali Keyhani, “Design of Smart Power Grid Renewable Energy Systems”, Wiley Publications, 3rd Edition, 2019.

2) Chowdhury S., Chowdhury S. P., Crossley P., "Microgrids and Active Distribution", Institution of Engineering and Technology, 2009.
3) Dugan R. C., Granaghen M. F., Beaty H. W., "Electrical Power System Quality", McGraw- Hill, 2nd Edition, 2017.
4) Ned Mohan, Tore M. Undeland, William P. Riobbins, "Power Electronics: Converters, Applications, and Design", John Wiley and Sons Inc., New York, 3rd Edition, 2009.
5) Robert W. Erickson, Dragan Maksimovic, "Fundamentals of Power Electronics", Springer, 3rd Edition, 2022.

(b) REFERENCES

1) James Momoh, "Smart Grid: Fundamentals of Design and Analysis", Wiley IEEE Press, 2015.
2) Remus Teodorescu, MarCOLiserre, Pedro Rodriguez, "Grid Converters for Photovoltaic and Wind Power Systems", Wiley Publications, 1st Edition, 2011.
3) Rashid M. H., "Power Electronics – Circuits, Devices and Applications", Prentice Hall of India, New Delhi, 4th Edition, 2014.
4) Robert Bausiere, Francis Labrique, Guy Seguier, "Power Electronic Converters: DC-DC Conversion", Springer, 2013.
5) Bimbhra P. S., "Power Electronics", Khanna Publishers, New Delhi, 6th Edition, 2018.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Distributed generation and Microgrid concept –** Distributed generation, Need for integration of Distributed Energy Resources, Active distribution network, Concept of Microgrid, A typical Microgrid configuration, Technical and economic advantages of Microgrid, Challenges and disadvantages of Microgrid development, Dynamic interactions of Microgrid with main grid.	9
II	**Distributed energy resources –** Introduction, Combined heat and power (CHP) systems, Wind energy conversion systems (WECS), Solar photovoltaic (PV) systems, Small-scale hydroelectric power generation. **Protection Issues for Microgrids –** Introduction, Islanding: separation from utility, Different islanding detection methods, Major protection issues of stand-alone Microgrid - Microgrid distribution system protection, Protection of microsources.	10
III	**Impact of DG Integration on Power Quality –** Introduction, Power Quality Disturbances- Transients, Voltage sags and swells, Over-voltages and under-voltages, Outage, Harmonic distortion, Voltage notching, Flicker, Electrical noise, Power quality sensitive customers,	9

	Existing power quality improvement technologies, Impact of DG Integration.	
IV	**DC-DC converters for distributed generation –** Power Devices: The ideal switch, Characteristics of ideal switches, Types of Power Semiconductor Devices - Power ratings. Block diagram of solar photovoltaic system, Types of solar PV system-stand-alone operation and grid integrated solar PV system, Need for DC-DC converters, Buck, Boost and Buck-Boost topologies.	**9**
V	**Voltage Source Inverters –** Single phase half bridge, full bridge and three phase bridge Voltage Source Inverters-square wave operation, PWM inverters, Grid connected inverters.	**8**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

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**

CONTINUOUS ASSESSMENT TEST

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

END SEMESTER EXAMINATION

Maximum Marks: 60
Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23EEL2MH	POWER ELECTRONICS AND ENERGY STORAGE DEVICES	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW: The goal of this course is to expose the students to the fundamental concepts of Power Electronic Devices. It also includes the circuit analysis of various power converter circuits. The course also provides an insight into the different energy storage devices.

ii) COURSE OUTCOMES

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

CO1	Explain the operation of modern power semiconductor devices and its characteristics.	Understand
CO2	Illustrate the working of controlled rectifiers.	Understand
CO3	Explain the working of AC voltage controllers and inverters	Understand
CO4	Choose different DC-DC converters based on their performance and applications.	Apply
CO5	Summarize different energy storage techniques	Understand

iii) SYLLABUS

Structure and principle of operation of power devices: Power diode, Power MOSFET & IGBT – switching characteristics - comparison, SiC, GaN

SCR- Structure, characteristics di/dt& dv/dt protection – Turn-on methods of SCR, Gate drive circuit: Triggering circuit-gate drive circuit-Isolation

AC-DC converters: Single phase half wave controlled; fully controlled, semi controlled ac-dc converter Three phase full wave Controlled converter

AC voltage controllers: Single phase AC voltage controller with R & RL load.

Inverters –Single phase half bridge and full bridge inverter, Three Phase inverters

DC choppers–Step up chopper –step down chopper -buck &boost switching regulators

Energy Storage: Battery based energy storage -Fuel Cell based energy storage, Super capacitor and Hydrogen energy storage. Hybridization of different energy storage devices.

iv) (a) TEXT BOOKS

1) Rashid M H, “Power Electronics – Circuits, Devices and Applications”, Prentice Hall of India, New Delhi, 4th Edition, 2014.
2) M.D. Singh and K.B. Khanchandani, “Power Electronics”, Tata McGraw Hills Publishing Company Limited, 2nd Edition, 2006.

(b) REFERENCES

1) Ned Mohan, Tore M. Undeland, William P. Robbins, “Power Electronics: Converters, Applications, and Design”, Wiley India, 3rd Edition, 2018.

2) Dubey G K, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2nd Edition, 2012.
3) Robert W. Erickson, Dragan Maksimovic, "Fundamentals of Power Electronics", Springer, 3rd Edition, 2001.
4) Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003.
5) A.G. Ter-Gazarian, "Energy Storage for Power Systems", 2nd Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN - 978-1-84919-219-4), 2011.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Structure and principle of operation of power devices**- Power Diode, Power MOSFET & IGBT –Basic principles of wideband gap devices-SiC, GaN. **SCR-** Structure, Static characteristics & Switching (turn-on & turn-off) characteristics - di/dt v dv/dt protection – Turn-on methods of SCR. **Gate triggering circuits**- Requirements of isolation and synchronization in gate drive circuits, Opto and pulse transformer-based isolation.	**9**
II	**Controlled Rectifiers (Single Phase)** – Half-wave controlled rectifier with R load– Fully controlled and half controlled bridge rectifier with R, RL (continuous conduction) – Average Output voltage equation. **Controlled Rectifiers (3-Phase)** - 3-phase half-wave controlled rectifier with R load – Fully controlled bridge converter with RLE load (continuous conduction, ripple free) – Output voltage equation-Waveforms for various triggering angles (detailed mathematical analysis not required).	**10**
III	**AC voltage controllers (ACVC)** – 1-phase full-wave ACVC with R, & RL loads – Waveforms – RMS output voltage **Inverters** – Voltage Source Inverters– 1-phase half-bridge & full bridge inverter with R and RL loads – THD in output voltage – 3-phase bridge inverter with R load – 120° and 180° conduction modes–Pulse width modulation techniques	**9**
IV	**DC-DC converters** – Step down and Step up choppers – Single-quadrant, Two-quadrant and Four quadrant chopper – Pulse width modulation & current limit control in dc-dc converters. **Switching regulators** – Buck, Boost–Operation with continuous conduction mode – Waveforms	**9**
V	**Energy Storage**: Energy Storage Requirements, Battery based energy storage -Battery parameters: C-rating -SoC- DoD- Specific Energy- Specific power, Fuel Cell based energy storage, Super capacitor and Hydrogen energy storage. Hybridization of different energy storage devices,	**8**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

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**

CONTINUOUS ASSESSMENT TEST

No. of tests: 02

Maximum Marks: 30

Test Duration: 1 ½ hours

Topics: 2 ½ modules

END SEMESTER EXAMINATION

Maximum Marks: 60

Exam Duration: 3 hours