SCHEME OF INSTRUCTION AND SYLLABI (R-22A)

OF

B.E. I to VIII SEMESTERS OF FOUR YEAR DEGREE COURSE

IN

ELECTRICAL & ELECTRONICS ENGINEERING

(Inline with AICTE Model Curriculum with effect from AY 2024-25)

(R–22A Regulation)

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Affiliated to OU, Approved by AICTE, Accredited by NBA, NAAC (A++)

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CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (Autonomous)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

INSTITUTE VISION AND MISSION

Vision:
To be centre of excellence in technical education and research

Mission:
To address the emerging needs through quality technical education and advanced research

DEPARTMENT VISION & MISSION

Vision:

To achieve Academic and Professional Excellence in Teaching and Research in the frontier areas of Electrical and Electronics Engineering Vis-a -Vis serve as a Valuable Resource for Industry and Society.

Mission:

Empowering the Faculty and Student Rendezvous to Nurture Interest for Conceptual Keystone, Applied Multidisciplinary Research, and Inspiring Leadership and Efficacious Entrepreneurship culture, Impeccable Innovation in frontier areas to be synergetic with Environmental, Societal and Technological Developments of the National and International community for Universal Intimacy.

M1: Emphasis on providing Strong Theoretical Foundation & Engineering Leadership Eminence, infusion of Creativity and Management skill while maintaining Ethics and Moral for Sustainable Development. **(Individual development**)

M2: Enable the Faculty and Student Interactions to trigger interest for Applied Multidisciplinary Research and Entrepreneurship Culture resulting in Significant Advancement of the field of Specialization with Involvement of Industries and Collaborative Educational Networks. **(Sense of Ownership, Networking and Eco system Development)**

M3: Extend the Conducive Neighbourhoods for Innovation in frontier areas to keep pace with Environmental, Societal and Technological Developments of the National and International Community to Serve Humanity. **(Service to Society, Atmanirbhar Bharat)**

PROGRAME EDUCATIONAL OBJECTIVES (PEOS):

- **PEO1-** Graduates will Ennoble in offering Design solutions for Complex Engineering Problems using appropriate modern Software tools, with the specified need of the Industry and Protagonist in transforming the Society into a Knowledge Society.

- **PEO2-** Graduates will Elevate Engineering Leadership and will be recognized as Experts working in in Government, Consulting firms, International organizations with their Creativity in Design of Experiments, Analysis and Interpretation of Data and Synthesis of Information.

- **PEO 3-** Graduates will Exalt in their Professional career by Persistence in Team work, Ethical behavior, Proactive involvement, and Effective Communication.
- **PEO 4-** Graduate will Excel by becoming Researches , Professors and Entrepreneurs who will create and Disseminate new knowledge in the frontier areas of Engineering , Technology and Management

PROGRAM OUTCOMES (POs):

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 analyse 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 lifelong learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOS):

PSO 1: Evaluate complex Engineering Problems to meet the distinct need of Industry & Society, by utilizing knowledge of Mathematics, Science, Emerging Technologies such as AI, Block chain & IT tools.

PSO 2: Exhibit Latent talent in understanding the Engineering and Administration standards at work place as a team leader to manage Projects in the Multi-Disciplinary Environments.

PSO 3: Establish Engineering Expertise in Power system, Machines and Drives Systems and also Pursue Research in the Frontier areas such as Embedded systems, Renewable Energy, E-Mobility and Smart grid.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

(Inline with AICTE Model Curriculum with effect from AY 2024-25)(R22A)

SEMESTER – I

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22MTC02	Calculus	3	1	-	3	40	60	4
2	22CYC01	Chemistry	3	-	-	3	40	60	3
3	22EEC01	Basic Electrical Engineering	2	1	-	3	40	60	3
4	22CSC40N	Problem Solving and Programming using Python	2	1	-	3	40	60	3
PRACTICAL									
5	22CYC02	Chemistry Lab	-	-	3	3	50	50	1.5
6	22MBC02N	Community Engagement	-	-	2	-	50	-	1
7	22CSC41N	Problem Solving and Programming using Python Lab	-	-	3	3	50	50	1.5
8	22MEC37N	Robotics and Drones Lab	-	1	3	-	100	-	2.5
9	22EEC02	Basic Electrical Engineering Lab	-	-	2	3	50	50	1
TOTAL			**10**	**4**	**13**	**-**	**460**	**390**	**20.5**
Clock Hours Per Week: 27									

L: Lecture **D:** Drawing **CIE:** Continuous Internal Evaluation
T:Tutorial **P:** Practical/ Project Seminar/ Dissertation **SEE:** Semester End Examination

22MTC02

CALCULUS
(EEE)

Instruction	3L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

COURSE OBJECTIVES: This course aims to
1. Explain the solutions of system of linear equations by Matrix Methods.
2. Discuss mean value theorems.
3. Explain the Partial Derivatives and the extreme values of functions of two variables.
4. Explain the shape of curves, their areas and volumes of revolutions.
5. Discuss the convergence and divergence of the series.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Apply the Matrix Methods to solve system of linear equations.
2. Analyze the geometrical interpretation of Mean value theorems and curvature.
3. Determine the extreme values of functions of two variables.
4. Find the shape of the curve, surface areas and volumes of revolution.
5. Examine the convergence and divergence of infinite Series.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	-	-	-	-	-	-	-	2			
CO 2	3	3	3	3	-	-	-	-	-	-	-	2			
CO 3	3	3	3	3	-	-	-	-	-	-	-	2			
CO 4	3	3	3	3	-	-	-	-	-	-	-	2			
CO 5	3	3	3	1	-	-	-	-	-	-	-	1			

1 - Slightly; 2 - Moderately; 3 - Substantially

UNIT-I
Matrices: Rank of a matrix, Echelon form, consistency of linear system of equations, Linear dependence and independence of vectors. Eigen values, Eigenvectors, Properties of Eigen values and Eigen vectors, Cayley Hamilton theorem, Quadratic form, Reduction of quadratic form to canonical form by linear transformation, Nature of quadratic form.

UNIT-II
Calculus: Rolle's Theorem, Lagrange's Mean value theorem, Cauchy's Mean value theorem (without proofs). Curvature, Radius of curvature, Centre of curvature, Evolute and Involute, Envelopes.

UNIT-III
Partial Differentiation and Its Applications: Functions of two or more variables, Partial derivatives, Higher order partial derivatives, Total derivative, Differentiation of implicit functions, Jacobians, Taylor's expansion of functions of two variables, Maxima and minima of functions of two variables.

UNIT-IV
Applications of definite integrals: Curve tracing of standard curves (Cartesian only), Applications of definite integrals to evaluate length of curves, surface areas and volumes of revolutions.

UNIT-V
Sequences and Series: Convergence of sequence and series. Tests for convergence of series: Comparison test, limit comparison test, D'Alembert's ratio test, Raabe's test, Cauchy's root test, Alternating series, Leibnitz's series, absolute and conditional convergence**.**

TEXT BOOKS:

1. B.S.Grewal, "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, 2017.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.

SUGGESTED READINGS:

1. B.V.Ramana., "Higher Engineering Mathematics", 11th Reprint, Tata McGraw-Hill, New Delhi, 2010.
2. R.K.Jain, S.R.K.Iyengar, "Advanced Engineering Mathematics", 5th edition, Narosa Publications, 2016.
3. David.Poole, "Linear Algebra: A Modern Introduction", 2nd Edition, Brooks/ Cole, 2005.

22CYC01

CHEMISTRY
(EEE)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. This syllabus helps at providing the concepts of chemical bonding and chemical kinetics to the students aspiring to become practicing engineers
2. Thermodynamic and Electrochemistry units give conceptual knowledge about processes and how they can be producing electrical energy and efficiency of systems.
3. To teach students the value of chemistry and to improve the research opportunities knowledge of stereochemistry and organic reactions is essential.
4. Water chemistry unit impart the knowledge and understand the role of chemistry in the daily life.
5. New materials lead to discovering of technologies in strategic areas for which an insight into Polymers, nanomaterials and basic drugs of modern chemistry is essential.

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

1. Identify the microscopic chemistry in terms of molecular orbitals, intermolecular forces and rate of chemical reactions.
2. Discuss the properties and processes using thermodynamic functions, electrochemical cells and their role in batteries and fuel cells.
3. Illustrate the major chemical reactions that are used in the synthesis of organic molecules.
4. Classify the various methods used in treatment of water for domestic and industrial use.
5. Outline the synthesis of various Engineering materials & Drugs.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	-	-	2	2	-	-	-	-	2			
CO 2	3	2	2	-	-	2	2	-	-	-	-	2			
CO 3	3	2	3	-	-	2	2	-	-	-	-	2			
CO 4	3	2	3	-	-	2	2	-	-	-	-	2			
CO 5	3	2	2	-	-	2	2	-	-	-	-	2			

1 - Slightly; 2 - Moderately; 3 - Substantially

UNIT-I

Atomic and molecular structure and Chemical Kinetics: Atomic and molecular structure: Molecular Orbital theory - atomic and molecular orbitals. Linear combination of atomic orbitals (LCAO) method. Molecular orbitals of diatomic molecules. Molecular Orbital Energy level diagrams (MOED) of diatomic molecules & molecular ions (H_2, He_2^+, N_2 , O_2 , O_2^- , CO, NO). Pi- molecular orbitals of benzene and its aromaticity.

Chemical Kinetics: Introduction, Terms involved in kinetics: rate of reaction, order & molecularity; First order reaction-Characteristics: units of first order rate constant & its half-life period, second order reaction-Characteristics: units of second order rate constant & its half- life period. Numericals.

UNIT-II

Use of free energy in chemical equilibria: Use of free energy in chemical equilibria: Thermodynamic functions: Internal energy, entropy and free energy. Significance of entropy and free energy (criteria of spontaneity). Free energy and emf (Gibbs Helmholtz equations and its applications). Cell potentials, electrode potentials, and – Reference electrodes (NHE, SCE) electrochemical series. Nernst equation and its applications. Determination of pH using combined Glass & Calomel electrode. Potentiometric Acid base & Redox Titrations. Numericals.

Battery technology: Rechargeable batteries & Fuel cells.
Lithium batteries: Introduction, construction, working and applications of Li-MnO_2 and Li-ion batteries.
Fuel Cells: Introduction, difference between conventional cell and fuel cell, limitations & advantages. Construction, working & applications of methanol-oxygen fuel cell.

UNIT- III
Stereochemistry and Organic reactions: Stereochemistry: Representations of 3 dimensional structures, Types of stereoisomerism- Conformational isomerism – confirmations of n-butane (Newman and sawhorse representations), Configurational isomerism -Geometrical (cis-trans) isomerism & Optical isomerism- optical activity, Symmetry and chirality: Enantiomers (lactic acid)&Diastereomers (Tartaric acid), Absolute configurations, Sequence rules for R&S notation.
Types of Organic reactions: Substitution Reactions- Electrophilic substitution (Nitration of Benzene); Nucleophilic Substitution (S_N1& S_N2); Free Radical Substitution (Halogenation of Alkanes)
Addition Reactions: Electrophilic Addition – Markonikoff's rule, Free radical Addition - Anti Markonikoff's rule (Peroxide effect), Nucleophilic Addition – (Addition of HCN to carbonyl compounds)
Eliminations-E1 and E2 (dehydrohalogenation of alkyl halides), Cyclization (Diels - Alder reaction)

UNIT–IV :
Water Chemistry: Hardness of water – Types, units of hardness, Disadvantages of hard water, Alkalinity and Estimation of Alkalinity of water, Boiler troubles - scales & sludge formation, causes and effects, Softening of water by lime soda process (Cold lime soda process), ion exchange method and Reverse Osmosis. Specifications of potable water & industrial water. Disinfection of water by Chlorination; break point chlorination, BOD and COD definition, Estimation (only brief procedure) and significance, Numericals.

UNIT-V
Engineering Materials and Drugs: Introduction, Terms used in polymer science; Thermoplastic polymers (PVC) &Thermosetting polymers (Bakelite); Elastomers (Natural rubber). Conducting polymers- Definition, classification and applications.
Polymers for Electronics: Polymer resists for integrated circuit fabrication, lithography and photolithography
Nano materials-Introduction to nano materials and general applications, basic chemical methods of preparation-Sol-gel method. Carbon nanotubes and their applications. Characterisation of nanomaterials by SEM and TEM (only Principle).
Drugs-Introduction, Synthesis and uses of Aspirin (analgesic), Paracetamol (Antipyretic), Atenolol (antihypertensive).

TEXT BOOKS:
1. P.C. Jain and M. Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company Ltd., New Delhi,16th edition (2015).
2. W.U. Malik, G.D.Tuli and R.D.Madan, "Selected topics in Inorganic Chemistry", S Chand & Company Ltd, New Delhi, reprint (2009).
3. R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, "Organic Chemistry", Pearson, Delhi, 7th edition(2019).
4. A Textbook of Polymer Science and Technology , Shashi Chawla ,Dhanpat Rai & Co. (2014)
5. T. Pradeep, Nano: The Essentials, Tata McGraw-Hill Education, Delhi, 2012 G.L. David Krupadanam, D. Vijaya Prasad, K. Varaprasad Rao, K.L.N. Reddy and C.Sudhakar, "Drugs", Universities Press (India) Limited, Hyderabad (2007).

SUGGESTED READINGS:
1. B. H. Mahan, "University Chemistry", Narosa Publishing house, New Delhi, 3rd edition (2013).
2. B.R. Puri, L.R. Sharma and M.S. Pathania, "Principles of Physical Chemistry", S. Nagin Chand & Company Ltd., 46th edition(2013).
3. T.W. Graham Solomons, C.B. Fryhle and S.A. Snyder, "Organic Chemistry", Wiley,12th edition (2017).
4. P.W. Atkins, J.D. Paula, "Physical Chemistry", Oxford, 8th edition (2006).

22EEC01

BASIC ELECTRICAL ENGINEERING

Instruction	2L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. Understand the behaviour of different circuit elements R, L & C, and the basic concepts of electrical AC circuit analysis
2. Comprehend the basic principle of operation of AC and DC machines
3. Infer about different types of electrical wires and cables, domestic and industrial wiring, safety rules and methods of earthing.

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

1. Understand the concepts of Kirchhoff's laws and their application various theorems to get solution of simple dc circuits.
2. Predict the steady state response of RLC circuits with AC single phase/three phase supply.
3. Infer the basics of single phase transformer
4. Describe the construction, working principle of DC machine and 3-phase Induction motor.
5. Acquire the knowledge of electrical wires, cables, earthing, Electrical safety precautions to be followed in electrical installations and electric shock and its safety and energy calculations.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	-	-	-	-	-	1	2	-	3			
CO 2	3	3	2	-	-	-	-	-	1	2	-	3			
CO 3	3	3	2	1	-	-	-	-	1	2	-	3			
CO 4	2	1	-	-	-	-	-	-	1	2	-	3			
CO 5	2	-	2	-	-	-	-	-	1	2	-	3			

1 - Slightly; 2 - Moderately; 3 - Substantially

UNIT-I

DC Circuits: Electrical circuit elements (R,L and C), voltage and current sources, Kirchhoff current and voltage laws, analysis of simple circuits with dc excitation, Superposition, Thevenin's and Norton's Theorems.

UNIT-II

AC Circuits: Representation of sinusoidal waveforms, peak and RMS values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits consisting of R, L, C, series RL and RC. Three phase balanced circuits, voltage and current relations in star and delta connections.

UNIT-III

Single Phase Transformer: Construction, Working principle, EMF Equation, Ideal and Practical transformer, Equivalent circuit of Transformer, OC and SC tests on a transformer, Efficiency and Regulation

UNIT-IV

DC and AC Machines: DC Generators: Construction, Principle of operation, EMF equation, Classification, Characteristics of shunt generators. DC Motors: Classification, Torque Equation, Characteristics and Speed control of DC Shunt and Series Motors, Losses and efficiency Three - Phase Induction Motors: Principle of operation, Applications

UNIT-V

Electrical Installations: Electrical Wiring: Types of wires and cables, Electrical Safety precautions in handling electrical appliances, electric shock, and first aid for electric shock, safety rules. Components of LT Switchgear:

Switch Fuse Unit (SFU), MCB, ELCB, Earthing (Elementary Treatment only), Elementary calculations for energy consumption

TEXT BOOKS:

1. L. S. Bobrow, Fundamentals of Electrical Engineering, Oxford University Press, 2011.
2. E. Hughes, Electrical and Electronics Technology, Pearson, 2010.

SUGGESTED READINGS:

1. D. P. Kothari & I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2. V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989
3. D.C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009
4. P.V. Prasad, S. Sivanagaraju, R. Prasad, "Basic Electrical and Electronics Engineering" Cengage Learning, 1st Edition, 2013

22CSC40

PROBLEM SOLVING AND PROGRAMMING USING PYTHON

(For Other Branches)

Instruction	2L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Basic Computer Skills.

COURSE OBJECTIVES: This course aims to

1. Master the fundamentals of writing Python scripts, learn core Python scripting elements such as variables, data types, operators and flow control structures.
2. Discover how to work with lists and sequence data and write Python functions to facilitate code reuse.
3. Explore Python Arrays, Perform Searching/Sorting using Collections, Use Python to read and write files.

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

1. Understand real world problems and Create algorithms/flowcharts/decision tables for solving those problems.
2. Interpret the data types, operators and tokens of Python for solving basic programming solutions.
3. Apply the constructs like selection, repetition and functions to modularize the programs.
4. Analyze searching/sorting techniques to solve problems that involve finding and manipulating data.
5. Design and build applications with built-in modules and files.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	1	1	1	-	-	-	-	-	1			
CO 2	3	3	3	1	1	1	-	-	-	-	-	2			
CO 3	3	3	3	1	1	1	-	-	-	-	-	2			
CO 4	3	3	2	1	1	-	-	-	-	-	-	2			
CO 5	3	3	3	1	2	1	-	-	-	-	-	2			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Techniques of Problem Solving: Algorithms, Flowcharts, Decision Table, Programming methodologies viz. top-down and bottom-up programming.

Software requirements for programming: Operating System, Editor (IDE), Compiler, Linker, Loader.

Introduction to Python: Structure of a Python Program, Python program execution steps, Python Interpreter and Script mode of programming, Lines and Indentation, Identifiers and keywords, Literals, Python suite, comments, quotation in python.

UNIT–II

Data Types in Python: Numeric (integer, float, complex), Sequence type with Functions and Methods (string, list and nested/multidimensional lists, tuple), Boolean, Set with Functions and Methods, Dictionary with Functions and Methods, Binary types (bytearray, bytes, memoryview). Type Conversion, Input-Output functions.

UNIT–III

Python Operators: Arithmetic, Relational, Logical, Bitwise, Assignment, Identity and Membership, Ternary operator. Operator precedence and associativity.

Decision Control Statements: Selection/Conditional Branching, Loop Control Structures, Nested Loops.

Comprehensions: List, Dictionary, Set comprehensions.

UNIT–IV

Arrays: Array Definition, Initialization and Accessing elements:1D arrays using array module, 2D arrays using numpy module.

Functions and Modules: Uses of functions, Function definition, Function call, Parameter types, Variable scope and Lifetime, Recursion, Lambda functions.

UNIT–V

Searching and Sorting Techniques: Linear Search, Binary Search, Selection Sort, Bubble Sort.

File Handling: File types, opening and closing files, reading and writing files, file positions.

TEXT BOOKS:

1. Taming Python by Programming, Jeeva Jose, Revised Edition 2019, Khanna Book Publications.
2. Python Programming, Reema Thareja, Oxford Press, 2017.
3. Let us Python, Yashavant Kanetkar and Aditya Kanetkar, First Edition, 2019, BPB Publications.

SUGGESTED READING:

1. Learn Python 3 the Hard Way, Zed A. Shaw, First Edition, 2018, Pearson Education Inc.
2. Python in easy steps: Makes Programming Fun, Mike Mc Grath, Kindle Edition, 2017.
3. The Python Standard Library by Example by Doug Hellmann, Second Edition, June 2017.

ONLINE RESOURCES:

1. https://onlinecourses.swayam2.ac.in/cec24_cs01/preview.
2. https://www.coursera.org/specializations/python.
3. https://www.python.org.
4. https://www.visual-paradigm.com/tutorials/decision-table-in-action.jsp.
5. https://www.coursera.org/specializations/python
6. https://www.python.org

22CYC02

CHEMISTRY LAB

(EEE)

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES: This course aims To

1. Impart fundamental knowledge in handling the equipment / glassware and chemicals in Chemistry laboratory.
2. Provide the knowledge in both qualitative and quantitative chemical analysis
3. The student should be conversant with the principles of volumetric analysis
4. Apply various instrumental methods to analyse the chemical compounds and to improve understanding of theoretical concepts.
5. Interpret the theoretical concepts in the preparation of new materials like drugs and polymers.

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

1. Identify the basic chemical methods to analyse the substances quantitatively & qualitatively.
2. Estimate the amount of chemical substances by volumetric analysis.
3. Determine the rate constants of reactions from concentration of reactants/ products as a function of time.
4. Calculate the concentration and amount of various substances using instrumental techniques.
5. Develop the basic drug molecules and polymeric compounds.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	-	-	2	2	-	-	-	-	2			
CO 2	3	2	1	-	-	1	2	-	-	-	-	2			
CO 3	3	2	3	-	-	2	2	-	-	-	-	2			
CO 4	3	2	2	-	-	2	2	-	-	-	-	2			
CO 5	3	2	3	-	-	2	2	-	-	-	-	2			

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

1. Introduction: Preparation of standard solution of oxalic acid and standardisation of NaOH.
2. Estimation of metal ions (Co+2 & Ni+2) by EDTA method.
3. Estimation of temporary and permanent hardness of water using EDTA solution
4. Determination of Alkalinity of water
5. Determination of rate constant for the reaction of hydrolysis of methyl acetate. (first order)
6. Determination of rate constant for the reaction between potassium per sulphate and potassium
7. Iodide. (second order)
8. Estimation of the amount of HCl Conductometrically using NaOH solution.
9. Estimation of amount of HCl and CH3COOH present in the given mixture of acids Conductometrically using NaOH solution.
10. Estimation of the amount of HCl Potentiometrically using NaOH solution.
11. Estimation of amount of Fe+2 Potentiometrically using KMnO4 solution
12. Preparation of Nitrobenzene from Benzene.
13. Synthesis of Aspirin drug and Paracetamol drug.
14. Synthesis of phenol formaldehyde resin.

TEXT BOOKS:

1. J. Mendham and Thomas , "Vogel's textbook of quantitative chemical analysis", Pearson education Pvt.Ltd. New Delhi ,6th ed. 2002.
2. Senior practical physical chemistry by B.D.Khosla, V.C.Garg & A.Gulati,; R. Chand & Co. : New Delhi (2011).

SUGGESTED READINGS:

1. Dr. Subdharani , “Laboratory Manual on Engineering Chemistry”, Dhanpat Rai Publishing, 2012.
2. S.S. Dara , “A Textbook on experiment and calculation in engineering chemistry”, S.Chand and Company, 9th revised edition, 2015.

22MBC02N

COMMUNITY ENGAGEMENT

Instruction	2P Hours per week
SEE	-
CIE	50 Marks
Credits	1

COURSE OBJECTIVES: This course aims to
1. Develop an appreciation of rural culture, life-style and wisdom among the Students.
2. Learn about the various livelihood activities that contribute to rural economy.
3. Familiarize the Rural Institutions and the Rural Development Programmes in India.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Gain an understanding of Rural life, Culture and Social realities.
2. Develop a sense of empathy and bonds of mutuality with Local Communities.
3. Appreciate significant contributions of Local communities to Indian Society and Economy.
4. Exhibit the knowledge of Rural Institutions and contributing to Community's Socio-Economic improvements.
5. Utilise the opportunities provided by Rural Development Programmes.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	2	2	2	-	3	3	1	2	-	-	2			
CO 2	-	1	2	2	-	3	2	-	2	1	-	1			
CO 3	-	1	1	2	-	2	2	1	3	1	2	1			
CO 4	2	2	3	2	-	2	2	1	2	2	1	-			
CO 5	1	2	2	1	-	1	1	-	1	-	1	1			

1 - Slightly, 2 - Moderately, 3 - Substantially

MODULE-I
Appreciation of Rural Society: Rural life style, Rural society, Caste and Gender relations, Rural values with respect to Community, Nature and Resources, Rural Infrastructure.

MODULE-II
Understanding Rural Economy and Livelihood: Agriculture, Farming, Landownership, Water management, Non-farm Livelihood and Artisans, Rural Entrepreneurs, Rural markets, Rural Credit Societies, Farmer Production Organization/Company.

MODULE-III
Rural Institutions: Traditional Rural organizations, Self-Help Groups, Panchayati Raj Institutions (Gram Sabha), Gram Panchayat, Standing Committees.

MODULE-IV
Rural Development Programmes: History of Rural Development in India, Current National Programmes: Sarva Shiksha Abhiyan, Beti Bhachao, Beti Padhao, Ayushman Bharat, Swachh Bharat, PM AwasYojana, Skill India, NRLM, MNREGA, etc

TEXT BOOKS:
1. Singh, Katar, Rural Development: Principles, Policies and Management, Sage Publications, New Delhi, 2015.
2. A Hand book on Village Panchayat Administration, Rajiv Gandhi Chair for Panchayati Raj Studies, 2002.
3. United Nations, Sustainable Development Goals, 2015, un.org/sdgs
4. M.P Boraia, Best Practices in Rural Development, Shanlax Publishers, 2016.

JOURNALS:

1. Journal of Rural development (published by NIRD & PR, Hyderabad).
2. Indian Journal of Social Work, (by TISS, Bombay).
3. Indian Journal of Extension Educations (by Indian Society of Extension Education).
4. Journal of Extension Education (by Extension Education Society).
5. Kurukshetra (Ministry of Rural Development, GOI).
6. Yojana (Ministry of Information & Broadcasting, GOI).

22CSC41

PROBLEM SOLVING AND PROGRAMMING USING PYTHON LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisite: Basic Computer Skills.

COURSE OBJECTIVES: This course aims to
1. Master the fundamentals of writing Python scripts.
2. Learn Python elements such as variables, flow controls structures, functions and modules.
3. Discover how to work with lists and sequence data, and files.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Inspect and identify suitable programming environment to work with Python.
2. Choose appropriate control constructs, data structures to design and build the solutions.
3. Develop the solutions with modular approach using functions to enhance the code efficiency.
4. Analyze and debug the programs to verify and validate code.
5. Demonstrate use of Standard Template Libraries and modules to build file handling/Searching/Sorting applications.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	-	1	1	-	-	-	-	-	-	2			
CO 2	3	3	3	1	1	1	-	-	-	-	-	2			
CO 3	3	3	3	1	2	1	-	-	-	-	-	2			
CO 4	3	3	3	1	1	1	-	-	-	-	-	2			
CO 5	3	3	3	1	2	1	-	-	-	-	-	2			

1 - Slightly, 2 - Moderately, 3 - Substantially

LABORATORY / PRACTICAL EXPERIMENTS:
1. Explore various Python Program Development Environments.
2. Design Flowcharts using raptor / draw.io tools.
3. Simple scripts to demonstrate the use of basic data types and operators.
4. Demonstrate the use of control structures.
5. Experiments using Comprehensions with List, Dictionary, Set.
6. Implementation using Functions, Lambda functions and parameter passing.
7. Experiments using Searching and Sorting techniques.
8. Experimentation with Arrays using array and numpy modules.
9. Simple scripts to demonstrate the use of built-in modules.(Ex: math, random).
10. Demonstration of File Handling.

TEXT BOOKS:
1. Taming Python by Programming, Jeeva Jose, Revised Edition 2019, Khanna Book Publications.
2. Python Programming, Reema Thareja, Oxford Press, 2017.
3. Let us Python, Yashavant Kanetkar and Aditya Kanetkar, First Edition, 2019, BPB Publications.

SUGGESTED READING:
1. Learn Python 3 the Hard Way, Zed A. Shaw, First Edition, 2018, Pearson Education Inc.
2. Python in easy steps: Makes Programming Fun, Mike Mc Grath, Kindle Edition, 2017.
3. The Python Standard Library by Example by Doug Hellmann, Second Edition, June 2017.

ONLINE RESOURCES:

1. https://onlinecourses.swayam2.ac.in/cec24_cs01/preview.
2. https://www.coursera.org/specializations/python
3. https://www.python.org

22MEC37N

ROBOTICS AND DRONES LAB

(Common to All Branches)

Instruction	1 T + 3P Hours per week
Duration of SEE	-
SEE	-
CIE	100 Marks
Credits	2.5

COURSE OBJECTIVES: This course aims to

1. Develop a thorough understanding of various autonomous robot structures
2. Gain expertise in working with various sensors and gain the ability to interface sensors with microcontrollers, read data, and seamlessly integrate them into robotics applications.
3. Acquire proficiency in understanding different types of motors, motor drivers, develop the skills to interface motors with microcontrollers, motors and construct two-wheel robots with controlled movements.
4. Attain proficiency in utilizing OpenCV for advanced image processing tasks master techniques such as RGB value extraction, creating colored shapes, and extracting Regions of Interest (ROI) from images.
5. Develop a thorough understanding of various drone structures/develop autonomous systems.

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

1. Understand mechanical structures, motors, sensors, and circuits essential for constructing robots.
2. Demonstrate the utilization of sensors (Ultrasonic, IR, Rotary Encoder) for Arduino interfacing, reading data, and integrating them seamlessly into robotics applications.
3. Demonstrate expertise in operating robot controllers, applying theory to precisely control servo and stepper motors, 2 wheel robots ensuring desired motion.
4. Able to apply Python and OpenCV for image processing, including RGB extraction and ROI tasks.
5. Proficiently assemble a quadcopter drone, showcasing understanding of its classification, parts, and operational principles/ Proficiency to develop autonomous systems fostering creativity and practical application.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	2	1	1	-	-	1	3	3	1	2	2	1	3
CO 2	1	2	2	1	1	-	-	1	3	3	1	2	2	1	3
CO 3	1	2	2	1	1	-	-	1	3	3	1	2	3	1	3
CO 4	2	2	2	1	1	-	-	1	3	3	1	2	2	1	1
CO 5	2	2	2	1	1	-	-	1	3	3	1	2	3	1	3

1 - Slightly, 2 - Moderately, 3 - Substantially

LAB EXPERIMENTS:

EXPERIMENT NO	TITLE	CO
1.	Introduction to Robotics, Definition and scope of robotics, Robot configurations- Cartesian, cylinder, polar and articulate. Uses and Significance of Robots, Parts of a Robot, Current applications and future trends. Introduction to Arduino, C++, Arduino Programming Environment. Interfacing Arduino with Electronic Devices such as LEDs/Piezo Buzzer	1
2.	Interfacing Arduino with Electronic Devices such as Push Button/Potentiometer	1
3.	Introduction to Sensors, Types of Sensors, Reading Data from Sensors, Interfacing Sensors with Microcontrollers. Interfacing Arduino with Ultrasonic Distance Sensor and Reading Sensor Data on Serial Monitor	2

4.	Interfacing Arduino with IR Sensor and Reading Sensor Data on Serial Monitor	2
5.	Interfacing Arduino with Rotary Encoder and Reading Sensor Data on Serial Monitor	2
6.	Introduction to motors, Types of motors, Motor drivers, Interfacing motors with Microcontrollers, Introduction to Li-ion, LIPO batteries, uses and safety precaution. Implement a system that utilizes an Arduino microcontroller to control the precise movement of a servo motor.	3
7.	Implement a system that utilizes an Arduino microcontroller to control the precise and sequential movements of a stepper motor.	3
8.	Construct a two-wheel robot using DC motors controlled by an Arduino microcontroller. Implement a program that allows the robot to execute specific movements. The robot should: i. Move forward with controlled acceleration. ii. Move backward with controlled deceleration.	3
9.	Construct an Obstacle avoidance robot	3
10.	Construct a Pick and place robot	3
11.	OpenCv for image processing: i. Extraction of RGB values of a pixel ii. Create colored shapes and save image iii. Extraction of ROI	4
12.	Assembly of quad copter drone.	5

Open-Ended Project on Autonomous System

NOTE:
- Mandatory Open-Ended Project (20 marks) in CIE.
- Any 10 experiments the students must do among the 12 experiments.

SUGGESTED READINGS:
1. https://www.geeksforgeeks.org/robotics-introduction/
2. https://www.ohio.edu/mechanical-faculty/williams/html/PDF/IntroRob.pdf
3. https://www.idtechex.com/en/research-report/new-robotics-and-drones-2018-2038-technologies-forecasts-players/584
4. https://dronebotworkshop.com/.

22EEC02

BASIC ELECTRICAL ENGINEERING LAB

Instruction	2P Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	50 Marks
Credits	1

COURSE OBJECTIVES: This course aims to

1. Acquire the knowledge on different types of electrical elements and to verify the basic electrical circuit laws and theorems.
2. Determine the parameters and power factor of a coil, calculate the time and frequency responses of RLC circuits and to familiarize with measurement of electric power & energy.
3. Determine the characteristics of Transformers, dc, ac machines and switch gear components

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

1. Comprehend the circuit analysis techniques using various circuital laws and theorems.
2. Analyse the parameters of the given coil and measurement of power and energy in AC circuits
3. Determine the turns ration/performance parameters of single-phase transformer
4. Infer the characteristics of DC shunt motor different tests.
5. Illustrate different parts and their function of electrical components, equipment and machines.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	-	-	2	2	-	-	-	-	2			
CO 2	3	2	1	-	-	1	2	-	-	-	-	2			
CO 3	3	2	3	-	-	2	2	-	-	-	-	2			
CO 4	3	2	2	-	-	2	2	-	-	-	-	2			
CO 5	3	2	3	-	-	2	2	-	-	-	-	2			

1 - Slightly, 2 - Moderately, 3 - Substantially

List of Laboratory Experiments/Demonstrations:

1. Verification of KCL and KVL.
2. Verification of Thevenin's theorem.
3. Verification of Norton's theorem.
4. Charging and discharging of Capacitor.
5. Determination of parameters of a choke or coil by Wattmeter Method.
6. Power factor improvement of single-phase AC System.
7. Active and Reactive Power measurement of a single-phase system using
   i. (i) 3-Ammeter method (ii) 3-Voltmeter method
8. Measurement of 3-Phase Power in a balanced system
9. Calibration of single-phase energy meter.
10. Verification of Turns/voltage ratio of single-phase Transformer.
11. Open Circuit and Short Circuit tests on a given single phase Transformer
12. Brake test on DC Shunt Motor
13. Speed control of DC Shunt Motor
14. Demonstration of Measuring Instruments and Electrical Lab components.
15. Demonstration of Low-Tension Switchgear Equipment/Components
16. Demonstration of cut - out section of Machines like DC Machine, Induction Machine etc.

Note: TEN experiments to be conducted to cover all five Course Outcomes.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

(Inline with AICTE Model Curriculum with effect from AY 2024-25)(R22A)

B.E. –ELECTRICAL & ELECTRONICS ENGINEERING

SEMESTER –II

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22MTC05	Vector Calculus and Differential Equations	3	1	-	3	40	60	4
2	22PYC06	Electromagnetic Theory and Quantum Mechanics	3	-	-	3	40	60	3
3	22CEC01N	Engineering Mechanics	3	1	-	3	40	60	4
4	22EGC01N	English	2	-	-	3	40	60	2
PRACTICAL									
5	22PYC09	Electromagnetic Theory and Quantum Mechanics Lab	-	-	3	3	50	50	1.5
6	22EGC02N	English lab	-	-	2	3	50	50	1
7	22MEC01N	Engineering Graphics	-	1	3	3	50	50	2.5
8	22MEC38N	Digital Fabrication Workshop	-	-	3	3	50	50	1.5
TOTAL			**11**	**3**	**11**	**24**	**360**	**440**	**19.5**

L: Lecture **D:** Drawing **CIE:** Continuous Internal Evaluation
T:Tutorial **P:** Practical / Project Seminar / Dissertation **SEE:** Semester End Examination

22MTC05

VECTOR CALCULUS AND DIFFERENTIAL EQUATIONS
(EEE)

Instruction	3 L+1T per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

COURSE OBJECTIVES: This course aims to
1. Explain scalar and vector functions with its Physical interpretations.
2. Discuss vector line, surface and volume integrals.
3. Explain relevant methods to solve first order differential equations.
4. Discuss the solution of higher order Differential Equations
5. Learn Numerical solution of ODE and Engineering problems.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Apply the vector differential operators to Scalars and Vector functions.
2. Solve line, surface & volume integrals by Greens, Gauss and Stoke's theorems.
3. Calculate the solutions of first order linear differential equations.
4. Solve higher order linear differential equations.
5. Find solution of algebraic, transcendental and ODE by Numerical Methods.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	-	-	-	-	-	-	-	2			
CO 2	3	3	3	3	-	-	-	-	-	-	-	2			
CO 3	3	3	3	3	-	-	-	-	-	-	-	2			
CO 4	3	3	3	3	-	-	-	-	-	-	-	2			
CO 5	2	2	2	2	-	-	-	-	-	-	-	1			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I:
Vector Differential Calculus and multiple Integrals: Scalar and Vector point functions, vector operator Del, Gradient, Directional derivative, Divergence, Curl, Del applied twice to point functions, Del applied to product of point functions (vector identities), Irrotational fields and Solenoidal fields, Double integral, Change of order of Integration and Triple integrals.

UNIT-II
Vector Integral Calculus: Line integral, Surface integral and Volume integral. Verification of Green's theorem in a plane (without proof), verification of Stroke's theorem (without proof) and Gauss's divergence theorem (without proof).

UNIT-III:
First Order Ordinary Differential Equations: Exact differential equations, Equations reducible to exact equations, Linear equation, Bernoulli's equation, Clairaut's equation, Riccati's equation, Orthogonal trajectories, Rate of decay of Radio-active materials**.**

UNIT-IV:
Higher Orders Linear Differential Equations: Higher order linear differential equations with constant coefficients, rules for finding Complementary function, Particular Integral and General solution. Method of variation of parameters, solution of Cauchy- Euler equation, LR and LCR circuits

UNIT-V:

Numerical Methods: Solution of Algebraic and transcendental equations by Bisection method, Regula-Falsi method Newton-Raphson method. Numerical Solutions of First Order Ordinary differential equations by Taylor's series method, Euler's method, Modified Euler's method and Runge-Kutta method of fourth order.

TEXT BOOKS:

1. B.S.Grewal, "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, 2017.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.

SUGGESTED READING

1. N.P.Bali and Dr. Manish Goyal, "A text book of Engineering Mathematics", 9th edition, Laxmi Publications, 2017.
2. R.K.Jain, S.R.K.Iyengar, "Advanced Engineering Mathematics", 5th edition, Narosa Publications, 2016.

22PYC06

ELECTROMAGNETIC THEORY AND QUANTUM MECHANICS
(ECE & EEE)

Instruction	3L Hours per week
Duration of SEE	3Hours
SEE	60Marks
CIE	40Marks
Credits	3

COURSE OBJECTIVES: This course aims to
The objectives of the course is to make the student
1. Understand the fundamentals of wave nature of light
2. Familiar with static and dynamic nature of electric and magnetic fields
3. Acquire knowledge of lasers and fiber optics
4. Learn basics of quantum mechanics and properties of solids

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Interpret the wave nature of the light
2. Extend the laws of electric and magnetic fields for wireless communication
3. Explain the principles of lasers and fiber optic communication
4. Find the applications of quantum mechanics
5. Identify semiconductors for engineering applications

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	1	1	1	2	2	1	1	2	1	2			
CO 2	3	2	2	1	1	1	1	1	1	2	2	3			
CO 3	3	1	2	1	2	2	2	1	2	2	2	2			
CO 4	2	2	1	1	1	1	1	1	1	2	1	2			
CO 5	3	2	2	2	2	1	2	2	1	2	1	2			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Wave Optics: Huygen's principle – Superposition of waves – Interference of light by wavefront splitting and amplitude splitting –Interference in thin films (reflected light) – Newton's rings – Fraunhofer diffraction from a single slit – Double slit diffraction–Concept of N-slits–Diffraction grating. Polarization: Introduction–Malus's law –Double refraction –Nicol's prism–Quarter-wave plate and half-wave plate– Optical activity–Laurent's half shade polarimeter.

UNIT-II

Electrostatics: Calculation of electric field and electrostatic potential for a charge distribution–Divergence and curl of electrostatic field– Laplace's and Poisson's equations for electrostatic potential– Uniqueness theorem.
Magnetostatics: Biot-Savart law–Divergence and curl of static magnetic field –Equation for magnetic vector potential and its solution for given current densities – Ferromagnetic, paramagnetic and diamagnetic materials–B-H curve.
Electromagnetic Theory: Review of steady and varying fields–Conduction current and displacement current–Maxwell's equations in differential and integral forms–Electromagnetic wave propagation in free space, dielectric and conducting media – Poynting theorem – Skin depth.

UNIT-III

Lasers: Characteristics of lasers – Einstein's coefficients –Amplification of light by population inversion – Ruby laser – He-Ne laser – Semiconductor laser –Applications of lasers in engineering and medicine.
Fiber Optics: Introduction –Construction –Principle –Propagation of light through an optical fiber – Numerical aperture and acceptance angle – Step-index and graded-index fibers –Pulse dispersion –Fiber losses –Fiber optic communication system –Applications.

UNIT-IV

Quantum Mechanics: Introduction –Wave nature of particles – de-Broglie hypothesis –Physical significance of ψ –Time-dependent and time-independent Schrodinger equations – Born interpretation – Probability current –Wave-packets –Uncertainty principle –Particle in infinite square well potential.

UNIT-V

Physics of Solids and Semiconductors: Salient features of free electron theory of metals (Classical and Quantum) – Fermi level – Bloch's theorem for particles in a periodic potential –Kronig-Penney model – Origin of energy bands –Classification of solids: metals, semiconductors and insulators –Intrinsic and extrinsic semiconductors–Carrier generation and recombination–Carrier transport: diffusion and drift–P-N junction – Thermistor – Hall effect – LED – Solar cell.

TEXT BOOKS:

1. B. K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Publications, 2012.
2. M. N. Avadhanulu and P.G. Kshirsagar, A Text Book of Engineering Physics, S. Chand Publications, 2014.
3. M. Arumugam, Materials Science, Anuradha Publications, 2015.
4. S. L. Gupta and Sanjeev Gupta, Modern Engineering Physics, Dhanpat Rai Publications, 2011.

SUGGESTED READINGS:

1. R. Murugeshan and Kiruthiga Sivaprasath, Modern Physics, S. Chand Publications, 2014.
2. V. Rajendran, Engineering Physics, McGraw-Hill Education Publications, 2013.
3. P. K. Palanisamy, Engineering Physics, Scitech Publications, 2012.
4. V. Raghavan, Materials Science and Engineering, Prentice Hall India Learning Private Limited; 6th Revised edition, 2015.

22CEC01N

ENGINEERING MECHANICS

Instruction	3L+1T Hours per week
Duration of SEE	3Hours
SEE	60Marks
CIE	40Marks
Credits	4

COURSE OBJECTIVES: This course aims to

1. Understand the resolution of forces and to obtain resultant of all force systems,
2. Understand equilibrium conditions of static loads for smooth and frictional surface
3. Analyse simple trusses for forces in various members of a truss
4. Obtain centroid, centre of gravity for various regular and composite areas and bodies
5. Obtain Moment of inertia for various regular and composite areas and bodies and also to obtain Mass moments of inertia of elementary bodies

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

1. Calculate the components and resultant of coplanar forces system and Draw free body diagrams to analyze the forces in the given structure
2. Understand the mechanism of friction and can solve friction problems
3. Analyse simple trusses for forces in various members of a truss.
4. Determine the centroid of plane areas, composite areas and centres of gravity of bodies.
5. Determine moments of inertia of plane and composite areas.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	-	-	-			
CO 2	3	2	-	-	-	-	-	-	-	-	-	-			
CO 3	3	2	-	-	-	-	-	-	-	-	-	-			
CO 4	3	2	-	-	-	-	-	-	-	-	-	-			
CO 5	3	2	-	-	-	-	-	-	-	-	-	-			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Resolution and Resultant of Force System: Basic concepts of a force system, Components of forces in a plane, Resultant of coplanar concurrent force system, Moment of a force, couple and their applications, Resultant of coplanar non-concurrent force system Equilibrium of force system: Free body diagrams, equations of equilibrium of planar force systems and its applications, Problems on general case of coplanar force systems.

UNIT-II

Theory of friction: Introduction, types of friction, laws of friction, application of friction to a single body & connecting systems. Wedge friction

UNI-III

Analysis of Simple Trusses: Introduction to trusses, Assumptions, analysis of simple trusses using method of joints and method of sections.

UNIT-IV

Centroid: Significance of centroid, moment of area, centroid of line elements, plane areas, composite areas, theorems of Pappu's & its applications. Center of gravity of elementary and composite bodies

UNIT-V

Moment of Inertia: Definition of Moment of Inertia, Area Moment of Inertia, Polar Moment of Inertia, Radius of gyration, Transfer theorem, Moment of Inertia of elementary & composite areas.

TEXT BOOKS:

1. K. Vijay Kumar Reddy and J. Suresh Kumar, Singer's Engineering Mechanics, BS Publications, Hyderabad, 2011.
2. Ferdinand L Singer, Engineering Mechanics, Harper and Collins, Singapore, 1904.

SUGGESTED READINGS:

1. S. Rajashekaran & G. Sankarasubramanyam, Engineering Mechanics, Vikas publications, Hyderabad, 2002.
2. Basudeb Bhattacharyya, Engineering Mechanics, Oxford University Press, New Delhi, 2008.
3. A K Tayal, Engineering Mechanics, Umesh Publications, New Delhi, 2010.

ONLINE RESOURCES:

1. https://archive.nptel.ac.in/courses/112/106/112106286/
2. https://archive.nptel.ac.in/courses/112/106/112106180/

22EGC01N

ENGLISH

(BE/B.Tech - Common to All Branches)

Instruction	2L Hours per week
Duration of SEE	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

Prerequisite: Basic knowledge of English grammar and vocabulary.

COURSE OBJECTIVES: This course aims to

1. Improve their understanding of communication skills while developing their usage of English for correct use of grammar and vocabulary.
2. Equip themselves with Reading Comprehension strategies and techniques.
3. Enhance their writing skills through paragraphs, précis and essays by using devices of cohesion and coherence.
4. Build appropriate, longer meaningful sentences for professional writing through formal letters and e-mails.
5. Demonstrate knowledge of drafting formal reports to define, describe and classify the processes by following a proper structure.

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

1. Step-up the awareness of correct usage of English grammar and vocabulary by speaking fluently and comprehensively with a grip on communication skills.
2. Apply effective reading techniques through critical reading exercises to enhance quality of life and to support lifelong learning.
3. Develop their ability to write paragraphs independently on any context with cohesion, edit essays coherently while realizing brevity through précis writing.
4. Construct sentences clearly and comprehensively to write effective business letters and draft emails for a better professional communication.
5. Advance efficiency in writing, distinguish formal from informal reports and demonstrate advanced writing skills by drafting formal reports.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	1	1	1	1	1	2	3	3	2	3	1	1	1
CO 2	1	1	1	1	1	1	1	1	1	2	1	3	1	1	1
CO 3	1	2	1	1	-	1	1	1	1	3	1	3	1	2	1
CO 4	1	2	1	1	-	1	1	2	2	2	2	3	1	2	1
CO 5	1	2	1	2	1	2	2	2	3	3	2	3	1	2	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Communication Skills: Introduction, nature and importance of communication; Process of communication; Types of communication: verbal and non-verbal; Barriers to communication; Intrapersonal, Interpersonal communication; Understanding Johari Window.

Vocabulary & Grammar: The concept of Word Formation - Root words, Use of prefixes and suffixes to form derivatives, Standard abbreviations. Basic Sentences.

Reading Task I.

UNIT-II

Reading Skills: The Reading process, purpose, different kinds of texts; Reading Comprehension; Techniques of comprehension – skimming, scanning, drawing inferences and conclusions. Practice in Critical Reading passages

Vocabulary and Grammar: Determiners. Use of Synonyms and Antonyms, Construction of Sentences.

Reading Task II.

UNIT-III

Writing Skills II: Paragraph Writing. – Structure and features of a paragraph; Essay writing, Cohesion and coherence. Techniques of writing précis.

Vocabulary & Grammar: Use of connectors and linkers, Tenses, Punctuation.

Reading Task III.

UNIT-IV

Professional Writing Skills-1: Letter Writing – Structure, format of a formal letter; Letter of Request and Response, Drafting Emails, Email and Mobile etiquette.

Vocabulary and Grammar: Phrasal verbs, Misplaced modifiers, Subject-verb agreement.

Reading Task IV

UNIT-V

Professional Writing Skills-2: Report writing – Importance, structure, elements & style of formal reports; Writing a formal report. Writing for Blogs.

Vocabulary and Grammar: Words often Confused, Common Errors. Avoiding Ambiguity & Redundancy.

Reading Task V.

TEXT BOOKS:

1. Sanjay Kumar & Pushp Lata, "English Language and Communication Skills for Engineers", Oxford University Press,2018.
2. "Language and Life: A Skills Approach", Board of Editors, 2018th Edition, Orient Black Swan, 2018.

SUGGESTED READINGS:

1. Ashraf, M Rizvi, "Effective Technical Communication", Tata McGraw-Hill, 2006.
2. Michael Swan, "Practical English Usage", Oxford University Press, 4th Edition,2016.
3. Meenakshi Raman and Sangeetha Sharma, "Technical Communication: Principles and Practice" 3rd Edition, Oxford University Press, 2015.

22PYC09

ELECTROMAGNETIC THEORY AND QUANTUM MECHANICS LAB
(ECE & EEE)

Instruction	3P Hours per week
Duration of SEE	3Hours
SEE	50Marks
CIE	50Marks
Credits	1.5

COURSE OBJECTIVES: This course aims to
1. Apply the concepts of physics while doing experiments
2. Understand the nature of the light experimentally
3. Analyzethebehaviourofsemiconductormaterialsandoptoelectronicdevices

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Experiment with the concept of errors and find the ways to minimize the errors
2. Demonstrate properties of light experimentally
3. Find the applications of lasers and optical fibers in engineering applications
4. Make use of semiconductor devices for practical applications
5. Illustrate the working of optoelectronic devices

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	3	1	3	1	3	3	2	1	2			
CO 2	3	2	1	2	2	2	1	2	2	1	1	3			
CO 3	3	2	3	2	3	1	2	2	3	2	1	2			
CO 4	3	3	2	2	2	1	2	3	2	1	1	3			
CO 5	3	1	2	3	2	1	1	2	2	2	1	2			

1 - Slightly, 2 - Moderately, 3 - Substantially

Experiments

1.	Error Analysis	:	Estimation of errors in the determination of time period of a torsional pendulum
2.	Newton's Rings	:	Determination of wavelength of given monochromatic source
3.	Single Slit Diffraction	:	Determination of wavelength of given monochromatic source
4.	Diffraction Grating	:	Determination of wavelengths of two yellow lines of light of mercury lamp
5.	Malus's Law	:	Verification of Malus's law
6.	Double Refraction	:	Determination of refractive indices of O-ray and E-ray of given calcite crystal
7.	Polari meter	:	Determination of specific rotation of glucose
8.	Laser	:	Determination of wavelength of given semiconductor laser
9.	Optical Fiber	:	Determination of numerical aperture and power losses of given optical fiber
10.	Energy Gap	:	Determination of energy gap of given semiconductor
11.	P-N Junction Diode	:	Study of V-I characteristics and calculation of resistance of given diode in forward bias and reverse bias
12.	Thermistor	:	Determination of temperature coefficient of resistance of given thermistor
13.	Hall Effect	:	Determination of Hall coefficient, carrier concentration and mobility of charge carriers of given semiconductor specimen

14.	LED	**:**	Study of I-V characteristics of given LED
15.	Solar Cell	**:**	Study of I-V characteristics of given solar cell and calculation of fill factor, efficiency and series resistance

NOTE: A minimum of TWELVE experiments should be done.

22EGC02

ENGLISH LAB

(BE/B.Tech Common to All Branches)

Instruction	2P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

COURSE OBJECTIVES: This course will introduce the students

1. To nuances of Phonetics and give them sufficient practice in correct pronunciation through computer-aided multi-media instruction.
2. To the significance and application of word and sentence stress and intonation.
3. To sufficient practice in listening to English spoken by educated English speakers in different socio-cultural and professional settings.
4. To reading and speaking activities enabling them to critically interpret and respond to different texts and contexts, and produce speech with clarity and confidence.
5. To team work, role behaviour while developing their ability to use language appropriately, to discuss in groups and make presentations.

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

1. Define the speech sounds in English and understand the nuances of pronunciation in English.
2. Produce speech with clarity and confidence using correct word and sentence stress, and intonation.
3. Achieve improved ability to listen, understand, analyse, and respond to English spoken in various settings.
4. Read, interpret, and review a variety of written texts, contexts, and perform appropriately in different situations.
5. Design effective posters collaboratively through creative decisions, give presentations, and efficiently participate in Group discussions

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	-	-	-	-	1	1	2	1	3	-	-	-
CO 2	-	-	-	-	-	1	-	1	2	2	1	3	-	-	-
CO 3	-	-	-	-	-	1	1	1	2	1	1	2	-	-	-
CO 4	1	1	1	1	1	1	2	2	3	3	1	3	1	1	1
CO 5	-	1	1	1	1	2	2	2	3	3	2	3	-	1	1

1 - Slightly, 2 - Moderately, 3 - Substantially

EXERCISES

COMPUTER-AIDED LANGUAGE LEARNING LAB

1. **Introduction to English Phonetics**: Introduction to English Phonetics and organs of speech.
2. **Sound system of English**: Speech sounds- Vowels andConsonants- structure of syllables (Introduction to syllables) - Basic phonetictranscription practice.
3. **Word and Sentence stress**: Rules of word stress -Primary stress, Secondary stress; Sentence stress (word emphasis in sentences) -Practice.
4. **Intonation**:Types of Intonation, Practice in Articulation – MTI-Errors in pronunciation.
5. **Listening skills**: understanding Listening- Practice in Listening comprehension texts.

INTERACTIVE COMMUNICATION SKILLS LAB

1. **JAM-** Ice Breaking, Speaking Activity**.**
2. **Role play/Public speaking –** Speaking with confidence and clarity in different contexts on various issues.
3. **GroupDiscussions -** Dynamics of a Group Discussion, Group Discussion Techniques,Non-Verbal Communication.
4. **Read and Review** - Preparation for active reading and instructing the students to cultivate effective reading habits to read select texts, review and write their responses.
5. **Poster presentation –** Theme, poster preparation, team work and presentation.

TEXT BOOKS:

1. T Balasubramanian, "A Textbook of English Phonetics for Indian Students", Macmillan, 2nd Edition, 2012.
2. J Sethi et al., "A Practical Course in English Pronunciation (with CD)", Prentice Hall India, 2005.
3. Priyadarshi Patnaik, "Group Discussions and Interview Skills", Cambridge University Press Pvt. Ltd., 2nd Edition, 2015.
4. Aruna Koneru, "Professional Speaking Skills", Oxford University Press, 2018.

SUGGESTED READING:

1. "English Language Communication Skills – Lab Manual cum Workbook", Cengage Learning India Pvt. Ltd., 2022.
2. KN Shoba& J. Lourdes Javani Rayen."Communicative English – A workbook", Cambridge University Press, 2019.
3. Sanjay Kumar& Pushp. Lata. "Communication Skills: A Workbook. Oxford University Press", 2019.
4. Veerendra Mishra et al. "English Language Skills: A Practical Approach", Cambridge University Press, 2020.

SUGGESTED SOFTWARE:

1. K-VAN Multi-Media Language Lab
2. TOEFL & GRE (KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS).
3. Digital All
4. Orell Digital Language Lab (Licensed Version).

2MEC01N

ENGINEERING GRAPHICS

Instruction	1 T + 3 D Hours per week
Duration of SEE	3Hours
SEE	50Marks
CIE	50Marks
Credits	2.5

COURSE OBJECTIVES: This course aims to

1. Get exposure to a cad package and its utility.
2. Understand orthographic projections.
3. Visualize different solids and their sections in orthographic projection
4. Prepare the student to communicate effectively by using isometric projection.
5. Prepare the student to use the techniques, skills, and modern tools necessary for practice.

COURSE OUTCOMES: upon completion of this course, student will be able to

1. Become conversant with appropriate use of CAD software for drafting and able to draw conic sections.
2. Understand orthographic projections of points and straight lines.
3. Draw the projections of planes.
4. Draw and analyze the internal details of solids through sectional views.
5. Create an isometric projections and views.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	1	2	2	-	1	2	3	1	3	2	1	2
CO 2	3	2	2	1	2	2	-	1	2	2	1	2	2	-	2
CO 3	3	3	2	1	2	2	-	1	2	2	1	2	2	-	2
CO 4	3	3	3	2	2	2	-	1	2	2	1	2	2	1	2
CO 5	3	2	2	1	2	2	-	1	2	2	1	2	2	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXERCISES:

1. Introduction to CAD package: Settings, draw, modify tools, dimensioning, documentation and practice exercises using Auto CAD software.
2. Construction of Conic Sections by General method.
3. Orthographic projection: Principles, conventions, Projection of points
4. Projection of straight lines: Simple position, inclined to one plane & inclined to both the planes (without traces and mid-point)
5. Projection of planes: Perpendicular planes
6. Projection of planes: Oblique planes
7. Projection of solids: Simple position
8. Projection of solids: Inclined to one plane
9. Sections of solids: Prism, pyramid in simple position
10. Sections of solids: Cone and Cylinder in simple position
11. Isometric projections and views
12. Conversion of isometric views to orthographic projections and vice-versa.

TEXT BOOKS:

1. N.D.Bhatt, “Elementary Engineering Drawing”, Charotar Publishers, 2012.
2. K.Venugopal, “Engineering Drawing and Graphics + AutoCAD”, New Age International Pvt.Ltd, 2011.
3. Basanth Agrawal and C M Agrawal, “Engineering Drawing”, 2/e, McGraw-Hill Education (India) Pvt. Ltd.

SUGGESTED READINGS:

1. Shaw M.B and Rana B.C., “Engineering Drawing”, 2/e, Pearson, 2009.
2. K.L. Narayana and P.K. Kannaiah, “Text Book of Engineering Drawing”, Scitech Publications, 2011

22MEC38N

DIGITAL FABRICATION WORKSHOP

Instruction	3P Hours per week
Duration of SEE	3Hours
SEE	50Marks
CIE	50Marks
Credits	1.5

Prerequisite: Nil

COURSE OBJECTIVES: This course aims to:

1. Give a feel of Engineering Practices and develop holistic understanding of various Engineering materials and Manufacturing processes.
2. Develop skills of manufacturing, safety, precision, quality, intelligent effort, optimization, positive and team work attitude to get things right the first time.
3. Provide basic knowledge of steel, plastic, composite, and other materials for suitable applications.
4. Study of principle and hands on practice on techniques of fabrication, manufacturing, and allied skills.
5. Advance important, hard and pertinent soft skills, productivity, create skilled manpower which is cognizant of industrial workshop components and processes and can communicate their work in a technical, clear and effective way.

COURSE OUTCOMES: Upon completion of this course, students will be able to

1. Understand safety measures to be followed in workshop to avoid accidents.
2. Identify various tools used in carpentry, house wiring and plumbing.
3. Make a given model by using workshop trades like carpentry, plumbing, House wiring and 3d modeling using solid works software for Additive Manufacturing.
4. Perform pre-processing operations on STL files for 3D printing, also understand reverse engineering process.
5. Conceptualize and produce simple device/mechanism of their choice.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	1	1	-	-	-	1	-	-	-	1	-	-	1
CO 2	1	-	1	-	-	-	-	-	-	-	-	1	-	2	1
CO 3	1	-	1	-	-	1	-	-	-	-	-	1	2	2	1
CO 4	1	-	1	-	-	1	-	-	-	-	-	1	2	2	1
CO 5	2	2	2	1	3	1	-	1	1	2	-	2	3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXERCISES:

GROUP 1: WORKSHOP PRACTICE

1. To make a lap joint on the given wooden piece according to the given dimensions
2. To make a dovetail joint on the given wooden piece according to the given dimensions.
3. (a)Wiring of one light point controlled by one single pole switch, a threepin socket controlled by a single switch
   (b)Wiring of two light points connected in series and controlled by single pole switch. Verify the above circuit with different bulbs. Wiring of two light points connected in parallel from two single pole switches and a threepin socket.
4. Stair case wiring Wiring of one light point controlled from two different places independently using two 2way switches.
5. To make external threads for GI pipes using die and connect the GI pipes as per the given diagram using taps, couplings, and bends.

6. To connect the GI pipes as per the given diagram using, Coupling, Unions, reducers, and bends. To connect the GI pipes as per the given diagram using shower, tap, and valves and demonstrate by giving water connection.

GROUP 2: ADDITIVE MANUFACTURING /3D PRINTING

1. To Study the methods of Additive manufacturing process using a 3D printer.
2. To create a 3D CAD model of a door bracket using a modelling software.
3. To print a door bracket using an extruder type 3D printer.
4. To create a 3D CAD model using Reverse engineering.
5. Engraving, Drilling and Cutting operations on printed circuit boards using CNC PCB Mate.
6. To design an innovative component using the CAD software./print the selected innovative component by the student using a 3D printer.

TEXT BOOKS:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I, 2008 and Vol. II, Media promoters and publishers private limited, Mumbai, 2010.
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.

SUGGESTED READING:

1. Gowri P. Hariharan and A. Suresh Babu, "Manufacturing Technology.
2. Oliver Bothmann, 3D Printers: A Beginner's Guide, January 1, 2015.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
(Inline with AICTE Model Curriculum with effect from AY 2025-26)(R22A)

SEMESTER – III

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22MTC09	Applied Mathematics	3	1	-	3	40	60	4
2	22EEC13	Signals and Systems	3	-	-	3	40	60	3
3	22EEC03	Electrical Circuit Analysis	3	-	-	3	40	60	3
4	22EEC04	Electromagnetic Fields	3	-	-	3	40	60	3
5	22EEC05	Electrical Measurements and Instrumentation	3	-	-	3	40	60	3
6	22EEC06	Analog Electronic Circuits	3	-	-	3	40	60	3
7	22CEM01	Environmental Science	2	-	-	2	-	50	Non Credit
PRACTICAL									
8	22EEC07	Electrical Circuits and Measurements Lab	-	-	3	3	50	50	1.5
9	22EEC08	Analog Electronic Circuits Lab	-	-	3	3	50	50	1.5
10	22EEI01	MOOCs/Training/ Internship	3-4 weeks/90 hours				50	-	2
Total			**20**	**1**	**6**	**-**	**390**	**510**	**24**
Clock Hours Per Week: 27									

L: Lecture **D:** Drawing **CIE:** Continuous Internal Evaluation
T:Tutorial **P:** Practical/ Project Seminar/ Dissertation **SEE:** Semester End Examination

22MTC09

APPLIED MATHEMATICS

(For EEE)

Instruction	3 L+1T Hours per week
Duration of Semester End Examination	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Prerequisites: The Student should be familiar with Differentiation, Integration and basic Linear Equations.

COURSE OBJECTIVES: This course aims to

1. Learn the Laplace and Z- Transform concepts.
2. To explain the expansion of functions in sine and cosine series.
3. To able to solve Linear and Non-Linear partial differential equations and fitting the data in Linear and Non-Linear Models.

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

1. Find Laplace, Inverse Laplace and solution of engineering problems.
2. Find the solution of Difference Equation.
3. Calculate the Euler's coefficients for Fourier series expansion of a function.
4. Understand the methods to find solution of linear and non-linear PDE and solution of wave equation.
5. Analyze the coefficient of correlation, regression and fitting of the data by various methods.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	3	-	-	-	-	-	-	-	2	2	-	1
CO 2	3	3	2	3	-	-	-	-	-	-	-	2	2	-	1
CO 3	3	2	2	3	-	-	-	-	-	-	-	2	2	-	1
CO 4	2	3	3	2	-	-	-	-	-	-	-	2	2	-	1
CO 5	3	2	3	2	-	-	-	-	-	-	-	2	2	-	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I: Laplace Transforms

Laplace Transform of Elementary functions, Linearity property, First Shifting property, Change of scale property. Laplace Transform of Periodic functions, Transforms of derivatives, Transforms of integrals, Multiplication by t and division by t evaluation of Integrals by Laplace Transforms. Inverse Laplace transforms of elementary functions, Inverse Laplace Transform by method of partial fractions and Convolution theorem, Solutions of Ordinary Differential Equations by Laplace Transform method. Laplace transform of Unit step and Unit Impulse function.

UNIT-II: Z-Transforms

Z-transforms of standard functions, linearity property, damping rule, shifting theorems, multiplication by 'n', Initial and Final value theorems. Inverse Z-transforms of standard functions, Inverse Z-transform by Convolution theorem and partial fractions method. Z-transform applications to difference equations.

UNIT-III: Fourier Series

Periodic functions, Euler's formulae, Condition for a Fourier series expansion, Fourier series of Functions having points of discontinuity even and odd functions, Change of interval, Half range Sine & Cosine Series

UNIT-IV: Partial Differential Equations

Formation of Partial Differential Equations, Linear Equations of First Order (Lagrange's Linear Equations), Solution of First Order Non-linear Partial Differential Equation (Standard forms) and Charpit's method. Solutions by method of separation of variables, solution of One dimensional wave equation and its applications.

UNIT-V: Curve Fitting

Correlation, coefficient of Correlation, Linear Regression, Regression coefficients, Properties of Regression Coefficients. Curve fitting by the Method of Least Squares, Fitting of Straight lines, Second degree parabola and curve
$y=ae^{bx}$, $y=ax^{b}$, and $y=ab^{x}$.

TEXT BOOKS:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, 2017.
2. S.C.Gupta, V.K.Kappoor, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, 2014.

SUGGESTED READINGS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.
2. Veerarajan T, "Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2008.
3. S.S. Sastry, "Introductory methods of numerical analysis", PHI, 4th Edition, 2005.

22EEC13

SIGNALS AND SYSTEMS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have prior knowledge on calculus, ordinary differential equations, Laplace & Z-transforms.

COURSE OBJECTIVES: This course aims to
1. Know about signal properties and their characteristics for LTI systems in time & frequency domain
2. Elucidate the techniques of Laplace & Z- transforms and their applications on various systems.
3. Study about sampling theorem and different methods to reconstruct the signal.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Understand the classification & properties of signals & systems.
2. Analyze the behavior of LTI systems in continuous and discrete time domain.
3. Representation of continuous & discrete time signals in complex frequency domain
4. Apply Laplace & Z-transforms to analyze the continuous & discrete signals
5. Analyze the concept of sampling theorem and Know about the process of reconstruction.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	-	-	-	-	-	-	-	1	-	-
CO 2	3	2	1	1	1	-	-	-	-	-	-	-	1	-	1
CO 3	3	3	2	2	3	-	-	-	-	-	-	-	3	-	1
CO 4	3	3	2	1	2	-	-	-	-	-	-	-	3	-	2
CO 5	2	1	1	3	2	-	-	-	-	-	-	-	2	-	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT -I

Introduction to Signals and Systems: Signals & systems with their examples in various fields-Continuous and Discrete time systems – Representation of Discrete time signals – Unit step -Impulse-Sinusoidal -Complex exponential signals in CT & DT domains-Special time limited signals - Signal properties: Even & Odd signals - Periodic & Aperiodic signals - Energy & Power signals in CT & DT domain- Basic operations on signals-Sketching of signals –System properties : Linearity (Additivity & Homogeneity)-Time invariance -Causality - Stability with examples.

UNIT -II

Behavior of Continuous and Discrete Time LTI Systems: Response of LTI system to arbitrary input signal-Convolution in CT & DT domain-Impulse response –step response – Characterization of stability & causality of an LTI system -System of Interconnections: Cascade & Parallel – System representation through differential and difference equations.

UNIT -III

Fourier series & Fourier Transforms:

Fourier series: Fourier series representation of periodic signals-Dirichlet's condition – Trigonometric & Exponential Fourier Series-Waveform symmetries – Fourier coefficients –Complex Fourier spectrum.

Fourier Transforms: Introduction- Fourier transform of arbitrary, periodic and standard signals – Properties of Fourier transform–Parseval's theorem.

UNIT -IV

Laplace Transforms & Z-Transforms: Review of Laplace transforms- Relation between Laplace transform & Fourier transform of a signal-Concept of R.O.C for Laplace transform - Poles and Zeros of rational function of s

and their R.OC -Properties of R.O.C - Stability in 's' domain -Laplace transform for LTI systems - Inverse Laplace transforms.

Z-Transforms: Concept of Z-Transform for discrete sequences -Distinction between Laplace -Fourier & Z-Transforms-R.O.C in Z-Transforms -Poles and Zeros of rational function of z and their ROC -Properties of R.O.C - Stability in Z-domain-Z-transforms for discrete time LTI systems -Inverse Z- Transforms - Properties of Z- Transforms.

UNIT -V

Sampling & Reconstruction: Sampling theorem & its implications - Spectra of sampled signals -Aliasing and its effects -Nyquist rate-Reconstruction: Ideal interpolator -Zero order & First order hold circuits.

TEXT BOOKS:

1. A.V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and Systems", Prentice Hall India, 1997.
2. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Pearson, 2006.
3. Anand Kumar. A, "Signals & Systems", 3rd Edition, Prentice Hall India, 2017.
4. A Nagoor Kani, "Signals & Systems", Tata McGraw Hill Education Private Limited 2010.

SUGGESTED READINGS:

1. H. P. Hsu, "Signals and systems", Schaum's series, McGraw Hill Education, 2010.
2. S. Haykin and B. V. Veen, "Signals and Systems", John Wileyand Sons, 2007.
   Michel J. Robert, "Fundamentals of Signals & Systems", MGH International Edition, 2008.

22EEC03

ELECTRICAL CIRCUIT ANALYSIS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have fundamental knowledge in Basic Electrical Engineering and concepts of Calculus in Mathematics.

COURSE OBJECTIVES: This course aims to

1. Study the nature of different circuit elements, laws and network theorems.
2. Study transient and steady state response of circuits with initial conditions & forcing functions
3. Learn the Laplace transforms and two-port networks.

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

1. Calculate the response of RLC networks with sinusoidal input at steady state & resonance conditions and to analyze three-phase circuits with different loads
2. Apply various network analysis techniques to find the responses in the circuits with dependent and independent sources.
3. Determine time constant, steady state and transient responses of RL, RC, RLC networks with initial conditions of network elements.
4. Evaluate the response of electrical circuits with Laplace transformation using initial & final value theorems and to obtain the pole-zero diagrams using network functions.
5. Find the impedance, admittance, ABCD, h and g- parameters of given two-port network and interconnected two-port networks.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	2	-	-	-	-	-	-	-	-	3	-	-
CO 2	3	3	1	2	-	-	-	-	-	-	-	-	3	-	-
CO 3	2	3	1	2	-	-	-	-	-	-	-	-	3	-	-
CO 4	3	3	1	2	-	-	-	-	-	-	-	-	3	-	-
CO 5	3	2	1	2	-	-	-	-	-	-	-	-	3	-	-

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT -I

Sinusoidal Steady State Analysis: Review of AC fundamentals, Steady state response of RLC networks with sinusoidal excitations, average power and complex power, series and parallel resonance, three phase circuits with balanced & unbalanced loads,

UNIT -II

Network Theorems: Node and Mesh Analysis, Analysis with dependent current and voltage sources, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation and Milliman's theorems.

UNIT -III

Solution of First and Second Order Networks: Solution of first and second order differential equations for series and parallel RL, RC, RLC circuits, initial and final conditions in network elements, forced and force-free responses, time constant, steady state and transient state responses.

UNIT -IV

Electrical Circuit Analysis Using Laplace Transforms: Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, inverse Laplace Transform, transformed network with initial conditions. Transfer function representation, Poles and Zeros.

UNIT -V

Two Port Networks: Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two-port networks.

TEXT BOOKS:

1. M. E. Van Valkenburg, "Network Analysis", 3rd Edition, Prentice Hall, 2015.
2. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", 6th Edition, McGraw Hill Education, 2019.
3. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", 8th Edition, McGraw Hill Education, 2013.
4. D. Roy Choudhury, "Networks and Systems", 2ndEdition, New Age International, 2010.

SUGGESTED READINGS:

1. Robert L. Boylestad, "Introductory Circuit Analysis", 13th Edition, Pearson Education, 2011.
2. Sudhakar and Shyam Mohan, "Circuits & Networks", 5th Edition, Tata McGraw Hill Education, 2017.
3. Asfaq Hussain, "Networks and Systems", 2nd Edition, Khanna Publishing House, 2021.

NPTEL Courses:

S.No.	NPTEL Course Name	Instructor	Host Institute
1	Basic Circuit Theory https://archive.nptel.ac.in/courses/108/104/108104139/	Prof. Ankush Sharma	IIT, Kanpur
2	Basic Electrical Circuits https://nptel.ac.in/courses/117106108	Dr. Gajendranath Chowdary, Dr. Nagendra Krishnapura	IIT, Madras
3	Network Analysis https://nptel.ac.in/courses/108105159	Dr. T. K. Bhattacharya	IIT, Kharagpur

22EEC04

ELECTROMAGNETIC FIELDS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have Fundamental knowledge in calculus and vector algebra.

COURSE OBJECTIVES: This course aims to

1. Understand coordinate systems, vector calculus and their applications to analyze electrostatic and magnetic fields.
2. Figure out Maxwell's equations, uniform plane wave and its propagation through different media.
3. Know the sources, effects & control techniques of EMI & EMC.

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

1. Understand the basic concepts of vector calculus, various coordinate systems and apply them appropriately for solving electromagnetic field problems.
2. Obtain the physical quantities like field intensity, flux density and potential due to various types of charge distributions in electric and magnetic fields using fundamental laws.
3. Differentiate between conduction & convections currents, and describe the behavior of static electric & magnetic fields in different media, boundary conditions and acquire the knowledge about energy storing elements.
4. Illustrate Maxwell's equations and their application to time-harmonic fields, wave propagation in different media and Poynting's power-balance theorem.
5. Recognize what is EMI & EMC, sources & effects of Electromagnetic Interferences in inter and intra systems and various methods to control EMI

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	1	-	-	-	-	-	-	-	-	3	-	1
CO 2	3	3	2	1	-	-	-	-	-	-	-	-	3	-	1
CO 3	3	3	2	1	-	-	-	-	-	-	-	-	3	-	1
CO 4	3	3	2	1	-	-	-	-	-	-	-	-	3	-	1
CO 5	3	3	2	1	-	-	-	-	-	-	-	-	3	-	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT -I

Orthogonal Coordinate Systems: Review of Vector Calculus, Rectangular, Cylindrical, Spherical Coordinate systems; Line, Surface and Volume integrals; Operator Del, Gradient, Divergence, Curl & Laplacian of a field; Divergence and Stoke's theorems.

Electrostatic fields: Various charge configurations, Coulomb's law, Electric field intensity and flux density of different charge distributions, Gauss's law, Integral and Point form of Maxwell's Electrostatic Equation.

UNIT -II

Electrostatic Field in Materials: Electrical Potential, Capacitance of Parallel plate capacitor, Equipotential lines, Properties of materials, convection and conduction currents, conductors, dielectric constant, continuity equation and relaxation time, boundary conditions, Poisson's and Laplace's equations, Uniqueness theorem.

UNIT -III

Magneto Static Fields: Biot-Savart's law, Ampere's law, Displacement current, Magnetic Scalar and Vector Potentials, boundary conditions, Forces in Magnetic fields, Lorentz force equation, Force between parallel conductors, Inductance Calculations (Solenoid, Toroid), Mutual Inductance, Coefficient of Coupling.

UNIT -IV

Time Varying Electromagnetic Fields: Faraday's laws of electromagnetic induction, Final forms of Maxwell's Equations, Power and Poynting theorem, Time-Harmonic Electromagnetic fields, Wave equations (One dimension), Plane Wave, Propagation in perfect and lossy-dielectrics.

UNIT -V

Electromagnetic Interference and Compatibility (Theoretical Aspects only): Introduction to Electromagnetic Interference and Electromagnetic Compatibility (EMI & EMC)- Sources and Characteristics of EMI, Control Techniques of EMI, Grounding, Shielding, Filtering. Introduction to numerical electromagnetics.

TEXT BOOKS:

1. Hayt W.H and J.A Buck, "Engineering Electromagnetics", 8th Edition, Tata McGraw Hill, 2018.
2. Sadiku, M.N.O, S.V. Kulkarni, "Principles of Electromagnetics", 7th Edition, Oxford University press, 2018.

SUGGESTED READINGS:

1. S. P. Seth, "Elements of Electromagnetic Fields", Danpat Rai & Co, 2011.
2. David K. Cheng, "Field and Wave Electromagnetics", 2nd Edition, Pearson Education 2014.
3. Ashutosh Pramanik, "Electromagnetism Theory and Applications", 3rd Edition, PHI Pvt. Ltd., 2015.
4. R.L. Yadava, "Electromagnetic Fields & Waves", Khanna Publishing House,
5. Narayana Rao, "Engineering Electromagnetics", PHI Pvt. Ltd

NPTEL Courses:

S.No.	NPTEL Course Name	Instructor	Host Institute
1	Electromagnetic Theory https://nptel.ac.in/courses/115101005	Prof. D.K. Ghosh	IIT, Bombay
2	Electromagnetic Theory https://nptel.ac.in/courses/108104087	Dr. Pradeep Kumar K	IIT, Kanpur
3	Electromagnetic Fields https://archive.nptel.ac.in/courses/108/106/108106073/	Dr.Hari Sankar Ramachandran	IIT, Madras

22EEC05

ELECTRICAL MEASUREMENTS AND INSTRUMENTATION

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have
1. Fundamental knowledge in calculus and complex algebra,
2. Electromagnetism and circuit theory concepts.

COURSE OBJECTIVES: This course aims to
1. Understand the principle of operation of various electrical Instruments
2. Measure electrical and magnetic parameters by demonstrating experimental setups
3. Introduce transducers and digital instruments with their working principle

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Identify a suitable instrument to measure a given electrical parameter.
2. Analyze the working principle by using suitable torque equations for DC and AC Instruments.
3. Design Bridge Circuits for measuring passive electrical parameters.
4. Distinguish between electrical and magnetic measurements and their instruments.
5. Select an Electrical transducer for a given physical quantity measurement.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	-	-	-	-	-	-	-	-	-	2	-	-
CO 2	2	2	2	-	-	-	-	-	-	-	-	-	2	-	-
CO 3	2	1	2	1	2	-	-	-	-	-	-	-	3	-	-
CO 4	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 5	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT -I

Introduction to Measurements: Objectives of measurement, static and dynamic characteristics, accuracy, precision, significant figures, errors and their classification, Standard Cell and Standard Resistance.

Instruments-1: Types of instruments, classification of instruments based on type of measurement and principle of working (PMMC, MI, Dynamometer, Induction and Electrostatic), types of torques (torque equations for MC, MI and dynamometer type instruments).

UNIT -II

Instruments-2: Single phase Induction type energy meter, concepts of driving torque & braking torque equations, (no derivation) ; Errors and their Compensation, Single phase Dynamometer type Power factor meter, Weston type frequency meter. Construction & theory of Instrument Transformers, Equations for ratio and phase angle error of C.T & P.T (Elementary treatment only).

UNIT -III

Resistance, Inductance and Capacitance parameters: Classification of resistance measuring methods Kelvin's double bridge, Wheatstone bridge and Meggar. Measurement of inductance using Maxwell's inductance bridge, Anderson's bridge, Measurement of capacitance using De-Sauty's bridge and Schering bridge, merits and demerits, Q-meter, measurement of relative permittivity, applications and related numerical problems.

UNIT -IV

Measurements of Magnetic and Electric Parameters: Ballistic galvanometer- Principle of operation, construction and applications of Ballistic galvanometer, flux meter its construction and principle of operation.

Epstein square bridge for measuring Iron losses, Potentiometers, -Principle - Classification – Salient features related to Practical applicability**.**

UNIT -V

Introduction to Digital Instruments (DVM and Transducers): Introduction to digital Instruments, Digital Voltmeters (DVM), Range extension of DVM, display, resolution, related numerical problems on DVM. Digital Multimeters.

Transducers: Introduction, Role of Transducers in measurement system, Strain Gauge, Linear variable Differential transformer(LVDT), Piezoelectric transducer, Temperature transducers, bimetallic strip, Thermocouples, Resistance Temperature Detectors(RTD), Thermostats, Radiation pyrometers.

TEXT BOOKS:

1. F.W. Golding and Widdis, "Electrical Measurements and measuring Instruments", A.H. Wheeler & Co., Jan-2011
2. A.K. Sawhney, "A Course in Electrical and Electronics Measurements and Instrumentation", 22ndEdition, Dhanapat Rai & Sons, New Delhi,2015.
3. CT. Baldwin, "Fundamentals of Electrical measurements", Kalyani publications, 2001.

SUGGESTED READINGS:

1. Helfrick, Albert D. Cooper, William D., "Modern Electronic Instrumentation and Measurement Techniques", PHI Publications, Jan-2015
2. Stanley Wold, Richard F.M. Smith, "Student reference manual for Electronic Instrumentation Laboratories", 2nd Edition, PHI. Alan.
3. S. Morris, "Essence of Measurement", PHI, Feb-1996

NPTEL Courses:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	EMI	Dr. Avishek Chattergee	IITKGP
2	Industrial Instrumentation	Dr. Alok Barua	IITKGP

22EEC06

ANALOG ELECTRONIC CIRCUITS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have a prior knowledge of semiconductor Physics and basics of circuit theory.

COURSE OBJECTIVES: This course aims to

1. Understand the V-I characteristics of diodes, BJTs, MOSFETs and the biasing techniques of transistors and MOSFETs.
2. Understand the functioning, DC & AC characteristics of Operational Amplifiers (Op-Amps).
3. Study the linear &non-linear applications of Op-Amps.

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

4. Comprehend the V-I characteristics of Diode and its applications.
5. Understand the V-I characteristics of BJT & MOSFET and to analyze the significance of operating point in the biasing techniques of BJT & MOSFET.
6. Apply the knowledge of differential amplifiers Understand the basic characteristics of Operational Amplifiers (Op-Amps) and their significance.
7. Design and analyze linear application circuits of Op-Amp like amplifiers, Integrator, differentiator, filters, and regulators.
8. Design and analyze non-linear application circuits of Op-Amps and design stable and mono-stable modes of 555 timer circuit.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	-	2	1	1	1	-	-	-	-	-	-			
CO 2	2	-	2	2	1	2	-	-	-	-	-	-			
CO 3	2	-	1	2	1	2	-	-	-	-	-	-			
CO 4	3	-	3	2	1	2	-	-	-	-	-	-			
CO 5	3	-	3	3	2	2	-	-	-	-	-	-			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT -I

Diode Characteristics and Applications: P-N junction diode- VI characteristics of a diode, Half-wave and Full- wave rectifiers, operation, performance characteristics, ripple factor calculations, C filter, Zener diode - VI characteristics, Regulator.

UNIT -II

BJT and MOSFET Circuits: BJTs: Structure and Operation of a BJT, Modes of transistor operation, Early effect, BJT input and output characteristics of CE, configuration, BJT as a switch, CE amplifier, small-signal model, significance of DC operating point, biasing circuits- Collector to base and voltage divider, numerical problems.

MOSFETs: Structure-Enhancement & Depletion mode MOSFETs and VI characteristics, MOSFET as a switch, MOSFET as an amplifier- common-source, biasing circuits- voltage divider numerical problems.

UNIT -III

Operational Amplifier (Op-Amp) Characteristics: Block diagram of an operational amplifier, ideal Op-Amp-characteristics, non-idealities in an Op-Amps - open loop voltage gain , output impedance, input impedance ,Output offset voltage, input bias current, input offset current, gain bandwidth product, common mode rejection ratio, slew rate, Frequency response, Stability.

Basic OP-Amp Applications: Inverting and non-inverting amplifier with ideal Op-Amps, voltage follower, current to voltage converter, voltage to current converter.

UNIT -IV

Linear Applications of Op-Amps: Summing amplifier, differential amplifier, instrumentation amplifier, ideal and practical integrator and differentiators, Active filters- First order RC, oscillators (Wein bridge).

UNIT -V

Applications of Op-Amps: Hysteretic Comparator, Zero Crossing Detector, Square-wave, and triangular-wave generators. Precision rectifier, Sample and Hold circuit, clamping and clipping circuits.
555 Timer: Functional diagram, Modes of operation- astable, mono stable.

TEXT BOOKS:

1. Robert L. Boylestad, "Electronic Devices and Circuit Theory", 11th Edition, PHI, 2015.
2. Gayakwad R.A. “Op-Amps and Linear Integrated Circuits”, 4th Edition, PHI, 2015.
3. Roy Choudhury, Shail B. Jain, “Linear Integrated Circuits”, 4th Edition, New Age Intern. (P) Ltd., 2002.
4. Malvino Albert Paul, “Electronic Principles”, 7th Edition, Tata McGraw Hill, 2006.
5. J. V. Wait, L. P. Huelsman and G. A. Korn, “Introduction to Operational Amplifier theory and applications”, 2nd Edition, McGraw Hill U. S., 2013.

SUGGESTED READINGS:

1. Millman and Halkias, “Electronic Devices and Circuits”, 4th Edition, McGraw Hill Publication 2015.
2. David Bell, "Fundamentals of Electronic Devices and Circuits", 5th Edition, Oxford University Press 2008.
3. Coughlin and Driscoll, “Operational Amplifiers and Linear Integrated Circuits”, 6th Edition, PHI, 2003.

NPTEL Courses:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Analog Circuits	Prof. Jayanta Mukherjee	IIT Bombay
2	Analog Electronic Circuits	Prof. Shouribrata	IIT Delhi

22CEM01

ENVIRONMENTAL SCIENCE

(Mandatory Course)

Instruction	2 L Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	-

Prerequisite: None

COURSE OBJECTIVES: This course aims to

1. Identify environmental problems arising due to engineering and technological activities and become aware of the importance of eco system and biodiversity for maintaining ecological balance.
2. Identify the threats and solve the issues of biodiversity, learn about various attributes of pollution management and waste management practices.
3. Contribute for capacity building of nation for arresting and/or managing environmental disasters.

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

1. Identify the natural resources and realize the importance of water, food, forest, mineral, energy, land resources and effects of over utilization.
2. Understand the concept of ecosystems and realize the importance of interlinking food chains.
3. Contribute for the conservation of bio-diversity.
4. Suggest suitable remedial measure for the problems of environmental pollution and contribute for the framing of legislation for protection of environment.
5. Follow the environmental ethics and contribute to the mitigation and management of environmental disasters.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	-	-	-	-	-	3	-	-	-	-	1	-	-	-
CO 2	1	-	-	-	-	-	2	1	-	-	-	1	-	-	-
CO 3	1	-	-	-	-	-	2	1	-	-	-	1	1	-	-
CO 4	1	-	-	-	-	1	2	1	-	-	-	1	1	-	-
CO 5	1	-	-	-	-	1	2	1	-	-	-	1	-	-	-

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT -I

Environmental Studies: Definition, Scope and importance, need for public awareness.

Natural resources: Use and over utilization of Natural Resources - Water resources, Food resources, Forest resources, Mineral resources, Energy resources, Land resources.

UNIT -II

Ecosystems: Concept of an ecosystem, structure and function of an ecosystem, role of producers, consumers and decomposers, energy flow in an ecosystem, food chains, food webs, ecological pyramids, Nutrient cycling, Bio-geo chemical cycles, Terrestrial and Aquatic ecosystems.

UNIT -III

Biodiversity: Genetic, species and ecosystem biodiversity, Bio-geographical classification of India, India as a Mega diversity nation. Values of biodiversity, hot-spots of biodiversity, threats to biodiversity, endangered and endemic species of India, methods of conservation of biodiversity.

UNIT -IV

Environmental Pollution: Cause, effects and control measures of air pollution, water pollution, marine pollution, soil pollution, noise pollution and Solid waste management, nuclear hazards

Environmental Legislations: Environment protection Act, Air, Water, Forest & Wild life Acts, issues involved in enforcement of environmental legislation, responsibilities of state and central pollution control boards

UNIT -V

Social issues and the environment: Water conservation methods: Rain water harvesting and watershed management, Environmental ethics, Sustainable development and Climate change: Global warming, Ozone layer depletion, forest fires, and Contemporary issues.

TEXT BOOKS:

1. Y. Anjaneyulu, "Introduction to Environmental Science", B S Publications, 2004.
2. Suresh K. Dhameja, "Environmental Studies", S. K. Kataria & Sons, 2009.

SUGGESTED READINGS:

1. C. S. Rao," Environmental Pollution Control Engineering", Wiley, 1991.
2. S. S. Dara, "A Text Book of Environmental Chemistry &Pollution Control", S. Chand Limited, 2006

22EEC07

ELECTRICAL CIRCUITS AND MEASUREMENTS LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisite: Students should have.
1. Fundamental Knowledge in Calculus and Complex Algebra,
2. Electromagnetism and Circuit Theory Concepts.

COURSE OBJECTIVES: This course aims to
1. To plot the frequency response & locus diagrams of first and second-order circuits
2. To verify various circuit theorems and to determine different parameters of a two-port network.
3. To measure the unknown values of different electrical elements and to become familiar with different transducers.

COURSE OUTCOMES*: After the completion of this course, the student will be able to*
1. Obtain and plot the frequency response and locus diagrams of RLC circuits.
2. Verify various circuit theorems.
3. Determine various two-port network parameters.
4. Validate DC and AC bridges for measuring unknown electrical parameters and demonstrate the principles of magnetic measurements.
5. Demonstrate the measurement of non-electrical quantity with an appropriate transducer, Study the operation of megger, CT & PT and to calibrate energy meter.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	1	-	-	-	-	-	-	-	-	3	-	1
CO 2	3	2	1	1	-	-	-	-	-	-	-	-	3	-	1
CO 3	3	2	1	1	-	-	-	-	-	-	-	-	3	-	1
CO 4	3	2	1	1	-	-	-	-	-	-	-	-	3	-	1
CO 5	3	2	1	1	-	-	-	-	-	-	-	-	3	-	1

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

PART-A
1. Frequency response of RLC series circuit.
2. Frequency response of RLC parallel circuit.
3. Locus diagrams of RL & RC circuits.
4. Verification of Maximum power transfer theorem.
5. Verification of Milliman's & Compensation theorems.
6. Determination of Z, Y, ABCD & h-parameters of two-port network.
7. Determination of parameters of two 2-port networks connected in Series, parallel and cascade.

PART-B
1. Determination of unknown low resistance using Kelvin's double bridge. Measurement of unknown Inductance using Maxwell's bridge and validating with an LCR meter.
2. Determination of unknown inductance using Anderson's bridge and validating with an LCR meter.
3. Determination of unknown capacitance using Schering Bridge and validating with LCR meter.
4. Measurement of iron losses using Epstein's square bridge.
5. Measurement of strain using a strain gauge.
6. Measurement of Displacement using LVDT.

7. Measurement of unknown voltage using D.C Crompton's potentiometer.
8. Study of analog hand-driven electrical Megger
9. Study of measurements with digital current and potential transformers.
10. Calibration of three phase energy meter.

Note: Five experiments from Part-A and Part-B should be conducted in the semester**.**

22EEC08

ANALOG ELECTRONIC CIRCUITS LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisite: Students should have a prior knowledge of semiconductor Physics and basics of circuit theory.

COURSE OBJECTIVES: This course aims to

1. Understand the V-I Characteristics of diode, transistor and MOSFET.
2. Understand the frequency response of BJT, FET amplifiers.
3. Design linear and non-linear applications of Op-Amp.

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

1. Demonstrate the working principle of PN junction diode, transistor and MOSFET from their V-I characteristics.
2. Realize half wave and Full wave rectifiers for C filter combinations.
3. Analyze the significance of choosing a DC operating point for a transistor/MOSFET and to analyze the frequency response of CE amplifier.
4. Design of linear and non-applications of Op-Amps.
5. Design a 555 Timer in A stable mode to produce pulses for Pulse Width Modulation (PWM) Schemes.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	2	1	2	-	-	-	-	-	-	-	2	2	2
CO 2	2	2	2	2	2	-	-	-	-	-	-	-	2	2	2
CO 3	1	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO 4	3	3	2	1	2	-	-	-	-	-	-	-	2	3	2
CO 5	1	2	2	1	2	-	-	-	-	-	-	-	1	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

PART A

1. V-I characteristics of (Silicon and Germanium) diodes and measurement of static and dynamic resistance.
2. Zener diode characteristics and its application as a voltage regulator.
3. Rectifier Circuits-
    a. Design, realization, and performance evaluation of half wave rectifier - without and with C-filter.
    b. Design, realization, and performance evaluation of Full wave rectifier- without and with C-filter.
4. Plotting the characteristics of BJT and MOSFET.
5. Design of Biasing circuits for BJT
6. Design of Biasing Circuits for MOSFET
7. Design and Frequency response of Common Emitter BJT amplifier and measurement of Gain, Bandwidth, Input and Output impedances.

PART B

1. Measurements of Op-Amp parameters
2. Design of integrator and differentiator using Op-Amp.
3. Design of Active filters –LPF & HPF
4. Generation of triangular, sine and square wave using IC's.
5. Design of Clampers using Op-Amps.
6. Design of Clippers using Op-Amps.
7. Analysis of Hysteric comparator using Schmitt Trigger circuit.

8. Design of 555 Timer in A stable mode

Note: At least FOUR experiments from Part-A and SIX from Part-B should be conducted in the semester

22EEI01

MOOCs/ Training/ Internship

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

(Inline with AICTE Model Curriculum with effect from AY 2025-26)(R22A)

SEMESTER – IV

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22EEC09	Electrical Machines-I	3	-	-	3	40	60	3
2	22EEC10	Power Systems I	3	-	-	3	40	60	3
3	22EEC11	Control Systems	3	-	-	3	40	60	3
4	22EEC12	Digital Electronics	3	-	-	3	40	60	3
5	22ITC24N	Data Structures using C	3	-	-	3	40	60	3
6	22EEM01	Universal Human Values- II: Understanding Harmony	-	1	-	-	50	-	1
PRACTICAL									
7	22EEC14	Electrical Machines-I Lab	-	-	3	3	50	50	1.5
8	22EEC15	Control Systems Lab	-	-	3	3	50	50	1.5
9	22EEC16	Digital Electronics Lab	-	-	3	3	50	50	1.5
10	22ITC25N	Data Structures using C Lab	-	-	2	3	50	50	1
11	22EEU01	Up-skilling Certification Course-I	-	-	-	-	25	-	0.5
Total			**15**	**1**	**11**	**-**	**475**	**500**	**22**
Clock Hours Per Week: 25									

L: Lecture **D:** Drawing **CIE:** Continuous Internal Evaluation
T:Tutorial **P:** Practical/ Project Seminar/ Dissertation **SEE:** Semester End Examination

22EEC09

ELECTRICAL MACHINES-I

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have prior knowledge of Basic Electrical Engineering.

COURSE OBJECTIVES: This course aims to
1. Inculcate the principles of Electromechanical Energy Conversions.
2. Determine the performance of DC Machines by conducting various tests.
3. Impart the knowledge of transformers and evaluate its performance.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Comprehend the nomenclature and principles related to the concepts of energy balance and various excited systems
2. Elucidate the principle of operation , characteristics and parallel operation of DC Generators
3. Analyze the starting methods , speed control and testing methods under different conditions of a given DC motor
4. Explain the principle of operation, performance ,testing methods and parallel operation aspects of 1-ph transformer
5. Explore the performance and other aspects of various 3-ph transformer

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	2	2	-	-	-	-	-	-	-	1	2	2
CO 2	3	3	2	2	2	-	-	--	-	-	-	-	1	2	2
CO 3	3	3	3	3	2	-	-	-	-	-	-	-	1	2	2
CO 4	3	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO 5	3	3	3	2	2	-	-	-	-	-	-	-	1	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT -I

Electromechanical energy conversion: Introduction to Magnetic circuits, forces and torques in magnetic field system, energy balance, singly excited and multiple excited magnetic systems, co-energy.

UNIT -II

DC Generators: Review of Constructional features and Principle of operation of a DC machine, armature windings diagram (Lap and Wave winding), analysis of EMF equation of a DC generator, Armature reaction and its effects, process of commutation, methods of improving commutation, methods of excitation and classification of DC generators, voltage build-up in a shunt generator, critical field resistance and critical speed, generator characteristics, losses and efficiency, parallel operation and applications of DC generators.

UNIT -III

DC Motors: Review of Principle of operation, back EMF and significance of back EMF, electromagnetic torque, types of DC motors, characteristics, analysis of speed control methods, necessity of starter, three-point starter and four-point starter, soft starters (elementary treatment only) losses and efficiency, applications of DC motors.

Testing of DC machines: Swinburne's test, brake test, Hopkinson's test, fields test, retardation test and separation of losses.

UNIT -IV

Single Phase Transformer: Review of Constructional features, principle of operation, EMF equation and ideal transformer, transformer on no-load and on-load and its phasor diagrams. Detailed study of equivalent circuits, voltage regulation and efficiency. All day efficiency, parallel operation of transformer.

Testing of transformer: Polarity test, analysis of open circuit and short circuit test, Sumpner's test, separation of losses.

Auto transformer: Construction, principle, applications, and comparison with two-winding transformers.

UNIT -V

Three-Phase Transformers: Construction, types of connection and their comparative features, Scott connection. Tap-changing transformers: No-load and on-load tap-changing of transformers, Three-winding transformers, cooling of transformers.

TEXT BOOKS:

1. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
2. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
3. H. Cotton, "Advanced Electrical Technology", 7th Edition, Wheeler & Co, CBS publishers, 2005.
4. J.B Gupta, "Theory and performance of electrical machines", 14th Edition, S.K. Kataria & Sons, 2014.

SUGGESTED READINGS:

1. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
4. Ashfaq Hussain "Electrical Machines", 3rd Edition, Danpat Rai and sons, 2012.

22EEC10

POWER SYSTEMS-I

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have knowledge in Electrical Circuit Analysis

COURSE OBJECTIVES: This course aims to

1. Introduce Generation of power through conventional sources such as: Thermal, Hydro, Nuclear and Renewable energy sources
2. Familiarize mechanical design of transmission lines and cables.
3. Familiarize present practices in tariff calculations and understand the classification and Connection schemes of distribution systems.

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

1. Discuss the construction and operation of conventional and non-conventional sources of energy along with financial management.
2. Determine the line parameters such as inductance and capacitance for different configurations of transmission line.
3. Calculate the sag and tension for given transmission line under different weather conditions.
4. Discuss the operation of underground cables, insulators and calculate the capacitance of cables and string efficiency of insulators.
5. Discuss the different tariff structures, types of costs and general aspects of distribution systems.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	1	-	-	2	-	-	-	-	-	1	-	2
CO 2	3	3	-	-	-	-	-	-	-	-	-	-	1	-	2
CO 3	3	3	-	-	-	-	-	-	-	-	-	-	1	-	2
CO 4	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT -I

Basic Concepts: Evolution of Power Systems and Present-Day Scenario. Structure of a power system: Bulk Power Grids and Micro-grids.

Generation: Thermal- Hydro -Power Plants: Principles, Choice of site, layout and various parts of generating stations, Brief description of Hydro Power Plant Dam, Spillways, Head works, Surge tank, Penstocks, Line diagram of Thermal Power Station (TPS) showing paths of coal, steam, water, air, ash and flue gasses, Brief description of TPS components: Economizers, Boilers, Super heaters, Turbines, Condensers, Chimney and Cooling towers.

Nuclear Station: Schematic Arrangement of Nuclear Power Station, Advantages and disadvantages, Types of Nuclear reactors.

UNIT -II

Solar and Wind Generation: Solar cell fundamentals, Solar Cell characteristics, solar cell classification, solar cell, Module, Panel and Array Construction, Maximizing the solar PV output and load matching, Solar PV Systems, Basic Principles of Wind Energy Conversion, The Nature of the Wind, The Power in the Wind, Forces on the Blades, Wind Energy Conversion, Wind Data and Energy Estimation, Site Selection Considerations.

UNIT -III

Line Parameter Calculations: Inductance & Capacitance calculations of Transmission Line, single-phase and three-phase symmetrical composite conductors, GMD, GMR, Transposition of conductors, bundled conductors, effect of earth capacitance.

UNIT -IV

Over-head Transmission Lines and Cables: Over-head line materials, supports, types, Ground wires, Sag/Tension calculations, Equal / Unequal supports, Effects of wind, ice/Erection Conditions stringing. charts, Insulators, Types, Material for construction, potential distribution over string of insulators, equalizing of potential, Methods.

Underground Cables: Construction of Cables, Insulating Materials for Cables, Classification of Cables, Insulation Resistance of a Single-Core Cable, Capacitance of a Single-Core Cable, Dielectric Stress in a Single-Core Cable, Most Economical Conductor Size in a Cable, Grading of Cables, Capacitance Grading, Intersheath grading, Capacitance of 3-Core Cables, Measurements of Ce and Cc.

UNIT -V

Economics of Power Generation: Load curve, Load demand and diversified factors, Base load operation, Types of costs and depreciation calculations; Tariffs, different types of tariffs; Methods of power factor improvement.

General Aspects of Distribution Systems-Types of Distribution, Ring main & Radial Distribution system, Calculations for Distributor fed at one end, distributor fed at both ends **(AC & DC).**

TEXT BOOKS:

1. J. Giangrande'd. Stevenson, "Power System Analysis", McGraw Hill Education, 1994.
2. C.L. Wadhwa, "Electric Power Systems Theory", New Academic Science Limited, 2012.
3. B.H. Khan, "Non-Conventional Energy Resources" McGraw Hill Education, 2015

SUGGESTED READINGS:

1. A.R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999.
2. D.P. Kothari and I.J. Nagrath, "Modern Power System Analysis", McGraw Hill, 2003.
3. B.M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, "Electric Power Systems", Wiley, 2012

22EEC11

CONTROL SYSTEMS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have a prior knowledge of Newton's laws of Motion, Circuit theory, Vector Calculus & Differential Equations, Laplace transform and linear algebra.

COURSE OBJECTIVES: This course aims to

1. Understand different types of linear control systems and their mathematical modeling.
2. Study the stability analysis both in time and frequency domains.
3. Study the concepts of State space representation of Linear Time invariant systems (LTI).

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

1. Demonstrate the characteristics of DC, AC Servo motors and Synchro Pair.
2. Analyze the performance parameters of a given second order plant in the time domain.
3. Analyze the performance of different compensators through its frequency response.
4. Design P, PI, PID and ON/OFF controller of a given system and to distinguish the merits and demerits of these controllers.
5. Demonstrate the effect of damping on the plant using the DC position control system.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	1	1	-	-	-	-	-	-	-	-	-	-	1
CO 2	3	3	2	2	2	-	-	-	-	-	-	-	1	-	1
CO 3	3	2	3	2	2	-	-	-	-	-	-	-	2	-	2
CO 4	3	3	2	3	2	-	-	-	-	-	-	-	3	-	2
CO 5	3	2	2	1	-	-	-	-	-	-	-	-	-	-	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT -I

Introduction to Control Systems: Open loop, closed loop System with illustrations and other classification of control systems, Impulse response and Transfer Function, Mathematical modeling of Mechanical and Electrical Systems, Analogous Systems, Feedback control characteristics - effects of feedback.

UNIT -II

Mathematical Models of Physical Systems: Introduction of servo motors & Synchro pair, Modeling of armature and field-controlled D.C motors, Block diagram algebra, Signal flow graphs and problems on conversion from block diagram to signal flow graph.

UNIT -III

Time Response Analysis: Standard test signals, Time response of first and second order systems for standard test inputs, Application of initial and final value theorem, Static error coefficients and steady state error (for standard test input signals), Performance parameters of a second-order systems based on the time-response. Concept of Stability, Routh-Hurwitz Criteria, Relative Stability analysis, root locus technique, Typical systems analyzed by root locus technique, Response with P, PI & PID controllers.

UNIT -IV

Frequency Response Analysis: Introduction, Frequency domain specifications for a second order system, Relationship between time and frequency response, bode plots, Polar plots, Nyquist stability criterion, Relative stability using Nyquist criterion. Stability analysis of plots based on gain and phase margin, Introduction to Lag and Lead networks and their Transfer functions.

UNIT -V

State Variable Analysis and Introduction to Discrete Control Systems: Concepts of state, state variable, State models of linear time invariant systems, Derivation for state models from transfer functions and differential equations, State transition matrix and its properties, Solution of state equations in time & Laplace domain, Eigenvalues and Stability Analysis, Concept of Controllability and Observability. Introduction to discrete control systems.

TEXT BOOKS:

1. I.J. Nagrath, M. Gopal, "Control System Engineering", 5thEdition, New Age International(P) Limited Publishers, 2008.
2. B.C. Kuo, "Automatic Control Systems", 9th edition, John Wiley, and son's Publishers, 2009.
3. K. Ogata, "Modern Control Systems", 5thEdition, PHI publication, 2010.
4. A. Anand Kumar, "Control Systems", 2ndEdition, PHI publications, 2014.

SUGGESTED READINGS:

1. M. Gopal, "Control Systems Principles and Design", 2nd Edition Tata McGraw Hill, 2003.
2. N.C Jagan "Control Systems", 2nd Edition, BS Publications, 2008.
3. N. Nise, "Control Systems Engineering", 6th Edition, Wiley Publications, 2011.

NPTEL Courses:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Control Engineering	Prof. Ramakrishna Pasumarthi	IITM

22EEC12

DIGITAL ELECTRONICS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basics of number systems, basics of transistors and MOSFETs

COURSE OBJECTIVES: This course aims to
1. Demonstrate the working of logic families and logic gates
2. Present design and implementation of combinational and sequential logic circuits.
3. Illustrate the process of A/D and D/A conversions and PLD's in implementing the given logical problems.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Understand the fundamental concepts and techniques used in logical operations.
2. Analyze and design various combination circuits using k Maps and Q-M method.
3. Design and implement Sequential logic circuits like counters shift register sand sequence generators
4. Understand the process of Analog to Digital conversion and Digital to Analog conversion.
5. Implement PLD's to solve the given logical problems.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	-	-	-	-	-	-	-	1	1	-
CO 2	2	3	3	2	1	-	-	-	-	-	-	-	1	2	-
CO 3	2	3	3	2	1	-	-	-	-	-	-	-	1	3	1
CO 4	2	2	2	2	1	-	-	-	-	-	-	-	1	1	1
CO 5	1	2	2	1	1	-	-	-	-	-	-	-	1	1	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT -I

Fundamentals of Digital Systems and Logic Families: Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital ICs, digital logic families, TTL, and CMOS logic.

UNIT -II

Combinational Digital Circuits: Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, digital comparator, parity checker/generator, code converters, priority encoders, decoders/Seven segment display device, Q-M method of function realization.

UNIT –III

Sequential Circuits and Systems: A 1-bit memory, the circuit properties of bi-stable latch, the clocked SR flipflop, J- K-T and D-types flip-flops, applications of flip-flops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, sequence detector, ripple(Asynchronous) counters, synchronous counters, counters design using flip flops, applications of counters.

UNIT -IV

A/D and D/A Converters: Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, analog to digital converters: parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, specifications of A/D converters. - Significance of size of data on the accuracy of conversion.

UNIT -V

Semiconductor memories and Programmable Logic Devices: Introduction to state diagram- Moore and Mealy machine Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory (RAM), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic.

TEXT BOOKS:

1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.

SUGGESTED READINGS:

1. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.
2. S. Salivahanan “Digital circuits and design”, 4th edition, Vikas Publishing house, 2010.

NPTEL Courses:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Digital Electronic Circuits https://onlinecourses.nptel.ac.in/noc20_ee32/preview	Prof. Goutam Saha	IIT Kharagpur

22ITC24N

DATA STRUCTURES USING C

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Problem Solving and Programming, Problem Solving and Programming Laboratory.

COURSE OBJECTIVES: This course aims to
1. Discuss the basics of C Programming.
2. Learn the usage of functions, arrays, pointers, and structures.
3. Familiarise with the concepts of Functions, Arrays, Pointers and Structures.
4. Introduce Stack, Queue and Linked lists data structures.
5. Explain the concepts of non-linear data structures like graphs and trees.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Understand the basic concepts of C Programming language.
2. Understand the usage of functions, arrays, pointers, and structures.
3. Apply the concepts of Stacks and Queues in solving the problems.
4. Demonstrate the standard operations on Linked lists.
5. Explain tree traversals and graph traversal techniques.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	1	-	-	-	-	-	-	-	-	1			
CO 2	2	1	1	-	-	-	-	-	-	-	-	1			
CO 3	2	2	2	-	-	-	-	-	-	-	-	1			
CO 4	2	2	2	-	-	-	-	-	-	-	-	1			
CO 5	2	2	2	-	-	-	-	-	-	-	-	1			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT -I

Introduction to C Language: C language elements, variable declarations and data types, operators and expressions, decision statements – If and switch statements, loop control statements – while, for, do-while statements, arrays.

UNIT -II

Functions: Types of functions, Recursion and argument passing, pointers, storage allocation, pointers to functions, expressions involving pointers, Storage classes – auto, register, static, extern, Structures, Unions, and Command line arguments.

UNIT -III

Basics: Algorithm specification, Data Abstraction, Performance Analysis
Stacks and Queues: Stack ADT, Queue ADT, Mazing Problem, Evaluation of Expressions

UNIT -IV

Lists: Singly Linked Lists, Dynamically Linked Stacks and Queues, Polynomials, Additional List Operations, Doubly Linked Lists
Hashing: Static Hashing

UNIT -V

Trees: Introduction, Binary Trees, Binary Tree Traversals, Heaps, Binary Search Trees
Graphs: Graph ADT, Elementary Graph Operations, Minimum Cost Spanning Trees.

TEXT BOOKS:

1. Pradip Dey and Manas Ghosh, "Programming in C", 2nd Edition, Oxford University Press 2011.
2. Ellis Horowitz, Sartaj Sahni, Susan, "Fundamentals of Data Structures in C", Computer Science, 1993.

SUGGESTED READING:

1. A.K. Sharma, "Computer Fundamentals and Programming in C", University Press, 2nd Edition.
2. M.T. Somashekara, "Problem Solving Using C", 2nd Edition, PHI 2009 Pearson, 2013.
3. E. Balaguruswamy, "C and Data Structures", 4th Edition, Tata McGraw Hill.

NPTEL Courses:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Programming and Data Structure, https://nptel.ac.in/courses/106105085	Dr. P.P. Chakraborty	IIT, Kharagpur
2	Programming, Data Structures and Algorithms using C https://archive.nptel.ac.in/courses/106/106/106106127	Prof. Shankar Balachandran	IIT, Madras

22EEM01

UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY
(**B.E/B. Tech** - Common to all Branches)

Instruction	1T Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1

INTRODUCTION:
This course discusses the role of human values in one's family, in society and in nature. During the Induction Program, students would get an initial exposure to human values through Universal Human Values–I. This exposure is to be augmented by this compulsory full semester foundation course.

COURSE OBJECTIVES: This course aims to
1. Understand the concept of universal human values
2. Cultivate empathy and respect for diversity
3. Inspire the social responsibility and global citizenship

COURSE OUTCOMES After the completion of this course, the student will be able to
1. Become familiar about themselves, and their surroundings (family, society, nature).
2. Develop empathy and respect for diversity by gaining an appreciation for different cultures, perspectives, and identities
3. Exhibit responsible and ethical behavior by adhering to principles of integrity, honesty, compassion, and justice.
4. Recognize their role as global citizens.
5. Exhibit a sense of social responsibility.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	1	-	-	1	-	-	1	-	-	1	-	1	1
CO 2	-	-	1	-	-	1	1	-	1	-	1	1	-	1	1
CO 3	--	-	-	-	-	1	-	-	-	1	-	-	-	1	1
CO 4	-	-	-	-	-	1	1	1	-	-	-	-	-	1	1
CO 5	-	-	-	-	-	1	1	1	-	-	-	-	-	1	1

1 - Slightly, 2 - Moderately, 3 - Substantially

MODULE -1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education
- Purpose and motivation for the course, recapitulation from Universal Human Values-I
- Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and
- Experiential Validation- as the process for self-exploration.
- Natural acceptance of human values.
- Definitiveness of Ethical Human Conduct.
- Continuous Happiness and Prosperity- A look at basic Human Aspirations.
- Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current Scenario.
- Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

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

MODULE- 2: Understanding Harmony in the Human Being - Harmony in Myself

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

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

MODULE-3: Understanding Harmony in the Family and Society- Harmony in Human- 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 society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co -existence as comprehensive Human Goals.
- 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.

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 scenarios. Elicit examples from students' lives.

MODULE -4: Understanding Harmony in Nature and Existence - Whole existence as Coexistence.

- Understanding the harmony in 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.
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.
- Holistic perception of harmony at all levels of existence.
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability Identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability Identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems.

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

MODE OF CONDUCT (L-T-P-C 0-1-0-0)

- While analyzing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.
- 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. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentors, in a group sitting.
- **Tutorials (experiments or practical) are important for this course**. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignments and/or activities are included.
- The practice sessions would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to the development of commitment, namely behaving and working based on basic human values.
- **It is advised to share the experience of the Faculty to the class in a capsule form.**
- **Involve more in evaluating the student by different activities with proper RUBRCCS**

ASSESSMENT:
This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self- assessment, peer assessment etc. will be used in evaluation.

EXAMPLE:

Module-1:	10 M
Module -2:	10 M
Module- 3:	10 M
Module-4:	10 M
Attendance & Attitude:	10 M

The overall pass percentage is 50%. In case the student fails, he/she must repeat the course.

TEXTBOOKS
1. "A Foundation Course in Human Values and Professional Ethics" by R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2022.
2. "Teacher's Manual for A Foundation Course in Human Values and Professional Ethics" by R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2022.

REFERENCE BOOKS
1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth – by Mohandas Karamchand Gandhi

22EEC14

ELECTRICAL MACHINES – I LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisite: Students should have the prior knowledge of Basic Electrical Engineering.

COURSE OBJECTIVES: This course aims to
1. Draw the characteristics of different types of DC generators.
2. Test the DC machines under different loading conditions.
3. Understand the performance of single-phase transformer.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Understand how to perform experiments to measure and analyze the performance of different types of electrical machines.
2. Realize the performance parameters through experimentation.
3. Understand the Practical aspects of electrical machines and control
4. Obtain the performance characteristics of the given Machine
5. Interpret the experimental data and **drawing conclusions.**

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	2	1	-	-	-	-	-	-	-	1	2	2
CO 2	3	3	2	2	1	-	-	-	-	-	-	-	1	2	2
CO 3	3	3	2	2	1	-	-	-	-	-	-	-	1	2	2
CO 4	3	3	2	2	1	-	-	-	-	-	-	-	1	2	2
CO 5	3	3	2	2	1	-	-	-	-	-	-	-	1	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

List of Experiments:
1. OCC and load characteristics of separately excited DC generator.
2. OCC and load characteristics of DC shunt generator.
3. Load characteristics of DC compound generator.
4. Swinburne's test on DC shunt machine to predetermine the efficiency at any given load.
5. Brake test on DC series motor.
6. Hopkinson's test on two identical DC shunt machines.
7. Separation of stray losses of DC shunt machine.
8. Load test on single phase transformers.
9. Sumpner's test on two identical single-phase transformers.
10. Separation of Magnetic losses of transformer.
11. Study of three-phase transformer connections.
12. Demonstration of three-point starter and four-point starter.
13. Study of excitation phenomenon of three-phase transformer.
14. Parallel operation of two single-phase transformers.

Note: At least TEN experiments should be conducted in the semester.

SUGGESTED READINGS:
1. S.G. Tarnekar, P.K. Kharbanda, "Laboratory course in Electrical engineering", S. Chand & Co 1990

22EEC15

CONTROL SYSTEMS LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisite: Students should have a prior knowledge of Newton's laws, Circuit theory, Vector Calculus & Differential Equations, Laplace transform and their properties and linear algebra.

COURSE OBJECTIVES: This course aims to
1. Understand different types of linear control systems and their mathematical modeling.
2. Study the stability analysis both in time and frequency domains.
3. Study the concepts of State space representation of Linear Time invariant systems (LTI).

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Obtain mathematical models and transfer functions for any electromechanical LTI system.
2. Determine the Transfer function of an LTI system using block diagram & signal flow graph approach.
3. Analyze the given first and second order systems based on their performance parameters & PID controllers.
4. Analyze the absolute and relative stabilities of an LTI system using time and frequency domain techniques and demonstrate the design of compensators.
5. Develop the state space models for various LTI systems and check their Controllability and Observability.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	2	2	-	-	-	-	-	-	-	2	-	-
CO 2	3	2	2	1	1	-	-	-	-	-	-	-	1	-	-
CO 3	3	2	1	3	2	-	-	-	-	-	-	-	2	-	1
CO 4	3	3	2	3	3	-	-	-	-	-	-	-	2	-	-
CO 5	3	3	3	3	3	-	-	-	-	-	-	-	2	-	1

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:
1. Characteristics of D.C Servomotor.
2. Characteristics of A.C. Servomotor.
3. Characteristics of Synchro Pair.
4. Performance parameters of a second order system excited with step input for different damping ratios.
5. Frequency response of lag and lead compensating networks.
6. Performance of a temperature control system using P, PI and PID Controllers.
7. Temperature control of a system using relay (ON/OFF Control).
8. Characteristics of magnetic amplifier for series and parallel connections with different values of resistive load.
9. Measurement of step angle for stepper motor.
10. Response of different components of a control system using Linear System Simulator.
11. Demonstration of damping effect on the plant using DC position control system.
12. Study of closed loop speed control of BLDC motor with the effect of PI controller

Note: At least TEN Experiments should be conducted in the semester from the above list of experiments

22EEC16

DIGITAL ELECTRONICS LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisite: Basic knowledge on logical operations, basics of logic gates, basics of flip-flops.

COURSE OBJECTIVES: This course aims to

1. Explain Demorgan's Theorem, SOP, POS forms.
2. Demonstrate implementation of Full/Parallel Adders, Subtractors and Magnitude Comparators, multiplexers, de-multiplexers and decoders using logic gates.
3. Illustrate various flip-flops, shift registers and design different counters.

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

Demonstrate the truth table of various expressions and combinational circuits using logic gates.

1. Design, test and implement various combinational circuits such as adders, sub tractors, comparators.
2. Apply knowledge of logic gates to design complex logic circuits like multiplexers and demultiplexers.
3. Design, test and implement various sequential circuits using flip-flops
4. Design various logic circuits using shift registers.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	-	-	-	-	-	-	-	1	1	-
CO 2	2	3	3	2	1	-	-	-	-	-	-	-	1	2	-
CO 3	2	3	3	2	1	-	-	-	-	-	-	-	1	3	1
CO 4	2	2	2	2	1	-	-	-	-	-	-	-	1	1	1
CO 5	1	2	2	1	1	-	-	-	-	-	-	-	1	1	1

1 - Slightly, 2 - Moderately, 3 - Substantially

List of Experiments:

1. Verify Demorgan's Theorem for 2 variables.
2. The sum-of product and product-of-sum expressions using gates.
3. Design and implement
    a. Full Adder using basic logic gates.
    b. Full subtractor using basic logic gates
4. Design and implement 4-bit Parallel Adder/ subtractor using IC 7483.
5. Design and Implementation of 4-bit Magnitude Comparator using IC 7485.
6. Realize
    a. 4:1 Multiplexer using gates.
    b. 3-variable function using IC 74151(8:1MUX).
7. Realize 1:8 Demux and 3:8 Decoder using IC74138.
8. Realize the following flip-flops using NAND Gates.
    a. Clocked SR Flip-Flop
    b. JK Flip-Flop
9. Realize the following shift registers using IC7474
    a. SISO
    b. SIPO
    c. PISO
    d. PIPO
10. Realize the Ring Counter and Johnson Counter using IC7476.
11. Realize the Mod-N Counter using IC7490.
12. Design of synchronous counters using flip-flops.

13. Design of Asynchronous counters using flip-flops.

Note: At least TEN experiments should be conducted in the Semester

22ITC25N

DATA STRUCTURES USING C LAB

Instruction	2P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Prerequisites: Problem Solving and Programming, Problem Solving and Programming Laboratory.

COURSE OBJECTIVES: This course aims to
1. Acquaint with the IDLE and execution process of C Programs
2. Learn the concepts of decision structures and Iteration structures in C
3. Introduce Functions, Arrays, Pointers and Structures.
4. Explore linear data structures such as Stack, Queue and Linked lists.
5. Explain C programs to implement Trees and Graphs

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Understand the execution of programs written in C language
2. Illustrate decision and iterative structures.
3. Demonstrate the concepts of functions, arrays, structures and pointers.
4. Implement basic operations on linked lists, stacks, queues
5. Construct Trees, graphs and implement traversals.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	-	-	-	-	-	-	-	-	1			
CO 2	2	2	1	-	-	-	-	-	-	-	-	1			
CO 3	2	2	2	-	-	-	-	-	-	-	-	1			
CO 4	2	2	2	-	-	-	-	-	-	-	-	1			
CO 5	2	2	2	-	-	-	-	-	-	-	-	1			

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:
1. Using if and Switch Constructs Programs.
2. Demonstration of Looping Statements Problems.
3. Demonstration of Iterative and recursive Functions.
4. Demonstration of Structures and Union Programs.
5. Demonstration of Pointers and Arrays Programs.
6. Implementation of Stacks, Queues and standard operations.
7. Implementation of Single Linked Lists and standard operations
8. Implementation of Double Linked Lists and standard operations.
9. Construct a Binary Search Tree and implement tree traversals
10. Represent Graph and implement DFS and BFS traversals.

TEXT BOOKS:
1. Pradip Dey and Manas Ghosh, “Programming in C”, 2nd Edition, Oxford University Press 2011.
2. Ellis Horowitz, Sartaj Sahni, Susan, “Fundamentals of Data Structures in C”, Computer Science, 1993

SUGGESTED READING:
1. M.T. Somashekara, “Problem Solving Using C”, 2nd Edition, PHI 2009 Pearson, 2013.
2. A.K. Sharma, “Computer Fundamentals and Programming in C”, University Press, 2nd Edition.
3. E. Bala Guruswamy, “C and Data Structures”, 4th Edition, Tata Mc Graw Hill.

NPTEL Courses:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Programming and Data Structure, https://nptel.ac.in/courses/106105085	Dr. P.P. Chakraborty	IIT, Kharagpur
2	Programming, Data Structures and Algorithms using C https://archive.nptel.ac.in/courses/106/106/106106127	Prof. Shankar Balachandran	IIT, Madras

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
(Inline with AICTE Model Curriculum with effect from AY 2026-27)(R22A)

SEMESTER – V

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22EEC17	Electrical Machines-II	3	-	-	3	40	60	3
2	22EEC18	Power Systems –II	3	-	-	3	40	60	3
3	22EEC19	Power Electronics	3	-	-	3	40	60	3
4	22EEC20	Microcontrollers and Applications	3	-	-	3	40	60	3
5	22EEExx	**PE-1**	3	-	-	3	40	60	3
6	22xxOxx	**OE-1**	3	-	-	3	40	60	3
PRACTICAL									
7	22EEC21	Electrical Machines- II Lab	-	-	3	3	50	50	1.5
8	22EEC22	Power Electronics Lab	-	-	3	3	50	50	1.5
9	22EEC23	Microcontrollers and Applications Lab	-	-	3	3	50	50	1.5
10	22EGC03	Employability Skills	-	-	2	3	50	50	1
11	22EEI02	Industrial / Rural Internship	3-4 weeks/ 90 hours			-	50	-	2
Total			**18**	**-**	**11**	**-**	**490**	**560**	**25.5**
Clock Hours Per Week: 29									

L: Lecture **D:** Drawing **CIE:** Continuous Internal Evaluation
T:Tutorial **P:** Practical/ Project Seminar/ Dissertation **SEE:** Semester End Examination

LIST OF PROGRAM ELECTIVES: SEMESTER – V

S.No	**List of Courses offered in Program Elective-1(PE-1)**	
	Course Code	**Title of the Course**
1	22EEE11	Basic VLSI Design
2	22EEE12	Design of Power Electronic Systems
3	22EEE13	Non-Conventional Energy Resources
4	22EEE14	Optimization Techniques
5	22EEE15	Computer Architecture and Organization

22EEC17

ELECTRICAL MACHINES– II

Instruction	3L Hours per week
Duration of SEE	3Hours
SEE	60Marks
CIE	40Marks
Credits	3

Prerequisites: Basic knowledge of Electrical Engineering, Machines and Circuit analysis.

COURSE OBJECTIVES: This course aims to

4. Understand the construction and operation of AC machines.
5. Analyze the performance aspects of induction motor and Synchronous generator.
6. Discuss about Synchronous Motor performance and its starting methods.

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

1. Analyze the AC machine windings, considering factors like slot harmonics, pitch factor, and distribution factor.
2. Understand the operational characteristics of three-phase induction motors, including torque-speed behaviour, starting methods, and speed control techniques.
3. Explain the working principle of single-phase Induction motors and their applications in various Situations.
4. Comprehend the construction, performance, and synchronization aspects of synchronous generators, including voltage regulation and parallel operation.
5. Analyze the behaviour of synchronous motors, including starting methods, power factor variation, and prevention of hunting. They will also understand the role of synchronous condensers.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	1	-	-	-	-	-	-	-	-	-	3	-	2
CO 2	2	2	-	-	1	-	-	-	-	-	-	-	3	-	-
CO 3	2	-	-	-	-	-	-	-	-	-	-	-	3	-	1
CO 4	2	1	-	-	-	-	-	-	-	-	-	-	3	-	1
CO 5	2	2	1	-	1	-	-	-	-	-	-	-	3	-	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Fundamentals of AC machine windings: Slots for windings, Harmonics (slot and teeth Harmonics), Suppression of Harmonics, full-pitch and short pitch coils, concentrated winding, distributed winding, pitch factor, distribution factor - Numerical problems.

UNIT-II

Three phase Induction Machines: Review of Construction and Operational features, equivalent circuit, torque expression, starting torque, maximum torque, torque-slip characteristics, parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency), cogging and crawling, power flow, losses and efficiency, no load and blocked rotor test-Numerical predetermination of performance characteristics using circle diagram. Starting methods: primary resistors, auto transformer, star-delta and DOL starting. Speed control methods from stator and rotor side, doubly fed induction generator (DFIG) - Numerical problems.

UNIT-III

Single-phase induction motors: Constructional features double field revolving theory, Split phase, Shaded pole andCapacitor type motors, equivalent circuit, applications-Numerical problems.

UNIT-IV

Synchronous generators: Constructional features, cylindrical and salient pole rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, open circuit, short circuit and zero power factor characteristics, voltage regulation by EMF, MMF and ZPF method, Salient pole alternators two reaction theory, Phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division. Analysis of short circuit current wave form – determination of sub-transient, transient and steady state reactance- Numerical problems.

UNIT-V

Synchronous motor: Principle of operation, methods of starting, variation of current and power factor with excitation. on no load and on load-V and inverted V curves. Hunting and its prevention. Synchronizing power, Synchronous condenser- Numerical problems.

TEXT BOOKS:

1. P. S. Bimbhra, “Electrical Machinery”, Khanna Publishers, 2021.
2. I. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 5th 2017.
3. Ashfaq Hussain “Electrical Machines” Danapatrai and sons, 3rd Edition 2016.
4. J.B Gupta, S.K. Kataria &Sons, “Theory and performance of electrical machines”, 15th Edition, 2015.

SUGGESTED READING:

1. A.E. Fitzgerald and C. Kingsley, "Electric Machinery”, McGraw Hill Education, 2020.
2. Juha Pyrhonen, Tapani Jokinen, Valeria Hrabovcova, “Design of Rotating Electrical Machines”, John Wiley& Sons, Ltd. 2013.
3. P. C. Sen, “Principles of Electric Machines and Power Electronics”, John Wiley& Sons, 2007.
4. M. G. Say, “Performance and design of AC machines”, CBS Publishers, 2002.
5. A. S. Langsdorf, “Alternating current machines”, McGraw Hill Education, 1984.

SWAYAM/NPTEL/MOOCs:

1. https://onlinecourses.nptel.ac.in/noc20_ee38/preview
2. https://ocw.tudelft.nl/courses/electrical-machines-and-drives/
3. https://www.careers360.com/university/indian-institute-of-technology-kharagpur/electrical-machines-ii-certification-course.

22EEC18

POWER SYSTEMS –II

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Power Systems-I.

COURSE OBJECTIVES: This course aims to
1. Understand the modelling of transmission lines and their performance calculations
2. Understand per unit representation of power systems and fault calculation analysis
3. Understand the causes of over voltages and power flow analysis of given power system.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Analyze the performance of different types of transmission lines and assess the impact of corona discharge on their performance.
2. Comprehend the use of per-unit measurements in power system analysis.
3. Classify different faults and utilize symmetrical components to solve power system issues under diverse fault conditions.
4. Illustrate the origin of over voltages and evaluate the reflection and refraction coefficients of both overhead lines and cables.
5. Utilize the Gauss-Seidel and Newton-Raphson methods to compute power flows and voltages within the specified power system.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	-	3	-	-	-	-	-	-	-	2	3	1
CO 2	3	3	2	2	2	-	-	-	-	-	-	-	2	3	2
CO 3	3	3	1	-	3	-	-	-	-	-	-	-	2	3	-
CO 4	3	3	2	2	3	-	-	-	-	-	-	-	3	3	2
CO 5	3	3	2	3	3	-	-	-	-	-	-	-	3	3	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Modelling of Transmission Lines: Short, medium, long lines, Line calculations, Tuned Lines, Surge impedance loading, series and shunt compensation of Transmission lines, numerical problems, Corona: Causes, Disruptive and Visual Critical Voltages, Power loss, minimization of Corona effects.

UNIT-II

Per Unit Representation: Utilization of per-unit quantities in power systems and understanding its benefits. Examination of symmetrical faults, including typical waveforms during balanced terminal short-circuit conditions, steady-state, transient, and sub transient equivalent circuits. Analysis of reactance in synchronous machines, fault calculations, and determination of short-circuit capacity of bus.

UNIT-III

Unsymmetrical Faults: Symmetrical components of unsymmetrical Phasors, Power in terms of symmetrical components, sequence impedance and sequence networks. Sequence networks of unloaded generators, Sequence impedances of circuit elements, Single line to ground, line-to-line and double line to ground faults on unloaded generator, Unsymmetrical faults of power systems.

UNIT-IV

Transients in Power Systems: Generation of Over-voltages Causes of over voltages, lightning and Switching Surges, Travelling wave equations, Reflection and refraction coefficients, Junction of cable and overhead lines, Junction of three lines of different natural impedances, Bewley Lattice diagram.

UNIT-V

Power Flow Analysis: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications, Utilizing numerical techniques-Gauss-Seidel and Newton-Raphson methods to solve nonlinear algebraic equations involved in power flow analysis.

TEXT BOOKS:

1. J.J Grainger and W. D. Stevenson, "Power System Analysis", McGraw Hill Education, 1994.
2. O. I. Elgerd, "Electric Energy Systems Theory", McGraw Hill Education, 1995.
3. C.L. Wadhwa, "Electric Power Systems Theory", New Academic Science Limited, 2012

SUGGESTED READING:

1. A.R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999.
2. D.P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003.
3. B.M. Weedy, B.J. Cory, N. Jenkins, J. Ekanayake & G. Strbac, "Electric Power Systems".

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108102179
2. https://nptel.ac.in/courses/108107157

22EEC19

POWER ELECTRONICS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Analog Electronic Circuits, Electrical Circuit Analysis, Basic Electrical Engineering

COURSE OBJECTIVES: This course aims to
1. Comprehend the characteristics of different static switches and their turn- ON & turn - OFF methods.
2. Impart the principles of AC-DC, DC-DC, DC-AC and AC-AC energy conversions.
3. Dispense various methods of voltage control in power converters.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Understand the construction, operation and characteristics of various power semiconducting devices and identify their selection in appropriate application.
2. Comprehend the driver/trigger circuits for various devices & also protection circuit, different turn -OFF methods, series & parallel operation of SCRs.
3. Illustrate the principle of working of AC-DC, AC-AC, DC-DC & DC-AC converters.
4. Analyse the performance for various power converters with different loads and modes of working.
5. Describe various voltage control techniques in power electronic converters with their applications

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	1	1	-	-	-	-	-	-	-	1	3	3	1
CO 2	2	1	1	1	-	-	-	-	-	-	-	1	3	3	1
CO 3	2	1	1	1	-	-	-	-	-	-	-	1	3	3	1
CO 4	3	2	1	1	-	-	-	-	-	-	-	1	3	3	1
CO 5	3	3	1	1	-	-	-	-	-	-	-	1	3	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Power Switching Devices: Power diode, Characteristics, Recovery characteristics, Types of power diodes, General purpose diodes, Fast recovery diodes, their applications. Bipolar Junction Transistors (BJT), Power MOSFET, IGBT, Basic structure and working, Steady state and switching characteristics, Gate drive circuits for MOSFET and IGBT, Comparison of BJT, MOSFET & IGBT and their applications.

UNIT-II

Silicon Controlled Rectifier (SCR): SCR-Static characteristics, Two transistor analogy, Protection of SCRs, Dynamic characteristics, Series and parallel operation of SCRs, SCR trigger circuits-R, RC and UJT triggering circuits, Commutation methods of SCR.

UNIT-III

Thyristors Rectifiers: Study of single-phase and three-phase half wave and full wave-controlled rectifiers with R, RL, RLE loads, Significance of freewheeling diode, Effect of source inductance, Dual converters - circulating and non-circulating current modes.

UNIT-IV

DC-DC Converters: Principles of Step-down, Step-up, Step UP/Down choppers, Time ratio control and current limit control, Types of choppers Type- A, B, C, D and E, Voltage commutated chopper, Introduction to Buck, Boost and Buck-Boost regulators, Basics of flyback and forward converters.

AC-AC Converters: AC voltage controller, Integral cycle control, Phase control, AC voltage controllers with R and RL loads

UNIT-V

DC-AC Converters: Single-phase bridge inverters, Voltage control methods, Single pulse width modulation, Multiple pulse width modulation, Sinusoidal pulse width modulation, Three-phase bridge Inverters, 180^0 & 120^0 modes of operation, Switch states, Instantaneous output voltages, average output voltages for single & three phase inverters, Current source inverters, Comparison of voltage source inverters and current source inverters,

TEXT BOOKS:

1. Singh. M. D, Khanchandani. K. B, "Power Electronics", Tata McGraw Hill, 2nd Edition, 2017.
2. Rashid. M. H., "Power Electronics Circuits Devices and Applications", 4th Edition, Pearson India, 2017.
3. Bimbra. P. S, "Power Electronics", Khanna Publishers, 3rd Edition, 2013.

SUGGESTED READING:

1. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science
2. N. Mohan, T.M. Undeland , "Power Electronics: Converters, Applications and Design", John Wiley & Sons,2007
3. P.C. Sen, "Power Electronics", Tata Mc-Graw Hill, 1st Edition, 2001.
4. L.Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

NPTEL Courses:

S.No	NPTEL Course Name	Instructor	Host Institute
1	Fundamental of Power Electronics	Prof. L Umanand	IISc Bangalore

22EEC20

MICROCONTROLLERS AND APPLICATIONS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basic knowledge of Digital Electronics and programming in C language.

COURSE OBJECTIVES: This course aims to
1. Understand the fundamentals and Programming using 8051 Microcontroller
2. Understand Programming and interfacing using 8051 Microcontroller.
3. Understand the fundamentals and programming using ARM 7 controller

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Understand the internal architecture of 8051 Microcontroller
2. Build Assembly Language Program using 8051 Microcontroller.
3. Develop Application interfaces to 8051 Microcontroller using Communication Protocols
4. Understand the internal architecture of ARM controller
5. Demonstrate the ability to Program ARM controller LPC 2148

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	-	-	-	-	-	-	-	1	1	-
CO 2	2	3	3	2	1	-	-	-	-	-	-	-	1	2	-
CO 3	2	3	3	2	1	-	-	-	-	-	-	-	1	3	1
CO 4	2	2	2	2	1	-	-	-	-	-	-	-	1	1	1
CO 5	1	2	2	1	1	-	-	-	-	-	-	-	1	1	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT – I

Fundamentals of processors controllers and the 8051 Architecture: Fundamentals of Microprocessor, Basic Block Diagrams of Microprocessor and Microcontroller, Role of Microcontrollers in embedded Systems. 8051 microcontroller- Internal Block Diagram, CPU, ALU, address, data and control bus, Working registers, SFRs, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory, Timing diagrams and Execution Cycles, timers, counters.

UNIT – II

Instruction Set and Programming: Instruction syntax, Data types, Addressing modes. 8051 Instruction set, Instruction timings, Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instruction. Assembly language programs, C language programs. Assemblers and compilers. Programming and debugging tools

UNIT – III

External Communication and Application Interface: Interfacing Memory and I/O expansion buses, control signals, memory wait states. Interfacing of peripheral devices such as General Purpose I/O, ADC, DAC, memory devices. LED, LCD and keyboard interfacing. Stepper motor interfacing, DC Motor interfacing, sensor interfacing.

Communication protocols: Brief overview on RS232, I2C, SPI, CAN, Blue-tooth and Zig-bee..

UNIT – IV

ARM: Introduction to RISC Processors, ARM Design Philosophy, ARM Processor families, Architecture-Revisions, Registers, Program status register, Pipeline, Introduction to Exceptions.

ARM 7 Microcontroller (LPC2148): Salient features of LPC 2148, Pin description of 2148, Architectural Overview. ARM 7(LPC2148) Peripherals: Description of General-Purpose Input/output (GPIO) ports, Pin control Block. Features, Pin description, Register description and operation of PLL, Timers, PWM, ADC, DAC.

UNIT – V

ARM Instruction Set: ARM data types, Data processing instructions, Branch instructions, Load-Store instructions, Software interrupt instruction, Program Status Register instructions, Loading constants, and Conditional executions. Introduction to THUMB instructions: Differences between Thumb and ARM modes, Register usage.

TEXT BOOKS:

1. M . A.Mazidi, J. G. Mazidi and R. D. McKinlay, "The8051Microcontroller and Embedded Systems: Using Assemblyand C",Pearson Education, 2007.
2. Andrew N.Sloss, Domonic Symes, Chris Wright, "ARM System Developers Guide Designing and Optimizing system software", 1/e, Elsever, 2004.
3. AndewN.Sloss, Dominic Symes, Chris Wright, "ARM system developers Guide - Designing and optimizing system".

SUGGESTED READING:

1. K. J. Ayala, "8051 Microcontroller", Delmar Cengage Learning,2004.
2. Lyla B. Das, "Architecture, Programming and Interfacing of Low-power Processors-ARM 7, Cortex-M", CENGAGE,2017.
3. David E Simson, "Embedded system Primer", Pearson Publication

NPTEL Courses:

S.No	NPTEL Course Name	Instructor	Host Institute
1	Microprocessors And Microcontrollers	Prof. Santanu Chattopadhyay	IIT Kharagpur
2	Embedded System Design with ARM	Prof.Indranil Sengupta	IIT Kharagpur

22EEE11

BASIC VLSI DESIGN
(Program Elective-1)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basic knowledge of Basic Electronics and Digital Electronics

COURSE OBJECTIVES: This course aims to
1. Understand the MOSFET structures and operations
2. Learn to design logic circuits using pMOS and nMOS
3. Learn to design concepts of CMOs and HDL Programming.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Design logic circuits using pMOS and nMOS technologies
2. Design cMOS logic circuits.
3. Build logical circuits using HDL programming
4. Understand different modelling strategies
5. Understand FPGA design strategies.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	-	-	-	-	-	1	1	1	1	-
CO 2	2	3	3	2	1	-	-	-	-	-	2	1	1	2	-
CO 3	2	3	3	2	1	-	-	-	-	-	2	2	2	3	1
CO 4	2	2	2	2	1	-	-	-	-	-	2	2	2	1	2
CO 5	2	2	2	1	1	-	-	-	-	-	2	2	2	1	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I
MOS CIRCUIT DESIGN PROCESS: Introduction of MOSFET: Symbols, Enhancement mode, Depletion mode transistor operation, Threshold voltage derivation, body effect, Drain current Vs voltage derivation, channel length modulation. nMOS and pMOS inverter, Determination of pull up to pull down ratio, Stick diagrams, VLSI Circuit Design Flow.

UNIT-II
MOSTECHNOLOGY: Basic MOS Transistors fabrication – CMOS Fabrication: n,well & p,well – twin tub process, nMOS, pMOS & CMOS inverters, Submicron CMOS Process, Gate delays, Logical Effort, CMOS Static Logic, Transmission Gate Logic – Tri, State Logic – Pass Transistor Logic

UNIT-III
LOGIC DESIGNUSING nMOS and cMOS: Dynamic CMOS Logic–Realization of logic gates, using nMOS and CMOS technologies– Stick diagrams, Masks and Layout, CMOS Design Rules: Lambda based layout. Design Simple full adder, four input Encoder, Decoder, MUX, DeMUX.

UNIT-IV
VERILOG HDL: Hierarchical modeling concepts, Basic concepts: Lexical conventions, Data types–Modules and ports. Gate level modeling, Dataflow modeling, Behavioral modeling, Design examples of Combinational and Sequential circuits, Switch level modeling.

UNIT-V

VLSI IMPLEMENTATION STRATEGIES: Introduction, Design of Adders: carry look ahead, carry select, carry save. Design of multipliers Introduction to FPGA, Full custom and Semi-custom design, Standard cell design and cell libraries, FPGA building block architectures.

TEXT BOOKS:

1. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
2. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.
3. P. VenkataRamani, M.Bhaskar, "Digital Signal Processo1, Architecture, Programming & Application", Tata McGraw Hill,2004

SUGGESTED READING:

1. Anandkumar A, Digital Signal Processing, Second edition PHI learing, 2015
2. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall,1992.
3. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
4. D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons,1988.
5. J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Prentice Hall, 1997.

NPTEL Courses:

S.No	NPTEL Course Name	Instructor	Host Institute
1	Introduction on VLSI Design	Dr. Nandita Dasgupta	IIT Madras
2	VLSI Circuits	Prof. S. Srinivasan	IIT Madras

22EEE12

DESIGN OF POWER ELECTRONIC SYSTEMS

(Program Elective-1)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: The student should be familiar with Knowledge on Electrical Circuits, Magnetics and Power Electronics.

COURSE OBJECTIVES: This course aims to

1. Understand the Gate and Base Driver circuits.
2. Understand the operation and design of Magnetic components.
3. Understand the Thermal Considerations of components that are used in Power Electronic Converters.

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

1. Understand the Static and Dynamic characteristics of Power Devices.
2. Analyze the Gate and Base Driver circuits for Power Semiconductor Devices.
3. Design the Snubber Circuits that are implemented in Bridge Configurations.
4. Identify basic requirements for Component Temperature Control and Heat Sinks
5. Design the Magnetics Components like Inductor, Leakage Inductance and Transformer.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO 2	3	2	1	1	-	-	-	-	-	-	-	1	3	3	1
CO 3	3	3	1	1	-	-	-	-	-	-	-	1	3	3	2
CO 4	3	2	1	1	-	-	-	-	-	-	-	1	3	3	2
CO 5	3	2	1	1	-	-	-	-	-	-	-	1	3	3	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Overview of Switching Power Devices: Static and dynamic characteristics of Fast Recovery Diodes, IGBT, GTO, Wide band gap devices (GaN, SiC)

UNIT-II

Gate and Base Driver circuits: Preliminary Design Considerations, DC Coupled Drive Circuits, Electrically Isolated Drive Circuits, Thyristor drive circuits-Gate Current Pulse Requirement, Gate Pulse Amplifiers.

UNIT-III

Snubber Circuits: Function and Types of Snubber Circuits, Diode Snubbers, Capacitive Snubber, Snubber Circuits for Thyristors, Need for Snubbers with Transistors- Turn-On Snubber, Turn - Off Snubber, Over Voltage Snubbers, Implementation - Snubber for Bridge Circuit Configurations.

UNIT-IV

Component Temperature Control and Heat Sinks: Control of Semiconductor Device Temperature, Heat Transfer by Conduction, Heat Sinks, Heat transfer by radiation and convection.

UNIT-V

Design of Magnetics Components: Magnetic Materials and Cores, Copper Windings, Thermal Considerations, Analysis of Specific Inductor Design, Inductor Design Procedure, Design of Transformers, Analysis of Specific Transformer Design, Eddy Currents, Transformer Leakage Inductance, Transformer Design Procedure.

TEXT BOOKS:

1. Mohan, Ned. et.al, "Power Electronics Converters, Applications and Design", Wiley India Pvt. Ltd., New Delhi, 3rd Edition 2007.
2. Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Academic Press, New Delhi, 2nd Edition, 2006.

SUGGESTED READING:

1. B. Jayant Baliga, "Fundamentals Of Power Semiconductor Devices", Springer-Verlag Publication, New Delhi , 1st Edition, 2008.
2. Robert Perret, "Power Electronics Semiconductor Devices", Wiley-ISTE Publications, New Delhi , New Edition, 2009.

ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_ee33/preview
2. https://onlinecourses.nptel.ac.in/noc24_ee07/preview

22EEE13

NON CONVENTIONAL ENERGY RESORUCES

(Program Elective-1)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Prior knowledge on Conventional sources of energy

COURSE OBJECTIVES: This course aims to

1. Know the different types of Non-Conventional Energy Sources.
2. Understand the working of Wind and Solar Renewable Energy Sources
3. Explore the latest technologies in Renewable Energy arena.

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

1. Understand the generation of electricity from various Non-Conventional sources of energy.
2. Comprehend the Solar Energy concepts, applications and various methods involved in Solar Energy conversion
3. Explain in detail the applications of Solar PV System
4. Explore the concepts of Wind Energy Conversion Systems, Types and performance
5. Describe the concepts and applications of Fuel cell and Hydrogen cell

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	2	-	-	-	-	1	1	1	1	-
CO 2	2	1	3	2	1	2	-	-	-	-	1	1	1	2	-
CO 3	2	1	3	2	1	2	-	-	-	-	2	2	1	2	1
CO 4	2	1	2	2	1	2	-	-	-	-	2	2	1	1	1
CO 5	1	1	2	1	1	2	-	-	-	-	2	2	1	1	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I:

Fundamentals of Energy: Introduction, Classification of energy resources, Consumption of Trend of Primary Energy Resources, Importance of Non-Conventional Energy sources (NCES), Common Forms of Energy, Merits and Demerits of NCES, Salient features of NCES, Environment-Economy-Energy and Sustainable Development, , Advantages and disadvantages of Small Hydro Schemes, Layout of a Micro-Hydro Scheme.- World Energy Status, Energy Scenario in India

UNIT-II

Solar Energy – The sun as a source of Energy, Sun, Earth Radiation Spectrums, Measurements of Solar Radiation, Solar Radiation Geometry, Solar Collectors, Solar water heaters, Solar refrigeration and air conditioning systems, Solar Cookers, Solar Furnaces. Solar Green House, Solar Dryer, Solar Distillation, Solar Thermo-Mechanical Systems.

UNIT-III

Solar Photovoltaic Systems – Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cells, Module, Panel and Array Construction, Maximizing the solar PV output and Load Matching, Maximum Power Point Tracker, Solar PV systems, Solar PV Applications.

UNIT-IV

Wind Energy – Origin of Winds, Nature of Winds, Major Application of Wind Power, Wind Turbine Aerodynamics, Wind Turbine Types and Their Construction, Wind Energy Conversion System, Wind Energy Storage, Environmental Aspects.

UNIT-V

Fuel Cell, -working principle –Technical parameters- Fuel cell types- efficiency and EMF of Fuel cell-lFuture potential of Fuel Cell, **Hydrogen Energy**- Characteristics and applications of Hydrogen—Economics of Hydrogen Fuel cell – Role of National Hydrogen Energy Board.

TEXT BOOKS:

1. B.H.Khan : "Non –Conventional Energy Resources "McGraw Hill Education (India) Pvt.Ltd,2015
2. D.P.Kothari, KC Singal , Rakesh Ranjan: "Renewable Energy Sources and Emerging Technologies, PHI Learning Pvt.Ltd.2014

SUGGESTED READING:

1. G.S Sawhney: "Non –Conventional Energy Resources", PHI Learning Pvt.Ltd. 2012
2. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004
3. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley& Sons, 1991

ONLINE RESOURCES:

1. https://elearn.nptel.ac.in/shop/nptel/non-conventional-energy-resources/?v=c86ee0d9d7ed

22EEE14

OPTIMIZATION TECHNIQUES

(Program Elective-1)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basic mathematics

COURSE OBJECTIVES: This course aims to

1. Study about classical optimization techniques which include single variable and multi-variable optimization with equality constraints
2. Study about linear programming and non-linear programming methods
3. Study about Dynamic programming.

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

1. Recall and comprehend techniques for solving optimization problems for single and multiple variables, with and without constraints.
2. Understand and implement methods such as the graphical method, simplex algorithm, and revised simplex algorithm to solve linear programming problems.
3. Calculate the optimal solution of nonlinear functions using various elimination and search methods.
4. Apply Steepest Descent, Conjugate Gradient, Newton's method, and David-Fletcher-Powell methods to find the optimal solution for given nonlinear functions.
5. Evaluate and discuss the principles of Dynamic programming, calculus, and tabulation methods and provide relevant examples demonstrating their applications in optimization.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	1	1	-	-	-	-	-	2	1	3	3	1
CO 2	3	1	1	1	1	-	-	-	-	-	2	1	3	3	1
CO 3	3	3	1	1	1	-	-	-	-	-	2	1	3	3	1
CO 4	3	3	1	1	1	-	-	-	-	-	2	1	3	3	1
CO 5	3	2	1	1	1	-	-	-	-	-	2	1	3	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction: Classical optimization techniques: Statement of an optimization problem, Objective function, Classification of optimization problems, Single-variable &amp, Multi-variable Optimization without constraints. Multi-variable optimization with equality Constraints, Lagrange multiplier method, Multi-variable optimization with inequality constraints,Kuhn- Tucker conditions

UNIT-II

Linear Programming: Standard form, Formulation of the LPP, Solution of simultaneous equations by Pivotal Condensation, Graphical method, Simplex algorithm, Revised simplex method

UNIT-III

Non-Linear Programming-I: Unimodal function, Elimination methods: Fibonacci method, Golden Section method.

Direct Search methods: Univariate Search method, Hook and Jeeve’s method, Powell’s method.

UNIT-IV

Non-Linear Programming-II: Gradient methods: Steepest Descent, Conjugate Gradient, Newton method, David-Fletcher-Powell method.

UNIT-V

Dynamic Programming: Dynamic programming multistage decision processes – types initial value problem, final value problem, boundary value problem, – concept of sub-optimization, principle of optimality – computational procedure– examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

TEXT BOOKS:

1. S.S.Rao, "Engineering Optimization Theory and Applications", New Age International, 3rd Enlarged Edition (in two colour), 2013
2. 2. Jasbir S. Arora, "Introduction to Optimum Design", Academic Press, 4th Edition, 2016.

SUGGESTED READING:

1. Kalyamoy, Deb, "Multi-Objective Optimization using Evolutionary Algorithms", Wiley publications, 2013.
2. S. Raja Sekharam, G.A. Vijaya Lakshmi, "Neural networks, Fuzzy logic and Genetic Algorithms Synthesis And Applications", PHI publications, 2010.
3. Xin-She Yang, "Engineering Optimization: An Introduction with Metaheuristic Applications"- Wiley publication, 2010.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/111105039

22EEE15

COMPUTER ARCHITECTURE AND ORGANIZATION

(Program Elective-1)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basic knowledge of Digital Electronics

COURSE OBJECTIVES: This course aims to:

1. Provide knowledge on overview of IAS computer function and addressing modes.
2. Hardware and software implementation of arithmetic unit to solve addition, subtraction, multiplication, and division.
3. Provide knowledge of memory technologies, interfacing techniques and sub system devices.

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

1. Understand fundamentals on machine instructions and addressing modes.
2. Comprehend the various algorithms for computer arithmetic.
3. Analyze the performance of various memory modules in memory hierarchy.
4. Compare and contrast the features of I/O devices and parallel processors.
5. Outline the evaluation of memory organization.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	1	1	1	-	-	-	-	1	-	1	2	-	1
CO 2	2	3	1	1	1	-	-	-	-	-	-	1	2	3	1
CO 3	2	2	1	1	-	-	-	-	-	-	-	1	2	3	1
CO 4	1	2	1	1	-	-	-	-	-	-	-	1	2	3	1
CO 5	2	2	1	1	-	-	-	-	-	-	-	1	2	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Computer Architecture: Functional blocks of a computer: CPU, memory, input-output subsystems, control unit. Instruction set architecture of a CPU: Registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set. Outlining instruction sets of some common CPUs.

UNIT-II

Data representation and Computer arithmetic: Signed number representation, fixed and floating-point representations, character representation. Integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication – shift- and add, Booth multiplier, carry save multiplier, etc. Division restoring and non-restoring techniques, floating point arithmetic, IEEE 754 format.

UNIT-III

CPU control unit design: Hardwired and micro-programmed design approaches, design of a simple hypothetical CPU. **Memory system design:** Semiconductor memory technologies, memory organization.

UNIT-IV

Peripheral devices and their characteristics: Input-output subsystems, I/O device interface, I/O transfers – program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions. Programs and processes – role of interruptions in process state transitions, I/O device interfaces – SCII, USB.

UNIT-V

Pipelining and Memory organization: Basic concepts of pipelining, throughput and speedup, pipeline hazards. **Parallel Processors:** Introduction to parallel processors, Concurrent access to memory and cache coherency, Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs. block size, mapping functions, replacement algorithms, write policies.

TEXT BOOKS:

1. M. M. Mano, "Computer System Architecture", 3rd ed., Prentice Hall of India, 1993.
2. David A. Patterson and John L. Hennessy, "Computer Organization and Design: The Hardware/Software Interface", 4th Edition,Elsevier, 2012. 4.
3. Carl Hamacher, ZvonkoVranesic, SafwatZaky, NaraigManjikian, "Computer Organization and Embedded Systems", McGraw-Hill Publishing, 2011

SUGGESTED READING:

1. John P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998
2. William Stallings, "Computer Organization and Architecture: Designing for Performance", 8th Edition, Prentice Hall, 2006.

NPTEL Courses:

S.No.	NPTEL Course Name	Instructor	Host Institute
1.	Computer architecture and organization https://onlinecourses.nptel.ac.in/noc20_cs64/preview	Prof. Indranil Sengupta, Prof. Kamalika Datta	IIT Kharagpur

22EEC21

ELECTRICAL MACHINES-II LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisite: Basic knowledge of Electrical Engineering, Machines and Circuit analysis.

COURSE OBJECTIVES: This course aims to

1. Understand the practical connections of the machines.
2. Calculate the various parameters of induction motor and synchronous machine by performing the experiment.
3. Analyze the performance of the induction motor and synchronous machine by conducting suitable experiments.

COURSE OUTCOMES: Upon completion of this course, students will be able to:

1. Identify the right connections and interpret it for the execution of the given AC Machine.
2. Design the meter ratings for various applications of Induction Machine & Synchronous Machine.
3. Compare and Contrast the Speed control techniques of given AC Machine.
4. Analyze and Evaluate the efficiency and regulation of given Alternator.
5. Correlate the No-Load and Load characteristics of Induction Motor.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	-	1	-	-	-	-	2	1	-	-	3	3	1
CO 2	2	2	1	3	1	-	-	-	2	1	-	-	3	3	1
CO 3	2	1	-	3	1	-	-	-	2	1	-	-	3	3	1
CO 4	2	2	1	3	1	-	-	-	2	1	-	-	3	3	1
CO 5	2	2	-	3	1	-	-	-	2	1	-	-	3	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS

1. Three phase to two phase conversion of transformer (Scott connection).
2. Performance characteristics of Single-phase induction motor.
3. Speed control of 3 phase induction motor by rotor resistance control and stator voltage control.
4. Speed control of 3 phase induction motor by V/f control method.
5. No- load test of slip ring induction motor to determine the relationship between
   i) Applied voltage and speed, ii) Applied voltage and rotor current, iii) Applied voltage and stator current, iv) Applied voltage and power factor, v) Applied voltage and power input.
6. No-load test, blocked rotor test and load test on 3-phase squirrel cage induction motor.
7. Power Factor Improvement of Induction motor using capacitors.
8. Voltage regulation of alternator by
   a) Synchronous impedance method
   b) Ampere-turn method.
9. Voltage regulation of alternator by zero power factor (ZPF) method.
10. Measurement of Xd and Xq of 3 phase salient pole synchronous machine by conducting slip test.
11. Synchronization of 3phase alternator to bus bar using dark lamp method.
12. Observation of change in the active and reactive power of an alternator connected to an infinite bus by (a) Varying excitation, (b) varying mechanical-power input.
13. V and Inverted V-curves of a given synchronous motor.
14. a) Grid Synchronization of DFIG. b) Active and reactive power control of DFIG

Note: At least TEN experiments should be conducted in the semester.

SUGGESTED READING:

1. Electrical Machines: A Practical Approach - Satish Kumar Peddapelli , Sridhar Gaddam, De Gruyter-2020
2. Laboratory Manual for Electrical Machines- D.P. Kothari & B.S. Umre I K International Publishing House- 2017

22EEC22

POWER ELECTRONICS LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisites: Students should have the prior knowledge of Analog Electronic Circuits.

COURSE OBJECTIVES: This course aims to
1. Comprehend the characteristics of different static switches.
2. Analyze the triggering and commutation circuits for SCR.
3. Familiarize the conversion principles of AC-DC, DC-DC, DC-AC and AC-AC conversion circuits.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Plot the characteristics of various controlled switches and identifies effect of variation of control signal on the regions of switching operation.
2. Demonstrate the effect of delay angle and nature of load on the performance of various power converters and able to plot the output voltage and current waveforms.
3. Simulate various types of power converters and discriminate between simulation models and practical models of various power converters.
4. Understand various voltage control techniques in different power converters.
5. Select proper equipment, precautions, implement connections keeping technical, safety and economic issues.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	3	-	-	1	-	3	1	1	2	3	3	1
CO 2	2	3	1	3	-	-	1	-	3	1	1	2	3	3	1
CO 3	2	3	1	3	1	-	-	-	3	1	1	2	3	3	1
CO 4	2	3	1	3	-	-	-	-	3	1	1	1	3	3	1
CO 5	2	1	1	1	1	2	-	-	3	1	1	1	3	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

PART-A

1. Study of static characteristics of S.C.R. and to obtain latching & holding currents.
2. Study the characteristics of BJT, MOSFET and IGBT.
3. R, RC and UJT triggering circuits for SCR
4. Study of forced commutation techniques of SCR.
5. Single-phase half-controlled bridge rectifier with Rand RL loads.
6. Single-phase fully controlled converter with R, RL & RLE loads and freewheeling diode
7. Three-phase half-controlled bridge rectifier with R and RL loads.
8. Three-phase fully controlled bridge rectifier with R and RL loads.
9. DC voltage control using Buck and Boost choppers.
10. Voltage and Current commutated choppers with R&RL loads.
11. Single-phase step down Cyclo-converter with Rand RL loads.
12. Single-phase A.C voltage controller with R and RL loads
13. Half and Full bridge inverters with R&RL loads.

PART-B

1. Obtain the performance specifications of Single-phase Full converter with and without freewheeling diode using simulation.
2. Obtain the performance specifications of three-phase Full converter with R & RL loads using simulation.

3. Simulation of Single-phase AC voltage controller with R & RL loads
4. Simulation of single-phase half-bridge & full-bridge inverters.
5. Simulation of three-phase bridge inverter in different modes.
6. Simulation of Single-phase inverter with single, multiple and sinusoidal pulse width modulations.

BEYOND SYLLABUS:

1. Design of power electronic components i. Inductor ii. Transformer.
2. Design of Buck / Boost chopper.
3. Study and implementation of two quadrant DC drive.

Note: At least **SEVEN** experiments from PART-A and **THREE** from PART-B should be conducted in the semester.

SUGGESTED READING:

1. S.G. Tarnekar, P.K. Kharbanda, "Laboratory course in Electrical engineering", S. Chand & Co 1990

22EEC23

MICROCONTROLLERS AND APPLICATIONS LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisites: Basic knowledge of programming in C language.

COURSE OBJECTIVES: This course aims to
1. Develop and understand the 8051 and ARM7 C programming
2. Understand the usage of Integrated Development Environment (Keil)
3. Illustrate interface modules using 8051 and ARM7 microcontroller

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Develop the programs of 8051 and ARM using their respective instruction set.
2. Understand the usage of various debugging tools available to program different microcontrollers
3. Build code for 8051 and ARM7 to interface various input/output modules
4. Analyze the hardware and software interaction and integration.
5. Design and develop the 8051 and ARM 7 based embedded systems for various applications

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	-	-	-	-	-	-	-	1	1	-
CO 2	2	3	3	2	1	-	-	-	-	-	-	-	1	2	-
CO 3	2	3	3	2	1	-	-	-	-	-	-	-	1	3	1
CO 4	2	2	2	2	1	-	-	-	-	-	-	-	1	1	1
CO 5	1	2	2	1	1	-	-	-	-	-	-	-	1	1	2

1 - Slightly, 2 - Moderately, 3 - Substantially

LAB EXPERIMENTS:

I. Programming using 8051 Microcontroller
1. Familiarity and use of 8051 microcontroller trainer kit, Keil IDE and simple programs under different addressing modes.
2. Assembly programming using instruction set
3. Timer and counter operations and programming using 8051.
4. Interfacing applications using LED, switch, relay and buzzer.
5. Generation of waveforms using DAC by interfacing it with 8051.
6. Stepper motor interfacing.
7. LCD interfacing.
8. Development of Embedded 'C' Code based on the module specifications. (under Structured enquiry)

II. Programming using ARM 7 Microcontroller
1. Study and use of LPC214x Microcontroller trainer kit and simple programs using its instruction set
2. Interfacing applications using LED, switches
3. Interfacing applications using relay and buzzer.
4. DC Motor interfacing.
5. Programming on-chip ADC.
6. Waveform generation using internal DAC.
7. Development of Embedded 'C' Code based on the module specifications

III. Design an experiment related to the Embedded Application of Students choice using 8051 / ARM based architectures. (under Open ended enquiry)

IV. Beyond Curriculum Syllabus

1. Design of Automatic Plant watering system for Agricultural Application
2. Generation of Gating pulses for power Electronic converters
3. Development of closed loop monitoring system using ARM processor

Note: Any 5 experiments are to be conducted in each cycle

SUGGESTED READING:

1. Mazidi M.A, Mazidi JG &Rolin D. Mckinlay, "The 8051 Microcontroller & Embedded Systems using Assembly andC", 2/e, Pearson Education, 2007.
2. Philips semiconductors, "ARM 7 (LPC 214x) user manual", 2005

NPTEL Courses:

S.No	NPTEL Course Name	Instructor	Host Institute
1	Microprocessors and Microcontrollers	Prof. Santanu Chatopadhyay	IIT Khargpur
2	Embedded System Design with ARM	Prof. Indranil Sengupta	IIT Khargpur

22EGC03

EMPLOYABILITY SKILLS

Instruction	2P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Prerequisites: Basic Knowledge of Soft skills in the professional setting.

Course Objectives: To help the students

1. Learn the art of communication, participate in group discussions and case studies with confidence and to make effective presentations.
2. With- resume packaging, preparing them to face interviews.
3. Build an impressive personality through effective time management, leadership qualities, self-confidence and assertiveness.
4. Understand professional etiquette and to make them learn academic ethics and value system.
5. To be competent in verbal aptitude.

Course Outcomes: By the end of the course**,** the students will be able to

1. Become effective communicators, participate in group discussions with confidence and be able to make presentations in a professional context.
2. Write resumes, prepare and face interviews confidently.
3. Be assertive and set short term and long term goals, learn to manage time effectively and deal with stress.
4. Make the transition smoothly from campus to work, use media with etiquette and understand the academic ethics.
5. Enrich their vocabulary, frame accurate sentences and comprehend passages confidently.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	1	-	-	-	1	-	2	3	3	1	3	1	2	1
CO 2	-	-	-	-	-	-	-	1	-	2	-	1	-	1	1
CO 3	-	-	-	-	-	1	-	1	2	1	1	3	-	2	1
CO 4	-	1	1	-	-	1	-	2	3	3	1	3	1	2	2
CO 5	-	-	-	-	-	-	-	1	2	2	1	3	-	1	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Verbal Aptitude: Error Detection, Articles, Prepositions, Tenses, Concord and Transformation of Sentences- Jumbled Words/Sentences- Vocabulary, Synonyms, Antonyms, One Word Substitutes, Idioms and Phrases, Word/Sentence/Text Completion- Reading Comprehension.

UNIT-II

Group Discussion & Presentation Skills: Dynamics of Group Discussion-Case Studies- Intervention, Summarizing, Modulation of Voice, Body Language, Relevance, Fluency and Accuracy, Coherence. Elements of Effective Presentation – Structure of a Presentation – Presentation tools – Body language - Preparing an Effective PPT.

UNIT-III

Behavioural Skills: Personal strength analysis-Effective Time Management- Goal Setting- Stress management- **Corporate Culture** – Grooming and etiquette-Statement of Purpose (SOP).

UNIT-IV

Mini Project: Research-Hypothesis-Developing a Questionnaire-Data Collection-Analysis-General and Technical Report - Writing an Abstract –Technical Report Writing-Plagiarism-Project Seminar.

UNIT-V

Interview Skills: Cover Letter and Résumé writing – Structure and Presentation, Planning, Defining the Career Objective, Projecting ones Strengths and Skill-sets – Interviews: Concept and Process, Pre-Interview Planning, Opening Strategies, Answering Strategies, Mock Interviews.

TEXT BOOKS:

1. Leena Sen, "Communication Skills", Prentice-Hall of India, 2005.
2. Gulati and Sarvesh, "Corporate Soft Skills", New Delhi: Rupa and Co., 2006.
3. Edgar Thorpe and Showick Thorpe, "Objective English", 2nd edition, Pearson Education, 2007.
4. Ramesh, Gopalswamy, and Mahadevan Ramesh, "The ACE of Soft Skills", New Delhi: Pearson, 2010.

SUGGESTED READING:

1. Van Emden, Joan, and Lucinda Becker, "Presentation Skills for Students", New York: Palgrave Macmillan, 2004.
2. R.S. Aggarwal, "A Modern Approach to Verbal & Non-Verbal Reasoning", 2018.
3. Covey and Stephen R, "The Habits of Highly Effective People", New York: Free Press, 1989.
4. Shalini Verma, "Body Language - Your Success Mantra", S Chand, 2006.

22EEI02

INDUSTRIAL / RURAL INTERNSHIP

Instruction	3-4 weeks/ **(90)** hours
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	2

Prerequisites: Knowledge of Basic Sciences and Engineering Sciences/Knowledge about rural environment.

COURSE OBJECTIVES: This course aims to

1. Exposing the students to the industrial environment/ rural environment
2. Create awareness with the current industrial technological developments relevant to program domain
3. Provide opportunity to understand the social, economic and administrative considerations in organizations/rural areas

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

1. Understand Engineer's responsibilities and ethics
2. Use various materials, processes, products and quality control
3. Provide innovative solutions to solve real world problems
4. Acquire knowledge in technical reports writing and presentation
5. Apply technical knowledge to real world industrial/rural situations

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	-	-	3	3	-	3	-	3	3	-	-	3
CO 2	1	1	1	3	3	-	2	1	-	-	-	-	3	3	-
CO 3	2	3	3	3	3	2	3	1	1	-	-	-	3	3	-
CO 4	-	-	-	-	-	3	-	1	3	3	-	1	-	-	3
CO 5	1	3	3	3	3	2	3	-	1	-	-	1	3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

For implementation procedures and letter formats, annexures I and III of Internship document maybe referred.
Evaluation of Internship: The industrial training/internship of the students will be evaluated in three stages:

a) Evaluation by the Industry(in the scale of 1 to 10 where 1-Unsatisfactory, 10-Excellent)
b) Evaluation by faculty Mentor on the basis of site visit(s) or periodic communication (15 marks)
c) Evaluation through seminar presentation/Viva-Voce at the Institute by the constituted committee (25 marks)

Evaluation through Seminar presentation/Viva-Voce at the institute: Students shall give a seminar before an Expert Committee constituted by college (Director, HoD / Senior faculty, mentor and faculty expert from the same department) based on his/her training/internship carried out.
The evaluation will be based on the following criteria:

- Quality of content presented
- Proper planning for presentation
- Effectiveness of presentation
- Depth of knowledge and skills

Attendance record, daily diary, departmental reports shall be analyzed along with the internship Report Monitoring/ Surprise Visits: During the internship program, the faculty mentor makes a surprise visit to the internship site, to check the student's presence physically. If the student is found to be absent without prior intimation to the concerned industry, entire training/internship may be cancelled. Students should inform through email to the faculty mentor as well as the industry supervisor at least one day prior to avail leave.
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CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
(Inline with AICTE Model Curriculum with effect from AY 2026-27)(R22A)

SEMESTER – VI

S.No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22EEC24	Power System Protection	3	-	-	3	40	60	3
2	22EEC25	Power System Operation and Control	3	-	-	3	40	60	3
3	22EEC26	Electrical Drives	3	-	-	3	40	60	3
4	22EEExxN	**PE-2**	3	-	-	3	40	60	3
5	22EEExx	**PE- 3**	3	-	-	3	40	60	3
6	22EGM01	Indian Constitution and Fundamental Principles	2	-	-	2	-	50	Non Credit
PRACTICAL									
7	22EEC27	Power Systems Lab	-	-	3	3	50	50	1.5
8	22EEC28	Electrical Drives Lab	-	-	3	3	50	50	1.5
9	22EEExxN	**PE-2 Lab**	-	-	3	3	50	50	1.5
10	22EEC33	Mini Project	-	-	4	-	50	-	2
11	22EEU02	Up-skilling Certification Course-II	-	-	-	-	25	-	0.5
Total			**17**	**-**	**13**	**-**	**425**	**500**	**22**
Clock Hours Per Week: 30									

L: Lecture **D:** Drawing **CIE:** Continuous Internal Evaluation
T:Tutorial **P:** Practical/ Project Seminar/ Dissertation **SEE:** Semester End Examination

LIST OF PROGRAM ELECTIVES: SEMESTER – VI

S.No	List of Courses offered in Program Elective-2(PE-2)		List of Laboratory Courses offered in Program Elective-2 Lab(PE-2 lab)	
	Course Code	Title of the Course	Course Code	Title of the Course
1	22EEE21	IoT for Electrical Engineering	22EEE26	IoT for Electrical Engineering Lab
2	22EEE22	Special Electrical Machine	22EEE27	Special Electrical Machines Lab
3	22EEE23	Machine Learning for Electrical Engineering	22EEE28	Machine Learning for Electrical Engineering Lab
4	22EEE24	AI for Electrical Engineering	22EEE29	AI Techniques Lab
5	22EEE25	Data Analytics with Python	22EEE30	Data Analytics Lab

S.No	List of Courses offered in Program Elective-3(PE-3)	
	Course Code	Title of the Course
1	22EEE31	Electrical Distribution Systems
2	22EEE32	Simulation Techniques in Electrical Engineering
3	22EEE33	Advanced Power Converters
4	22EEE34	Power Quality
5	22EEE35	Electrical Machine Design

22EEC24

POWER SYSTEM PROTECTION

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basics of Electrical Engineering and Circuit analysis.

COURSE OBJECTIVES: This course aims to
1. Impart principles of operation of the different power system protection devices.
2. Provide comprehensive protection schemes employed for the protection of power system.
3. Comprehend the fundamental principles of numerical protection.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Understand basic terminology and working principles of relays and applications of over current relays.
2. Select the type of distance protection for three- phase transmission lines.
3. Apply suitable differential scheme for the protection of various equipment in electrical power system.
4. Analyze and compare the principle of operation, calculate the ratings of circuit breakers and different protection methods against over-voltages.
5. Evaluate various elements of numerical relays, their functions and different techniques used in their design.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	1	-	-	-	-	-	1	-	2	2	3	1
CO 2	3	2	1	1	-	-	-	-	-	1	-	2	2	3	1
CO 3	3	3	1	1	-	-	-	-	-	1	-	2	2	3	1
CO 4	3	3	1	1	-	-	-	-	-	1	-	2	2	3	1
CO 5	3	3	1	1	-	-	-	-	-	1	-	2	2	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Protection Schemes: Need for protection, Backup protection, Zones of protection, Definitions of relay pickup, Dropout and reset values, Classification of relays, Operating principles and construction of Electromagnetic and Induction relays.

Over-current Protection: Time-current characteristics, Current settings, Time settings, Over-current protection schemes, Direction relay, Applications of Definite Time, IDMT and Directional relays distribution feeders, Earth fault and phase fault protection schemes, Directional earth fault relay, Static over current relay.

UNIT-II

Distance Protection: Introduction, Impedance relay, Reactance relay, MHO relay, Effect of arc resistance and power swings on the performance of distance relaying, Selection of distance relays, Three-stepped distance protection, Comparison of different distance protection schemes, Distance protection of three-phase lines.

UNIT-III

Differential Protection: Introduction, Simple differential protection, Zone of differential protection, Percentage differential relay, Protection of generator against Inter-turn faults, Overheating, Loss of excitation, Protection of transformers, Differential protection of transformer against inrush phenomenon,. Differential protection of bus-bars.

UNIT-IV

Circuit Breakers: Arc interruption, Restriking voltage, Recovery voltage, RRRV, Current chopping, Resistance switching, Classification of circuit breakers, Selection of circuit breaker

Over voltage protection: Causes for over voltages, Protection of transmission lies against direct lightning strokes, Ground wires, Arcing horns, Lightning arrestors, Surge absorbers, Peterson coil earthing, Insulation coordination.

UNIT-V:

Basics of Numerical Protection: Block diagram of numerical relay, Sampling theorem, Least Error Square technique, Digital filtering, Numerical relaying for over current, Differential and distance protection (Elementary Treatment).

TEXT BOOKS:

1. Badriram Viswakarma, "Power System Protection and Switchgear", Tata McGraw Hill, 2011
2. Y.G. Paithankar, S.R. Bhide, "Fundamentals of power system protection", Prentice Hall, India, 2010.
3. Bhuvanesh Oza, Nirmal-Kumar Nair, Rashesh Mehta, Vijay Makwana, "Power System Protection", Tata McGraw-Hill Education, 2010

SUGGESTED READING:

1. T.S.Madhava Rao, Power System Protection: Static Relays, Tata McGraw-Hill Education 1989
2. P.M.Anderson, Power System Protection, John Wiley, 2012.
3. Electricity Training Association, Power System Protection. Vol. 2.: Systems and Methods, Institute of engineering and Technology, 1995.

22EEC25

POWER SYSTEM OPERATION AND CONTROL

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Power Systems, Control Systems, Synchronous Machines.

COURSE OBJECTIVES: This course aims to
1. Understand the importance of Economic Operation of power system
2. Understand the load frequency control of Power Systems
3. Gain the knowledge on power system stability.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Demonstrate the Economic operation of power system without and with Losses
2. Illustrate the concept of Unit Commitment
3. Analyze the Load Frequency Control for single and two area systems
4. Analyze the rotor angle stability of a power system under any disturbance.
5. Understand Voltage Control methods and voltage stability.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	1	1	-	-	-	-	1	2	1	3	3	1
CO 2	3	3	1	1	1	-	-	-	-	1	2	1	3	3	1
CO 3	3	2	1	1	1	-	-	-	-	1	2	1	3	3	1
CO 4	3	3	1	1	-	-	-	-	-	1	1	1	3	3	1
CO 5	3	1	1	1	-	-	-	-	-	1	1	1	3	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Economic Operation of Power System: Input-Output curves, Heat rate and Incremental Cost curves, Economic Operation neglecting Transmission Losses, with and without Generator Limits, Derivation of Bmn Coefficients, Economic Operation including transmission losses.

UNIT-II

Unit Commitment (UC): Introduction, Constraints in UC, Thermal unit constraints and other constraints, Solution Methods: Priority-list method, Dynamic Programming solution, Lagrange Relaxation Solution method.

UNIT-III

Control of Frequency: Frequency control, Concept of single-area load frequency control, Modeling of single-area control, Steady state and dynamic analysis on single-area, PI control for single- area, Introduction to two-area load frequency control, Modeling of two-area control

UNIT-IV

Rotor Angle Stability: Introduction to Rotor Angle Stability, Classification, Steady state stability, Steady state stability Limit, Factors affecting the Steady state stability, Introduction to Transient Stability, Swing Equation, Equal-area Criterion, Critical Clearing Angle, Critical Clearing Time, Application of Equal area criterion, Factors affecting the Transient stability.

UNIT-V

Control of Voltage: Introduction to Voltage Stability, Comparison between Angle stability and Voltage stability. Conventional Methods for Reactive power Generation and Absorption, Automatic Voltage Regulators. Introduction to Flexible AC Transmission Systems.

TEXT BOOKS:

1. I. J. Nagrath & D.P. Kothari, “Modern Power System Analysis”, 4th Edition TMH Publication, 2011.
2. Allen J. Wood, Bruce. F.Woolenberg, “Power Generation, Operation & Control”, Wiley Publishers, 2006
3. K. R. Padiyar, “Power system dynamics: stability and control, Second Edition”, BS Publications, 2008.

SUGGESTED READING:

1. O. Elgard, “Electric Energy Systems Theory, 2nd Edition”, TMH Publication, 2001
2. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power Systems”, Wiley, 2012.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108104052
2. https://nptel.ac.in/courses/108106026

22EEC26

ELECTRICAL DRIVES

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Power Electronics, Electrical Machines

COURSE OBJECTIVES: This course aims to

1. Know the characteristics of various Electric Drives and its control using different power electronic converter circuits
2. Understand the concept of speed control of DC motor drives with single phase, three- phase converters and choppers.
3. Explore the concept of speed control of induction motor by using AC voltage controller, VSI, CSI and Cyclo-Converter.

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

1. Understand the classification, choice, dynamics and stability of Electric Drives.
2. Analyse 1-Φ & 3-Φ converters fed DC motors.
3. Understand the operational variance between single and multi-quadrant operation of various Electric Drives
4. Analyse chopper fed DC motors.
5. Comprehend the speed control of a converter fed induction motor drives

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	2	-	-	-	-	-	-	-	-	-	2	2
CO 2	3	3	2	3	-	-	-	-	-	-	-	-	1	3	3
CO 3	3	2	2	3	-	-	-	-	-	-	-	-	1	2	3
CO 4	3	2	2	3	-	-	-	-	-	-	-	-	1	2	3
CO 5	3	2	2	3	-	-	-	-	-	-	-	-	1	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Electric Drive: Introduction, Block diagram and parts of electric drive.

Dynamics of Electrical Drives: Types of Load- Types and Characteristics of load torque – Dynamics of motor-load combination – steady state & transient stability of an electrical drive.

Phase control converters fed DC drives: Single Phase and Three phase fully controlled converters connected to DC separately excited and DC series motors– continuous current mode of operation, output voltage and current waveforms, Speed- Torque Characteristics.

UNIT–II

Four quadrant operation of DC drive: Introduction to four quadrant operation, motoring operation, electric braking – Plugging, Dynamic and regenerative braking operations. Four quadrant operation of dual converter f e d D.C motor drive– Closed loop operation of DC motor.

UNIT–III

Chopper fed DC drives: Single, two and four quadrant chopper fed dc separately excited and series excited motors– continuous current operation, output voltage and current wave forms, speed torque expressions, speed torque characteristics, Problems on Chopper fed DC Motors, closed loop operation.

UNIT–IV

Stator side Control of Induction Motor Drives: Variable voltage characteristics–Control of Induction Motor by AC Voltage Controllers – Waveforms –Speed torque characteristics, Variable Voltage Variable Frequency control of induction motor by voltage source inverter (VSI), current source inverter (CSI) and cyclo-converters, Comparison of VSI and CSI, closed loop operation of induction motor drives.

UNIT-V

Rotor Side Control of Induction Motor: Rotor resistance control- fixed resistance control, variable resistance control-converter controlled rotor resistance control, Slip power recovery schemes- Static Kramer drive-Phasor diagram-Torque expression-Speed control of a Kramer drive-Static scherbius drive-Modes of operation

TEXT BOOKS:

1. G. K. Dubey, "Fundamentals of Electrical Drives", CRC Press, 2002
2. Vedam Subramanyam, "Electric Drives", McGraw Hill, 2011
3. J. Gnanavadivel, et al. Electrical Drives & Control, Anuradha Publications, 2004

SUGGESTED READING:

1. H. Rashid, "Power Electronic Circuits, Devices and applications", PHI.
2. Bimal K. Bose, Modern Power Electronics and Ac Drives, Prentice Hall, 2001
3. W. Leonhard, "Control of Electric Drives, Springer Science & Business Media, 2001.
4. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control", Prentice Hall, 2001.

NPTEL Courses:

S. No	NPTEL Course Name	Instructor	Host Institute
1	Fundamental of Electrical Drives https://archive.nptel.ac.in/courses/108/104/108104140/#	Prof. S. P. Das	IIT Kanpur

22EEE21

IoT FOR ELECTRICAL ENGINEERING

(Program Elective-2)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Students should have prior knowledge on basic programming knowledge and networking

COURSE OBJECTIVES: This course aims to

1. Provide knowledge of basic IoT Network Architectures, IoT Processing, Connectivity and Communication technologies.
2. Provide knowledge of Arduino boards and basic components and Develop skills to design and implement various smart system application.
3. Provide knowledge of programming skills, application development and prototyping using Python.

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

1. Understand the basic principles and terminologies of computer networking, network security, WSN, M2M, CPS, sensors and actuators.
2. Comprehend various data types in IoT applications, connectivity protocols in IoT, communication protocols in IoT.
3. Understand basic concepts of Arduino UNO and Design smart system applications using Arduino UNO.
4. Apply Python programming for Problem solving and application development.
5. Understand the working of Raspberry Pi and develop IoT applications.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	1	3	-	-	-	-	-	-	-	2	3	-
CO 2	3	3	2	2	3	-	-	-	-	-	-	-	2	3	-
CO 3	3	3	2	2	3	-	-	-	-	-	-	-	2	3	-
CO 4	3	3	2	2	3	-	-	-	-	-	-	-	3	3	-
CO 5	3	3	2	2	3	-	-	-	-	-	-	-	2	3	-

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to IoT: Introduction-Network types, IoT Protocol and Architecture, Network Security, Wireless Sensor Networks (WSN), Machine-to-Machine (M2M) Communications, Cyber Physical Systems (CPS), IoT Sensors and Actuators, Advantages and Disadvantages of IoT.

UNIT-II

IoT Processing, Connectivity and Communication: Data format, Importance of Processing in IoT- Processing Topologies, IoT Device Design and Selection Considerations, IEEE 802.15.4, Thread, ISA100.11A, Wireless HART, RFID, LoRa, Wi-Fi, Bluetooth, Infrastructure Protocols, Discovery Protocols, Data Protocols, Identification Protocols.

UNIT-III

Introduction to Arduino Programming: Introduction – Features of Arduino-Types of Arduino board, Arduino UNO - Arduino IDE Overview-Sketch Structure, Data types - Function Libraries - Operators in Arduino - Control statement – Loops – Arrays – String - Math Library - Random number - Interrupts, Wireless Connectivity to Arduino, Integration of Sensors with Arduino, Integration of Actuators with Arduino.

Example programs: Blink LED, Traffic Control system- Pulse Width Modulation, Analog to Digital Conversion

UNIT-IV

Introduction to Python Programming: Introduction to Python, Variables and Data types- Operators-NumPy, matplotlib, Array - Pandas - Lists - Loops - Conditional statements, Functions – Strings - Tuples, Sets, Dictionaries - Array, Data Visualization, File handling.

UNIT-V

Introduction to Raspberry Pi and IoT Applications: Introduction to Raspberry Pi - Basic architecture - Working of Raspberry Pi - Pin configuration - Sensor and actuator interfaced with Raspberry Pi, Implementation of IoT with Raspberry Pi.

Example programs: Capture Image using Raspberry Pi, Speed control of DC and AC machines, Measuring parameters of Solar panel.

TEXT BOOKS:

1. S. Misra, A. Mukherjee, and A. Roy, "Introduction to IoT", Cambridge University Press, 2020
2. S. Misra, C. Roy, and A. Mukherjee, "Introduction to Industrial Internet of Things and Industry 4.0", CRC Press, 2020
3. Adeel Javed, "Building Arduino Projects for the Internet of Things Experiments with Real-World Applications", Apress, 2016
4. Allen B. Downey, "Think Python", O'Reilly, 2016
5. John Zelle, "Python Programming an introduction to computer science", Tom Sumner, 2012
6. Rajkumar Buyaa and Amir V Dastjerdi, "Internet of things: Principles and Paradigms", Morgan Kaufmann
7. A Bahga & V Madisetti, "Internet of Things: A Hands On Approach", Universities Press

SUGGESTED READING:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press, 2017
2. Mark Lutz, "Learning Python", O'Reilly, 2009.
3. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", Wiley
4. Olivier Hersent, David Boswarthick and Omar Elloumi, "The Internet of Things: Key applications and Protocols, Wiley

NPTEL Courses:

S.No	NPTEL Course Name	Instructor	Host Institute
1	Introduction To Internet Of Things	Prof. Sudip Misra	IIT Kharagpur
2	Internet of Things: Design Concepts and Use Cases	Prof. Maitreyee Dutta	NITTTR, Chandigarh

22EEE22

SPECIAL ELECTRICAL MACHINES

(Program Elective-2)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basic knowledge of Circuit Theory, Electrical Machines, Control systems and Power Electronics.

COURSE OBJECTIVES: This course aims to

1. Study the operating principles of different special machines
2. Make the learner to be aware of latest special machines which are in vogue.
3. Be familiar with salient features of special electrical machines.

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

1. Recognize the applications of specific special electrical machines.
2. Explain the working principle of various special electrical machines.
3. Classify the special electrical machine based on their principle.
4. Develop equivalent circuit of a given special electrical machine.
5. Implement a control technique for controlling a given Special Electric machine.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	2	1	2	1	-	-	-	-	3	1	1	3
CO 2	3	3	3	2	1	-	-	-	-	-	-	2	1	1	2
CO 3	3	2	2	2	-	2	1	-	-	-	2	3	1	2	3
CO 4	3	3	3	2	1	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	2	2	-	2	1	-	-	-	-	-	-	-	-

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Stepper Motors and Linear Electric Machines: Stepper Motors - Introduction, Classification, Principle of Operation, Discussion on Torque equation, Static and dynamic characteristics, Open loop and closed loop control, Comparison between different types of Stepper Motor, Linear Electric Machines – Working principle of Linear Induction Motor, Linear Synchronous Motor, DC Linear Motor, Linear Reluctance Motor, and Linear Levitation Machines, Applications.

UNIT-II

Reluctance Motors: Switched Reluctance Motor (SRM) - Construction, Principle of Working, Analysis of SRM (basics), Constraints on Pole Arc and Tooth Arc, Torque Equation and Characteristics, Power Converter Circuits, Control of SRM, Rotor Position Sensors, Current Regulators, Synchronous Reluctance Motor (SynRM) - Constructional of SynRM, working principle, Phasor Diagram and Torque Equation, Control of SynRM, Advantages and Applications.

UNIT-III

Permanent Magnet Motors-I: Permanent Magnet Materials, Magnetic Characteristics, Permanent Magnet DC (PMDC) Motor - Construction, Principle of Operation, Performance Characteristics, Brushless Permanent Magnet DC (BLDC) Motor - Construction, Principle of Operation, Power Converter (3-Phase), DSP Based Control of BLDC Motor, Applications.

UNIT-IV

Permanent Magnet Motors-II: Permanent Magnet Synchronous Motor (PMSM)-Construction, Principle of operation, EMF and torque equations, Phasor diagram, Power Controllers, Converter, Torque speed characteristics, Closed loop Speed control of PMSM, Permanent Magnet Axial Flux (PMAF) Machines-

Comparison of Permanent Radial and Axial Flux Machines, Construction of PMAF Machines, Armature Windings, torque and EMF Equations of PMAF, Phasor Diagram, Output Equation (elementary treatment), Applications

UNIT-V

Energy Efficient Motors: Standard Motor efficiency, Importance of efficient motors, ways to improve efficiency, Construction of EEM, Industrial Electric Motor Systems – Introduction to IE-1, IE-2, IE-3, IE-4, and IE-5 Motors,

TEXT BOOKS:

1. E. G. Janardhanan,: "Special Electrical Machines" PHI learning private limited, 2014
2. J. Gnanavadivel, Dr. S. Muralidharan, Dr. J. Karthikeyan,: "Principles of Special Electrical Machines" Anuradha publications, 2010.
3. Ali Emadi, "Energy-Efficient Electric Motors" Marcel Dekker, 3rd Edition, 2005.

SUGGESTED READING:

1. K. Venkata Ratnam, "Special electrical Machines", University press, New Delhi, 2009.
2. H. Bülent Ertan, M. Yildirim Üçtug, Ron Colyer, Alfio Consoli, "Modern Electrical Drives" Springer Science Business Media, 2000.
3. T.J.E. Miller, "Brushless Permanent magnet and reluctance motor drives", Clarenden press, Oxford, 1989.
4. Referred Journals/Conference publications.

NPTEL Courses:

S.No	NPTEL Course Name	Instructor	Host Institute
1	**Special Electromechanical Systems** https://www.youtube.com/watch?v=yLw1x9dyKOo&amp,t=3079s	Prof. S. S. Murthy	IIT Delhi
2	**Advanced Electrical Drives** https://www.youtube.com/watch?v=6DctdwlDKhc&amp,list=PLA5CA7D35114BA425	Prof. S. P. Das	IIT Kanpur

22EEE23

MACHINE LEARNING FOR ELECTRICAL ENGINEERING

(Program Elective-2)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Students should have prior knowledge of basic programming skills, and algorithm design.

COURSE OBJECTIVES: This course aims to

1. Understand the basics of Machine Learning.
2. Apply different machine learning models to various datasets.
3. Introduce advanced concepts and methods of machine learning.

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

1. Understand basic concepts of Machine Learning Techniques.
2. Implement various supervised learning algorithms such as KNN, SVM, and Random Forest for reducing overfitting challenges.
3. Apply regression techniques to model relationships within data sets and make predictions accurately.
4. Analyze and work with different datasets.
5. Apply Machine Learning Algorithms for Electrical Engineering problems.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	2	-	-	-	-	1	-	3	3	2
CO 2	3	3	3	3	3	-	1	-	-	-	1	2	3	3	2
CO 3	3	3	3	3	3	2	-	-	-	-	1	-	3	3	2
CO 4	3	3	3	3	3	-	-	-	-	-	1	-	3	3	1
CO 5	3	3	3	3	3	-	-	-	-	-	1	-	3	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT -I

Introduction to Machine Learning (ML): Introduction, Types of Learning, Data Representation, Hypothesis Space, Inductive Bias, Evaluation of ML model, Training and test set, Cross-Validation, Difference between traditional programming and Machine Learning, Applications of ML.

UNIT -II

Supervised Learning-I: Classification: K-Nearest Neighbor (K-NN), Naive Bayes Classifiers, Decision Trees-CART algorithm, Gini Index, ID3 algorithms, Support Vector Machine (SVM), Random Forest Classification, Overfitting, Numerical Problems.

UNIT -III

Supervised Learning-II: Regression: Linear Regression- Least Square method, Matrix method, Linear Regression Metrics, Multiple Linear Regression, Polynomial Linear Regression, Logistic Regression, Linear Regression vs Logistic Regression.

UNIT -IV

Unsupervised Learning: Introduction to clustering, Types of Clustering: Hierarchical clustering- Hierarchical Agglomerative clustering using the single link, Complete Link, and Average Link Techniques, Divisive clustering, Partitioning clustering- K-means clustering and Fuzzy C-Means clustering, K-Means versus Fuzzy C-Means, Association, Types of Association Rule Learning, Apriori Algorithm, ECLAT Algorithm: (Equivalence Class Transformation), F-P Growth Algorithm (Frequent Pattern).

UNIT -V

Dimensionality Reduction Techniques: Introduction, Types of Dimensionality Reduction-Feature selection, Feature extraction, Principal Component Analysis (PCA), Independent Component Analysis (ICA), Difference between PCA and ICA, Deep Learning (DL), Basic Components of Perceptron, Types of Activation functions, Biological Neurons, Applications of DL, Difference between Machine Learning and Deep Learning, Load Forecasting using ML.

TEXT BOOKS:

1. Tom Mitchell, "Machine Learning", First Edition, McGraw- Hill, 1997.
2. Ethem Alpaydin, "Introduction Machine Learning", Edition 2.
3. M.Gopal, "Applied Machine Learning", McGraw Hill Education (India) Private Limited, 2018.
4. Andreas C. Mueller and Sarah Guido, "Introduction Machine Learning with Python", O'Reilly Media, Inc, 2016.
5. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2011.

SUGGESTED READING:

1. Jeeva Jose, "Introduction Machine Learning", Khanna Book Publishing Co., 2020.
2. John Paul Mueller and Luca Massaron, "Machine Learning for Dummies", 2016.
3. Rajeev Chopra, "Machine Learning", Khanna Book Publishing Co., 2021.
4. Ethem Alpaydin, "Machine Learning: The New AI", The MIT Press, 2016.

NPTEL Courses:

S.No	NPTEL Course Name	Instructor	Host Institute
1	Machine Learning for Engineering and Science Applications	Dr. Balaji Srinivasan	IIT Madras

22EEE24

AI FOR ELECTRICAL ENGINEERING

(Program Elective-2)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None

COURSE OBJECTIVES: This course aims to

1. Practice the concept of fuzziness involved in various systems.
2. Design artificial neural network to solve real time problem.
3. Analysis genetic algorithm, genetic operations and genetic mutations.

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

1. Understand fuzziness involved in various systems and fuzzy set theory.
2. Comprehend fuzzy logic control for applications in electrical engineering.
3. Study the design of multi-layer artificial neural network.
4. Understand feed forward neural networks, feedback neural networks and learning techniques.
5. Develop system using AI to solve real time electrical engineering problem.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	2	2	1	1	1	1	1	1	2	3	-	1
CO 2	3	3	2	2	3	1	1	1	1	1	1	2	3	3	2
CO 3	3	2	3	2	3	1	1	1	2	1	2	2	3	3	1
CO 4	3	2	2	2	3	1	1	1	2	1	2	2	3	3	1
CO 5	3	3	3	3	3	2	2	1	2	2	3	3	3	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Fuzzy Logic: Introduction, fuzzy versus crisp, fuzzy sets, membership function: triangular membership function- trapezoidal membership function- Gaussian membership function- sigmoidal membership function, basic fuzzy set operations, properties of fuzzy sets, fuzzy Cartesian product, operations on fuzzy relations, fuzzy logic, fuzzy quantifiers, fuzzy inference, fuzzy rule based system, defuzzification methods.

UNIT-II

Artificial Neural Networks (ANN): Introduction, models of neural network, architectures, knowledge representation, artificial intelligence and neural networks, learning process, error correction learning, Hebbian learning, competitive learning, Boltzman learning, supervised learning, unsupervised learning, reinforcement learning, learning tasks.

UNIT-III

ANN Paradigms: Perceptron: Basic structure-activation function-learning algorithm, multilayer perceptron: forward propagation-error calculation-back propagation-gradient descent, self-organizing map, radial basis function network, functional link.

Network: feedforward neural networks-convolutional neural networks-recurrent neural networks- Hopfield network.

UNIT-IV

Hybrid Systems: Basic principle of genetic algorithm, evolution of genetic algorithm, hybrid genetic algorithm, parallel genetic algorithm, trends in stochastic search, hybrid systems: Neural symbolic integration-Integrating reinforcement learning with neural networks-Bayesian neural networks-Attention mechanisms in neural networks, integrated hybrid systems such as neuro fuzzy-fuzzy-neuro.

UNIT–V

Applications of AI Techniques: Load forecasting, load flow studies, economic load dispatch, small signal stability (dynamic stability) reactive power control, speed control of dc and ac motors.

TEXT BOOKS:

1. S. Rajasekaran and G.A.V. Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms"- PHI, New Delhi, 2010.
2. Xin-She Yang, "Engineering Optimization: An Introduction with Metaheuristic Applications"- Wiley publication, 2010.

SUGGESTED READING:

1. P.D. Wasserman, Van Nostrand Reinhold," Neural Computing Theory & Practice"- New York,1989.
2. Bart Kosko," Neural Network & Fuzzy System" Prentice Hall, 1992.
3. Yagna Narayana, " Artificial Neural Networks" -PHI, New Delhi,2012

NPTEL Courses:

S.No	NPTEL Course Name	Instructor	Host Institute
1	Introduction to soft computing	Prof.D. Samanta	IIT Kharagpur
2	Introduction to AI	Prof. S. Sarkar	IIT Khargpur

22EEE25

DATA ANALYTICS WITH PYTHON

(Program Elective-2)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basic knowledge of programming language Python.

COURSE OBJECTIVES: This course aims to

1. Understand and use python data base libraries as a tool for data analytics.
2. Use and reshape dataset using python
3. Create Python codes for the data aggregation.

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

1. Understand and apply data types of python.
2. Develop python based application using OOPs concepts.
3. Develop a new dataset using data wrangling operations.
4. Analyze the data by aggregations and grouping operations.
5. Analyze the data by time series.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	-	-	-	-	-	-	-	3	3	-
CO 2	3	2	1	3	1	-	-	-	-	-	-	-	3	3	1
CO 3	2	3	1	2	1	-	-	-	-	-	-	-	3	3	1
CO 4	3	3	2	2	2	-	-	-	-	-	-	-	3	3	-
CO 5	3	2	2	2	2	-	-	-	-	-	-	-	3	3	-

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to data analytics and Python fundamentals: Introduction to data analytics**,** Basics of python**,** Import new function to python**,** Numpy: NDArray, Create an Array, Types of Data, Dtype option, intrinsic creation of an array, Basic operator: arithmetic operator, the matrix, increment and decrement operator, universal function, aggregate function, Indexing, Slicing, Iterating, Joining array, Splitting array, Structured array.

UNIT-II

Introduction to Pandas and Data modeling techniques: Introduction to Tools and Environment, Application of Modeling, Databases and Types of Data and Variables, Data Modeling Techniques, The series, Data farm, Index objects, Re-indexing, Dropping, Operation between data structures, Function application and mapping, Sorting and Ranking, NaN Data, Indexing and leveling.

UNIT-III

Data Wrangling: Reading writing data in text format, Combine and marge Dataset: data frame marge, margining on index, concatenating, combining, Reshaping and pivoting: hierarchical Indexing, Long to wide format,

Data transformation: removing duplicates, transforming data, replacing value, modify axis index, Discretization and binning, Detecting and filtering, Random sampling, Dummy variables, Sting manipulation, Case study: create a list of amount of power generated by different kind of power plants, generate a list of top five suppliers in power industry of specific area.

UNIT-IV

Data Aggregation: Group operation: grouping with dictionary and series, function and index level, Column wise data aggregation, Returning aggregated data, Concept of Regression, Blue property assumptions, Least square Estimation, Group wise operation and transformation, Case study: classify different types of fault in power system, show the effect of climate in renewal energy.

UNIT-V:

Plotting and Visualization: Introduction to Matplotlib: figures and sub-plot, colors, markers, line style, ticks, labels, and legends, Matplotlib configuration, Plotting functions in pandas: line plots, bar plots, histograms and density plots, Visualization Techniques, Visualizing Complex Data and Relations, case study: visualize the bar graph for power consumption in every month.

TEXT BOOKS:

1. Wes McKinney, "Python for Data Analysis", 1st Edition, O'Reilly Media, Inc., 2012.
2. Fabio Nelli, "Python Data analitics", Apress, 2018.

SUGGESTED READING:

1. Phuong Vo.T.H , Martin Czygan , Ashish Kumar and Kirthi Raman, "Python: Data Analytics And Visualization", Packt Publishing Limited, 2017.
2. Alvaro Fuentes, "Become a Python Data Analyst: Perform exploratory data analysis and gain insight into scientific computing using Python", Packt Publishing Limited, 2018.
3. Data Analytics with Python by By Prof. A Ramesh | IIT Roorkee -SWAYAM course.

NPTEL Courses:

S.No	NPTEL Course Name	Instructor	Host Institute
1	Data Analytics with Python	Prof. A. Ramesh	IIT Roorkee
2	Python for Data Science	Prof.Ragunathan Rangasamy	IIT Madras

22EEE31

ELECTRICAL DISTRIBUTION SYSTEMS

(Program Elective-3)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Power systems-II, Switchgear and Protection

COURSE OBJECTIVES: This course aims to:

1. Analyze distribution system load characteristics, substation schemes, and conduct voltage drop calculations for diverse service areas.
2. Acquire knowledge of primary and secondary distribution systems, and comprehend their distinct characteristics.
3. Investigate voltage control methods and applications of capacitors within distribution systems.

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

1. Apply problem-solving skills to compute load factor, loss factor, coincidence factor, and analyze load characteristics, including load growth considerations.
2. Demonstrate proficiency in illustrating substation bus schemes, determining substation ratings, and calculating voltage drops in substations.
3. Explain the types and characteristics of primary and secondary distribution systems, and calculate voltage drop and power losses.
4. Analyze voltage drop and power loss in both three-phase and non-three phase lines, evaluate distribution costs, and assess various voltage control methods in distribution systems.
5. Calculate reactive power requirements for distribution systems and summarize functions and communications utilized in distribution automation.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	1	-	-	-	-	-	-	-	1	3	3	2
CO 2	3	3	1	1	-	-	-	-	-	-	-	1	3	3	2
CO 3	3	3	1	1	-	-	-	-	-	-	-	1	3	3	2
CO 4	3	3	1	1	-	-	-	-	-	-	-	1	3	3	2
CO 5	3	3	1	1	-	-	-	-	-	-	-	1	3	3	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Load Characteristics: Demand, demand curve, load duration curve, Diversified demand, Non-coincident Demand, Coincidence factor, Contribution factor problems, Relationship between load and loss factors load growth, Rate structure, Customer billing, Classification of loads (residential, commercial, agricultural, and industrial) and their characteristics

UNIT-II

Sub-Transmission Lines and Substations: Types of sub-transmission lines, Distribution substations, Substation bus schemes, Rating of distribution substation, Service area with multiple feeders, Percent voltage drop calculations, Benefits derived through optimal location of substation, classification of substations: Air insulated substations- Indoor & outdoor substations: Substation layout showing the location of all the substation equipment. Bus-bar arrangement in substations.

UNIT-III

Primary and Secondary Feeders: Requirements and Design features of distribution feeders, Types of primary systems, Radial type, Loop type and Primary network, Primary feeder loading, Radial feeder with uniformly

distributed load, basic design practice of the secondary distribution system, Secondary voltage levels, Secondary banking, Secondary networks.

UNIT-IV

Voltage Drop and Power Loss Calculations: Voltage drop and power loss calculations, 3-phase, Non 3-phase primary lines, Single phase two-wire laterals with ungrounded neutral, Single phase two wire ungrounded laterals, two phase plus neutral lateral, Method to analyze distribution costs, Voltage control methods, Feeder voltage regulators.

UNIT-V

Distribution System Automation and Capacitors allocation: Definitions, control functions, Level of penetration of DA, Types of communication systems, Supervisory control and data acquisition (SCADA)- Consumer Information Service (CIS)- Geographical Information Service (GIS)- Automatic Meter Reading (AMR). Effects of series and shunt capacitors, Power factor Improvement, causes of low P.F.- Methods of Improving P.F –Phase Advancing and generation of reactive KVAR using static capacitors, Power factor correction, Economic justification for capacitors, Location and sizing of capacitors in distribution system

TEXT BOOKS:

1. Turan Gonen, “Electric Power Distribution Engineering”, TMH, 3rd Edition,2016.
2. A.S.Pabla, “Electric Power Distribution”, TMH, 6th Edition, 2012.

SUGGESTED READING:

1. M.K.Khed Kar, G.M.Dhole, “Electric Power Distribution automation”, Laxmi Publications, 2010.
2. William Kersting, “Distribution System Modelling and Analysis”, 3rdEdition CRC Press, 2015.
3. S.Sivanagaraju, and V.Sankar, “Electric Power Distribution and Automation”, Dhanpat Rai & Co,2012

22EEE32

SIMULATION TECHNIQUES IN ELECTRICAL ENGINEERING

(Program Elective-3**)**

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Students should have prior knowledge on basic programming languages

COURSE OBJECTIVES: This course aims to

1. Introduce basics of MATLAB
2. Build knowledge about matrices and plots
3. Introduce various simulation techniques and computational methods using MATLAB

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

1. Understand the various data types and operators in MATLAB.
2. Apply matrix mathematics, functions, and structures to solve both linear and nonlinear equations.
3. Understand the utilization of plots for visualization and the creation of MATLAB m-files.
4. Analyse electrical circuits and power electronic applications using MATLAB environment.
5. Analyse computational intelligence techniques within the MATLAB environment.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
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CO 2	2	2	1	3	3	-	-	-	-	-	-	1	3	3	2
CO 3	2	3	1	1	1	-	-	-	-	-	-	1	3	3	1
CO 4	2	3	2	2	2	-	-	-	-	-	-	1	3	3	1
CO 5	2	2	2	2	2	-	-	-	-	-	-	1	3	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Basics: MATLAB environment, variables, Basic data types, Relational and Logic operators, Conditional statements, Input and Output, Loops.

UNIT-II

Matrices: Creating and Manipulating matrices, Matrix mathematics and Matrix functions, Colon operator, Line space, Cross product, Dot product, Logical functions, Logical indexing, 3 – Dimensional arrays, Cell arrays, Structures.

UNIT-III

Plotting and M –file Scripts: Plotting: 2-D and 3-D plots: Basic plots, subplots, Histograms, Bar graphs, Pie charts, creating and running of a function, function definition line, H1 and help text lines, Function body, Sub – functions, File I/O handling

UNIT-IV

Electrical and Power Electronics Applications: Analysis of Electrical Networks-Solution of Series-Parallel Circuits, Solution of mesh and nodal analysis, Network theorems-validation of Maximum power transfer theorem and Verification of Super position theorem, Solution of linear differential equations-Solution of First-Order differential equation. Simulation of 1- Φ Half wave uncontrolled rectifier with R & RL loads, Simulation of 1- Φ Full wave uncontrolled rectifier with highly inductive loads, Simulation of 3 - Φ full wave uncontrolled rectifier with R load.

UNIT-V

Computational Intelligence Techniques: Introduction to optimization- Teaching Learning Based Optimization (TLBO) - Particle Swarm Optimization (PSO) -Artificial Bee Colony (ABC) Algorithm-Implementation of TLBO, PSO and ABC algorithms using MATLAB for Sphere function-Booth function-Himmelblau's functions.

TEXT BOOKS:

1. D Hanselman and B Little Field, "Mastering MATLAB 7", Pearson Education, 2005.
2. Y Kirani Singh and B B Chaudhari, "MATLAB Programming", Prentice Hall of India, 2007.
3. Dr. Shailendra Jain, "Modeling and Simulation using MATLAB-Simulink, Wiley publication, second edition, 2015

SUGGESTED READING:

1. Xin-She Yang, "Engineering Optimization An Introduction with Metaheuristic Applications", Wiley publications, 2010
2. A Gilat, "MATLAB: An Introduction with Applications", John Wiley and Sons, 2004
3. Computer Aided Applied Single Objective Optimization by Prof. Prakash Kotecha, IIT Guwahati,

22EEE33

ADVANCED POWER CONVERTERS

(Program Elective-3)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Student should have a prior knowledge of Power Electronics

COURSE OBJECTIVES: This course aims to

1. Study different modern Power Electronic Devices and Isolated/Non-Isolated DC- DC converters.
2. Study the concepts of Multi pulse and Multilevel Power Electronic Circuits.
3. Understand different applications of Power Converters.

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

1. Outline various features and Electrical Specifications for a chosen Modern Power Electronic Device.
2. Design Isolated DC-DC converters.
3. Design Non-Isolated DC-DC converters.
4. Apply the concepts of different Multilevel Inverters that suit Industrial Applications.
5. Recognize the applications of Power Converters.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
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CO 2	2	2	3	1	1	-	-	-	-	-	-	-	3	2	3
CO 3	2	2	3	1	1	-	-	-	-	-	-	-	3	2	2
CO 4	3	2	3	1	1	-	-	-	-	-	-	-	3	3	3
CO 5	2	2	2	2	2	-	-	-	-	-	-	-	2	2	3

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Modern Power Semiconductor Devices: Gate Turn Off- SCR(GTO-SCR), MOS Turn off Thyristor (MTO), Emitter Turn Off Thyristor (ETO), Integrated Gate Commutated Thyristor (IGCTs), MOS-controlled Thyristors (MCTs), symbol, structure and equivalent circuit, comparison of their features.

UNIT-II

D.C to D.C converters-I: Non -Isolated D.C to D.C converters in CCM and DCM, Boundary conditions, Non-Ideal Behaviour, Design of Passives for: Buck, Boost, Buck-Boost and Cuk converter circuits

UNIT-III

DC-DC converters-II: Isolated DC-DC converters: Flyback converter, Forward converter, Push-Pull converter, Half-Bridge converter and Full-Bridge converter

UNIT-IV

Multilevel Inverters: Multilevel concept, Classification of Multilevel Inverters, Diode Clamped Multilevel Inverter, principle of operation, main features, improved Diode Clamped Inverter, principle of operation, Flying Capacitors Multilevel Inverter, principle of operation, main features, Cascaded Multilevel Inverter, principle of operation, main features, Multilevel Inverter applications.

UNIT-V

Applications of Power Converters: AC power supplies, classification, switched mode AC power supplies, online and offline Uninterruptible Power Supplies applications, DC circuit breakers.

TEXT BOOKS:

1. Mohammed H. Rashid, “Power Electronics, Devices, circuits and applications”, Pearson Education, 4th Edition, 2017.
2. Ned Mohan Tore M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley& Sons, 3rd Edition, 2007.

SUGGESTED READING:

1. H. W. Whittington, B. W. Flynn and D. E. MacPherson, “Switched Mode Power Supplies, Design and Construction”, Universities Press, 2009 Edition.
2. Uman and L., Bhat S.R., “Design of Magnetic Components for Switched Mode Power Converters”, Wiley Eastern Ltd., 1992
3. Robert. W. Erickson, D. Maksimovic, “Fundamentals of Power Electronics”, Springer International Edition, 2013.

ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_ee33/preview
2. https://onlinecourses.nptel.ac.in/noc24_ee07/preview

22EEE34

POWER QUALITY ENGINEERING

(Program Elective-3)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basic knowledge in power systems and power electronics

COURSE OBJECTIVES: This course aims to

1. Understand the Power Quality(PQ) standards and its monitoring concepts
2. Understand PQ issues and sources of harmonics in Industrial systems and its mitigation.
3. Understand the problems and solutions to wiring and Grounding

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

1. Illustrate the basic concepts of power quality issues and power quality monitoring, standards and measuring instruments.
2. Apply the mitigation techniques in real time power system to solve power quality issues.
3. Analyze voltage sags effect on three-phase AC- Adjustable speed drive (ASD), DC- Adjustable speed drive (ASD) for industrial applications.
4. Identify the sources of harmonics and its mitigation techniques in industrial systems.
5. Discuss the protection devices for transient over voltages and solutions for Wiring and Grounding problems

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	-	-	-	-	-	-	-	-	-	1	3	-	2
CO 2	3	3	1	-	-	-	-	-	-	-	-	1	3	-	2
CO 3	2	3	1	-	-	-	-	-	-	-	-	1	3	3	2
CO 4	3	3	1	-	-	-	-	-	-	-	-	1	3	-	2
CO 5	2	2	1	-	-	-	-	-	-	-	-	1	2	-	-

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Power Quality problems in distribution systems: Voltage Sag, Swells, Interruptions, and Wave-form Distortions: harmonics, noise, notching, DC-offsets, fluctuations, flicker and its measurement. Tolerance of Equipment: CBEMA curve, Power quality monitoring, standards and measuring instruments.

UNIT-II

Power quality mitigation techniques: Active shunt compensators, Classification of D-STATCOM, Principle of Operation and Control of DSTATCOMs, Single-phase PQ theory, Single-phase DQ theory, Active series compensators, Classification of Active Series Compensators, Principle of Operation and Control of Active Series Compensators, Single-phase PQ theory, Single-phase DQ theory

UNIT-III

PQ Consideration in Industrial Power Systems: Adjustable speed drive (ASD) systems and applications, Characterization of voltage sags experienced by three-phase AC-ASD, DC-ASD systems, Effects of momentary voltage dips on the operation of induction and synchronous motors.

UNIT-IV

Harmonics: Sources of power system harmonics, Harmonic distortion, Harmonic Indices, Odd and Even Order Harmonics, Causes of Voltage and Current Harmonics, Locating Harmonic sources, Effect of Harmonics on Power System Devices, Mitigation of harmonics.

UNIT-V

Transient Over-voltages & Wiring and Grounding: Sources of Transient Overvoltage's, Principles of Overvoltage Protection Devices, Definitions, Reasons for Grounding and wiring, Typical Wiring and Grounding Problems, Solutions to Wiring and Grounding Problems.

TEXT BOOKS:

1. C.Sankaran, 'Power Quality', CRC Press, 2001.
2. R. SastryVedam, M. Sarma, "Power Quality-Var Compensation in Power Systems ", CRC Press, 2009.

SUGGESTED READING:

1. Math H.J. Bollen, 'Understanding Power Quality Problems', IEEE Press, 2000.
2. Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, H. Wayne Beaty, 'Electrical Power Systems Quality', 3rd Edition,Tata McGraw-Hill, 2012.

NPTEL Courses:

S.No	NPTEL Course Name	Instructor	Host Institute
1	Power Quality	Prof. Bhim Singh	IIT Delhi

22EEE35

ELECTRICAL MACHINE DESIGN

(Program Elective-3)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basic knowledge of Electrical Engineering, Machines and Circuit analysis.

COURSE OBJECTIVES: This course aims to

1. Impart the design parameters of various electrical machines.
2. Provide the electrical and mechanical characteristics of electrical machines.
3. Disseminate the fundamentals of CAD usage.

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

1. Compute the design parameters of any given Electrical Machine.
2. Design a Transformer for given specifications
3. Design an Induction Motor for given specifications.
4. Design a Synchronous machine for given specifications.
5. Comprehend the basic Knowledge of Computer aided Design Concepts

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	-	-	-	-	-	-	-	-	1	3	-	1
CO 2	3	1	1	-	-	-	-	-	-	-	-	1	3	-	1
CO 3	3	2	1	-	-	-	-	-	-	-	-	1	3	-	1
CO 4	3	2	1	-	-	-	-	-	-	-	-	1	3	-	1
CO 5	3	1	1	-	-	-	-	-	-	-	-	1	3	-	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Basics of Machine design aspects: Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, temperature rise, rating of machines.

UNIT-II

Design of Transformer: Sizing of a transformer, main dimensions, KVA output for single-phase transformer, window spacefactor, overall dimensions, methods for cooling of transformers.

UNIT-III

Design of Induction Motors: Sizing of an induction motor, main dimensions, length of air gap of squirrel cage machines, design of rotor bars & slots, magnetizing current.

UNIT-IV

Design of Synchronous Machines: Sizing of a synchronous machine, main dimensions, design of salient pole machines, shortcircuit ratio, armature design, estimation of air gap length, design of rotor.

UNIT-V

Computer aided Design (CAD): Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation.

TEXT BOOKS:

1. A.K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.
2. K. M. V. Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2008.

SUGGESTED READING:

1. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.
2. V. N. Mittle and Arvind Mittal "Design Of Electrical Machines" Standard Publishers Distributors, New Delhi, 2009.

ONLINE RESOURCES :

1. https://www.emetor.com
2. https://quickfield.com/app_elmach.htm
3. https://onlinecourses.nptel.ac.in/noc24_ee50/preview.

22EGM01

INDIAN CONSTITUTION & FUNDAMENTAL PRINCIPLES

Instruction	2L Hours per week
Duration of SEE	-
SEE	50
CIE	-
Credits	Non Credit

Prerequisites: Basic awareness of Indian Constitution and Government.

COURSE OBJECTIVES: This course aims to
1. Understand the history of framing of the Indian Constitution.
2. Awareness on Fundamental Rights, Duties and Directive Principles of State Policy.
3. Explore the organization of Union Government, and functions of President and Prime Minister.
4. Gain an insight into the inter-functionality of Union Legislature and Judiciary
5. Educate on the local governance and problems in development of rural and urban areas.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Understand the history of framing of the Indian Constitution and its features.
2. Assess the realization of Fundamental Rights and Directive Principles of State Policy.
3. Analyze the challenges to federal system and position of the President and the Prime Minister in the Union Government.
4. Underline the role of the Legislature and the Judiciary in Union Government and their mutual relations.
5. Evolve the development of the local governments in India and assess the role of Collector in district administration.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	1	-	-	1	1	1	1	-	-	-	-	-	-
CO 2	-	-	2	-	-	3	2	2	1	-	-	-	1	1	1
CO 3	-	-	1	-	-	1	1	-	-	-	-	-	-	-	-
CO 4	-	-	1	-	-	1	1	-	-	-	-	-	-	-	-
CO 5	-	-	2	-	-	3	2	1	1	-	-	-	1	1	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Constitutional History and Framing of Indian Constitution: East India Company rule (1757-1857): Social, Economic, Political and Administrative impact of Company rule in India. British Rule (1858-1947): Indian National Movement, Government of India Acts 1909, 1919 and 1935, and Indian Independence Act 1947. Framing of the Indian Constitution: Constituent Assembly, Preamble and Salient Features.

UNIT-II

Fundamental Rights, Duties and Directive Principles of State Policy: The Fundamental Rights**:** Features and significance of Rights. Fundamental Duties: Importance and the legal status of Duties. Directive Principles of State Policy: Socialist, Gandhian and Liberal-intellectual principles, importance and relevance.

UNIT-III

Union Government and its Administration: Federalism: Division of legislative and financial powers between the Union and the State. Union Executive: Role and position of President, Prime Minister and Council of Ministers. Emergency Provisions: National Emergency, Constitutional Emergency and Financial Emergency.

UNIT-IV

Union Legislature and Judiciary: Union Legislature: Parliament of India-Composition and functions of Parliament, and Parliamentary Committees. Union Judiciary: Supreme Court of India-Composition and Functions.

UNIT-V

Local Self Governments: Rural Local Governments: Zilla Parishad- CEO and functions of Zilla Parishad, Mandal Parishad- Role of Elected and Officials, Gram Panchayat- Sarpanch, Secretary and Gram Sabha. Urban Local Governments: Structure and functions of Municipalities and Municipal Corporations. District Collector: Powers and functions of Collector.

TEXT BOOKS:

1. Sastry Ravindra, (Ed), "Indian Government & Politics", Telugu Akademy, 2nd edition, 2018.
2. "Indian Constitution at Work", NCERT, First edition 2006, Reprinted in 2022.

SUGGESTED READING:

1. D.D. Basu, "Introduction to the Constitution of India", Lexis Nexis, 2015.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, "Framing of Indian Constitution", 1stEdition, 2015.
3. Granville Austin, "The Indian Constitution: The Cornerstone of a Nation", OUP, 2nd Edition, 1999.
4. M.V. Pylee, "India's Constitution", S. Chand Publishing, 16th Edition, 2017.
5. Rajeev Bhargava (ed), "Politics and Ethics of the Indian Constitution", OUP, 2008.

ONLINE RESOURCES:

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

2EEC27

POWER SYSTEMS LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisites: Power systems-I, Power systems-II, Switchgear and Protection

COURSE OBJECTIVES: This course aims to

1. Determine regulation & efficiency of short, medium and long transmission lines and to calculate A, B, C and D constants.
2. Understand the importance of protective relays in power system such as differential protection of Transformer, IDMT Characteristics of over current relay and static relays.
3. Understand steps involved in finding sequence impedances of Transformers and Alternators.
4. Determine dielectric strength of Transformer oil, sting efficiency and Fault location of Underground cables.

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

1. Calculate ABCD constants of transmission lines and evaluate regulation and efficiency.
2. Examine relay setting and compensation techniques for safe operating of power system.
3. Determine sequence impedances of transformer and alternator and discuss their significance.
4. Conduct fault analysis of an alternator to determine its time constant. Identify the fault location of an underground cable.
5. Determine the dielectric strength of transformer oil and calculate the efficiency of string insulators of a transmission line.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	2	1	1	2	-	-	-	1	-	1	2	-	1
CO 2	3	2	2	1	1	1	-	-	-	1	-	1	2	-	1
CO 3	3	2	2	1	1	1	-	-	-	1	-	1	2	-	1
CO 4	3	2	2	1	1	1	-	-	-	1	-	1	2	-	1
CO 5	3	2	2	1	1	1	-	-	-	1	-	1	2	-	1

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

1. Determination of regulation & efficiency of 3-Phase transmission lines.
2. IDMT characteristics of Over-current relay.
3. Determination of A, B, C, D constants of 1-Phase transmission line.
4. Differential protection of 1-phase transformer.
5. Sequence impedance of 3-PhaseAlternators by fault Analysis.(LG,LL & LLL)
6. Determination of positive, negative and zero-sequence impedance of 3-Phase transformers.
7. Determination of Synchronous machine reactance and Time constant from 3-Phase Short Circuit test.
8. Determination of dielectric strength of Transformer oil.
9. Characteristics of Static Over current Relays.
10. Measurement of capacitance of 3-corecables.
11. Determination of positive, negative and zero-sequence impedance of 3 phase Alternator.
12. Determination of Voltage distribution and String efficiency of string of Insulators.
13. Study of series-shunt compensation of a long transmission line using FPGA.
14. Fault location of Underground cables.
15. Visiting nearby substation and submitting the report.

16. Study of Radial and Ring main Distribution system.
17. Characteristics of Overvoltage and Under voltage relays.
18. Harmonic analysis of non-liner loads using power analyzer.

Note: At least TEN experiments should be completed in the semester.

2EEC28

ELECTRICAL DRIVES LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisites: Power Electronics, Electrical Machines (Theory & Lab).

COURSE OBJECTIVES: This course aims to

1. Experiment and analyze the motor performance connected with power semiconductor source.
2. Be familiar with different speed control techniques of Drives.
3. Validate the experimental results with simulations.

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

1. Analyze the control strategies to modify the output parameters of dc and ac drives.
2. Develop, testing and experimental procedures by applying basic knowledge of electrical engineering.
3. Demonstrate the concept of regeneration/ braking in electrical motors.
4. Interpret the performance of a given drive by suitable experimentation.
5. Investigate the performance of a given drive by using suitable simulation software.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	2	-	-	-	-	3	1	1	2	3	3	1
CO 2	2	3	1	2	-	-	-	-	3	1	1	2	3	3	1
CO 3	2	2	1	2	-	-	-	-	3	1	1	1	3	3	1
CO 4	2	2	1	2	-	-	-	-	3	1	1	1	3	3	1
CO 5	2	3	1	3	1	-	-	-	3	1	1	2	3	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

PART-A

1. Speed control of DC drive using Thyristor controlled rectifier.
2. Speed control of DC drive using DC-DC Chopper.
3. Four-Quadrant Operation of DC drive.
4. Closed loop speed control of DC motor using PID controller.
5. Speed control of single-phase induction motor speed using TRIAC.
6. Speed control of Three-Phase Induction Motor using V/f control.
7. Speed Control of Three-Phase Induction Motor using AC-AC converter.
8. Regenerative/Dynamic braking operation for AC drive.

PART-B

1. Simulation of Speed control of DC Motor using BJT based H-Bridge.
2. Simulation of Regenerative/ Dynamic breaking operation of DC motor.
3. Simulation of Step/ Ramp speed response of DC motor.
4. Simulation of VSI-fed 3-Phase Induction Motor drive.
5. Simulation of CSI-fed 3-Phase Induction Motor drive.
6. Simulation of Permanent Magnet Synchronous Motor drive.
7. Simulation of speed control of Permanent Magnet synchronous motor using open loop V/f control method.

Note: Any Six experiments from Part-A and Four from Part-B should be performed

22EEC26

IoT FOR ELECTRICAL ENGINEERING LAB
(Program Elective-2 Lab)

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisites: Students should have prior knowledge on basic understanding of C programming language, understanding the IoT technologies and standards

COURSE OBJECTIVES: This course aims to
1. Understand fundamental connectivity schemes of Arduino/ Raspberry Pi boards.
2. Understand the recent application domains of IoT in everyday life.
3. Interface external objects with Arduino/ Raspberry Pi.
4. Develop programming skills, application development and prototyping using Arduino/ Raspberry Pi.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Understand use of Arduino / Raspberry Pi board circuit.
2. Implement interfacing of various sensors with Arduino / Raspberry Pi.
3. Demonstrate the ability to transmit data wirelessly between different devices.
4. Show an ability to upload/download sensor data on cloud and server.
5. Analyze basic protocols in wireless sensor network.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	-	-	2	1	-	-	-	-	-	3	2	3	-
CO 2	3	3	3	3	3	2	-	-	3	3	1	3	3	3	-
CO 3	3	3	3	3	3	2	-	-	3	3	1	3	3	3	-
CO 4	3	3	3	3	3	2	-	-	3	3	1	3	3	3	-
CO 5	3	3	3	3	3	2	-	-	3	3	1	3	3	3	-

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:
1. Functional testing of Arduino IDE/Raspberry Pi and GPIO Programming.
2. Interfacing LCD display with Arduino/ Raspberry Pi.
3. Generating PWM pulses to control Full bridge converter using Arduino/Raspberry Pi.
4. IoT based home automation using Arduino/Raspberry Pi.
5. Interfacing RFID with Arduino/Raspberry Pi.
6. Interfacing of camera with Arduino/Raspberry Pi.
7. Traffic Light Controller using Arduino/ Raspberry Pi.
8. Interfacing GPS Module with Arduino/Raspberry Pi.
9. Interfacing Wi-Fi module with Arduino and switching on and off LED using blynk app.
10. Measurement of voltage, current and power in half wave rectifier using Arduino/Raspberry Pi.
11. Interfacing of sensors (temperature, IR, ultra-sonic and humidity) with Arduino/Raspberry Pi.
12. Interfacing of dc motor and servo motor using relay with Arduino/ Raspberry Pi.

BEYOND SYLLABUS:
1. Interfacing of Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smart phone using Bluetooth.
2. Designing of MPPT Solar Charge Controller using Arduino/Raspberry Pi.
3. Uploading of temperature and humidity data from Arduino/Raspberry Pi to thingspeak cloud.
4. Retrieval of temperature and humidity data from thingspeak cloud to Arduino/Raspberry Pi.

Note: At least **TEN** experiments from above should be conducted in the semester.

SUGGESTED READING:

1. Rajesh Singh and Anita Gehlot "IOT Based Projects", BPB Publications, First Edition, 2020.
2. Yashavant Kanetkar and Shrirang Korde "21 IOT Experiments", BPB Publications, First Edition, 2018.

22EEE27

SPECIAL ELECTRICAL MACHINES LAB
(Program Elective-2 Lab)

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisites: Prior knowledge of Electrical Drives, Machines Theory.

COURSE OBJECTIVES: This course aims to
1. Experimentally analyse the effect of changing DC bus voltage on motor speed at a particular load.
2. Implement closed loop speed control of Special machine drives and analyse the effect of varying phase voltage by changing duty cycle with PI controller.
3. Model and control various Special machines on MATLAB/Simulink platform.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Analyze the effect of DC bus voltage on speed control of Special machine drives.
2. Demonstrate the effect of varying Duty cycle on special electrical machine drive.
3. Demonstrate the effect of varying load on motor speed.
4. Implement the mathematical model of a Special machine in MATLAB/Simulink.
5. Investigate the performance of a given drive by using MATLAB/Simulink.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	2	-	-	-	-	3	1	1	2	3	3	1
CO 2	2	3	1	2	-	-	-	-	3	1	1	2	3	3	1
CO 3	2	2	1	2	-	-	-	-	3	1	1	1	3	3	1
CO 4	2	2	1	2	-	-	-	-	3	1	1	1	3	3	1
CO 5	2	3	1	3	1	-	-	-	3	1	1	2	3	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

PART-A
1. Speed control of BLDC Motor by changing DC bus voltage and also investigating the directional control (CW/CCW) feature using switch.
2. Speed control of BLDC Motor by changing PWM duty cycle using switch and by ADC potentiometer.
3. Closed loop speed control of BLDC motor by taking hall feedback & changing duty cycle with PI controller.
4. Speed control of SRM by changing DC bus voltage and also investigating the directional control (CW/CCW) feature using switch.
5. Closed loop speed control of SRM by taking hall feedback & changing duty cycle/phase voltage with PI controller.
6. Speed control of PMSM by changing DC bus voltage and also investigating the directional control (CW/CCW) feature using switch.
7. Speed control of PMSM by changing PWM duty cycle.
8. Closed loop speed control of PMSM by taking hall feedback & changing duty cycle with PI controller.

PART-B
1. Implementation of Parks transformation in MATLAB/SIMULINK.
2. Implementation of Inverse Parks transformation in MATLAB/SIMULINK.
3. Modelling of PMSM in MATLAB/SIMULINK.

4. Modelling of SynRM in MATLAB/SIMULINK.
5. Simulation of Closed loop speed controlled PMSM Drive.
6. Simulation of Closed loop speed controlled SynRM Drive.
7. Simulation of Closed loop speed controlled BLDC Drive.
8. Simulation of Closed loop speed controlled SRM Drive.

Note: Any Five experiments from Part-A and Five from Part-B should be performed

22EEE28

MACHINE LEARNING FOR ELECTRICAL ENGINEERING LAB

(Program Elective-2 Lab)

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisites: Students should have prior knowledge of Machine Learning and programming skills.

COURSE OBJECTIVES: This course aims to

1. Understand the basics of Machine Learning.
2. Apply different machine learning techniques to solve real-world problems.
3. Analyze new insight into different datasets.

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

1. Understand the mathematical and statistical prospective of machine learning algorithms through programming.
2. Design and Evaluate the Supervised models.
3. Design and Evaluate the Unsupervised models.
4. Apply Dimensionality reduction techniques.
5. Apply Machine Learning Algorithms for Electrical Engineering problems.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	2	-	-	-	-	1	-	3	3	2
CO 2	3	3	3	3	3	-	1	-	-	-	1	2	3	3	2
CO 3	3	3	3	3	3	2	-	-	-	-	1	-	3	3	2
CO 4	3	3	3	3	3	-	-	-	-	-	1	-	3	3	1
CO 5	3	3	3	3	3	-	-	-	-	-	1	-	3	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

1. Write a Program to find the mean, median, standard deviation and mode using user-defined functions
2. Write a program to import and export data
3. Demonstrate various data pre-processing techniques for a given dataset
4. Implement Simple and Multiple Linear Regression Models
5. Develop a Logistic Regression Model for a given dataset.
6. Develop a Decision Tree Classification model for a given dataset and use it to classify a new sample
7. Implement Naïve Bayes Classification
8. Implement Support Vector Machine algorithm to classify the data set.
9. Build a KNN Classification model for a given dataset.
10. Implement the Random Forest ensemble method on a given dataset
11. Implement the K-Means clustering Algorithm
12. Implement Dimensionality reduction using the Principle Component Analysis (PCA) method.
13. Implement Electrical Load demand forecasting using a given data set.
14. Implement Electricity Price Forecasting using a given data set.

BEYOND SYLLABUS :

1. Implement Fault identification and localization using a given data set.
2. Estimate Electrical Grid Stability.
3. Time Series Forecasting for Microgrid Power Generation.

Note: At least **TEN** experiments from above should be conducted in the semester

SUGGESTED READING:

1. Vijayvargia, Abhishek, “Machine Learning with Python: An Approach to Applied Machine Learning”, BPB Publications, 1st edition,2018
2. Aurelien Geron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow”, Oreilly, March 2017.
3. Dr. M Gopal, “Applied Machine Learning”, 1st Edition, McGraw-Hill,2018
4. Jeeva Jose, “Introduction Machine Learning”, Khanna Book Publishing Co., 2020
5. Tom Mitchell, “Machine Learning”, First Edition, McGraw- Hill, 1997

22EEE29

AI TECHNIQUES LAB

(Program Elective-2 Lab)

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES: This course aims to

1. Comprehend the concepts of artificial intelligence (AI) techniques.
2. Design an artificial neural network for forecasting future data related to power system.
3. Develop fuzzy rule base model to solve electrical engineering problem.

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

1. Understand the real time electrical engineering problem.
2. Implement fuzzy logic systems using Python.
3. Demonstrate the ability to apply fundamental concepts and techniques of artificial intelligence (AI).
4. Implement AI algorithms, models, and frameworks using Python.
5. Analyse AI techniques, algorithms, and models based on their performance.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	-	-	-	-	-	-	-	3	-	1
CO 2	3	2	1	3	1	-	-	-	-	-	-	1	3	3	2
CO 3	2	3	1	2	1	-	-	-	-	-	-	1	3	3	1
CO 4	3	3	2	2	2	-	-	-	-	-	-	1	3	3	1
CO 5	3	2	2	2	2	-	-	-	-	-	-	1	3	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

1. Exploring fuzzy logic rule design: Comparative analysis
2. Fuzzy rule based controller design to stabilize a mechanical system.
3. Design of buck boost converter using fuzzy logic control.
4. Intelligent temperature controller design using Fuzzy logic.
5. Speed control of DC motor using AI.
6. Fault Detection in Power Systems using Artificial Neural Networks
7. Intelligent Control of DC-DC Converters using Artificial Neural Networks
8. Prediction of equipment failures in electrical systems.
9. Analyse sensor data from electrical equipment to detect and classify various types of faults.
10. Develop an AI model to forecast electricity load demand.
11. Energy Pricing Prediction: Forecasting Models and Analysis for Market Insights.
12. Develop AI-based systems to monitor and control power quality parameters (e.g., voltage stability, harmonics).

BEYOND SYLLABUS:

1. Develop algorithms to optimize the charging schedules of electric vehicles (EVs) considering factors such as grid congestion, electricity prices, and user preferences.
2. Maximize energy generation while considering variable environmental conditions and grid constraints.
3. Develop algorithms to mitigate power quality issues in real-time, such as using active power filters controlled by neural networks.

TEXT BOOKS:

1. S. Rajasekaran and G.A.V. Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms"- PHI, New Delhi, 2010.
2. Xin-She Yang, "Engineering Optimization: An Introduction with Metaheuristic Applications"- Wiley publication, 2010.

SUGGESTED READING:

1. P.D. Wasserman, VanNostrandReinhold," Neural Computing Theory & Practice"- New York,1989.
2. Bart Kosko," Neural Network & Fuzzy System" Prentice Hall, 1992.
3. Yagna Narayana, " Artificial Nueral Networks" -PHI, New Delhi,2012

RECOMMENDED NPTEL SOURCES:

1. https://nptel.ac.in/courses/106105078

22EEE30

DATA ANALYTICS LAB

(Program Elective-2 Lab)

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisites: None

COURSE OBJECTIVES: This course aims to

1. Plan the operation required in data analytics.
2. Define real time problems of electrical engineering.
3. Analyze data related to electrical engineering.

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

1. Understand and comprehend the basics of python programming.
2. Identify real-world applications using oops, files and exception handling provided by python
3. Distinguish the real time problem of electrical engineering.
4. Utilize the data related to electrical engineering.
5. Resolve the electrical engineering problems.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	-	-	-	-	-	-	-	3	3	-
CO 2	3	2	1	3	1	-	-	-	-	-	-	-	3	3	1
CO 3	2	3	1	2	1	-	-	-	-	-	-	-	3	3	1
CO 4	3	3	2	2	2	-	-	-	-	-	-	-	3	3	1
CO 5	3	2	2	2	2	-	-	-	-	-	-	-	3	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

1. Visualizing Graphs and Charts for a Given Dataset
2. Power Consumption Analysis:
3. Fault Detection in Electrical Grids:
4. Predictive Maintenance for Transformers:
5. Energy Generation Forecasting:
6. Load Forecasting for Smart Grids:
7. Anomaly Detection in Electrical Equipment:
8. Power Quality Analysis:
9. Energy Efficiency Optimization in Buildings:
10. Smart Meter Data Analytics for Demand Response:
11. Renewable Energy Integration Analysis:
12. Determining Electric Vehicle (EV) Battery Life Under Various Driving Conditions
13. Modelling an Inverter for DC to AC Power Conversion

BEYOND SYLLABUS:

1. Energy Consumption Optimization for a Specific Area Using Data-Driven Techniques
2. Designing a Fault Protection Alarm System Using Fault Data Analysis
3. Designing Dynamic Pricing Models for Utilities Based on Historical Data Analysis

Note: At least TEN experiments should be conducted in the semester.

SUGGESTED READING:

1. Alvaro Fuentes, “Become a Python Data Analyst: Perform exploratory data analysis and gain insight into scientific computing using Python”, Packt Publishing Limited, 2018.

22EEC33

MINI PROJECT

Instruction	4 P Hours per week
CIE	50 Marks
Credits	2

Prerequisites:

- Completion of relevant coursework in electrical and electronics engineering.
- Proficiency in programming languages (e.g., C/C++, Python, MATLAB) and software tools for circuit design and simulation.

COURSE OBJECTIVES: This course aims to

1. Provide students with hands-on experience in designing, implementing, and testing small-scale electrical and electronics projects.
2. Apply theoretical knowledge gained in previous semesters to practical engineering problems.

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

1. Develop practical skills in electrical and electronics engineering.
2. Enhance problem-solving abilities through project-based learning.
3. Foster creativity and innovation in designing electrical and electronics systems.
4. Encourage teamwork and collaboration in project development.

1. PROJECT SELECTION AND PROPOSAL:

- Ensure that your selection criteria cover aspects like feasibility, relevance, impact, and alignment with your objectives.
- Clearly define your project proposal with SMART (Specific, Measurable, Achievable, Relevant, Time-bound) objectives, methodology, and expected outcomes.
- Present your proposal effectively, highlighting the significance and potential of your project.

2. LITERATURE REVIEW:

- Conduct a comprehensive review of literature, patents, and existing solutions relevant to your project topic.
- Analyze and critically evaluate existing methodologies and technologies Identify gaps or areas for improvement.

3. DESIGN AND PLANNING:

- Develop a detailed conceptual design and system architecture, considering factors like scalability, flexibility, and compatibility.
- Thoroughly research and select components based on performance, availability, and cost-effectiveness.
- Create a comprehensive project plan with clear milestones, schedules, and resource allocation.

4. IMPLEMENTATION:

- Utilize appropriate software tools for circuit design and simulation, ensuring accuracy and reliability.
- If applicable, design a PCB layout efficiently, considering factors like signal integrity and manufacturability.
- Prototype and construct your project meticulously, following best practices and safety guidelines.

5. TESTING AND EVALUATION:

- Conduct rigorous testing to verify and validate the functionality of your project under various conditions.
- Analyze test results systematically, comparing them with expected outcomes and identifying any discrepancies or areas for improvement.

6. DOCUMENTATION AND REPORTING:

- Prepare detailed documentation including design specifications, schematics, and user manuals to facilitate understanding and replication of your project.
- Write a comprehensive final project report, summarizing key findings, challenges, and lessons learned throughout the project.
- Deliver a polished presentation to effectively communicate your project's objectives, methodologies, results, and implications to your audience.

ASSESSMENT:

- Project Proposal: 10%
- Literature Review: 15%
- Design and Planning: 20%
- Implementation: 25%
- Testing and Evaluation: 15%
- Documentation and Reporting: 15%

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
(Inline with AICTE Model Curriculum with effect from AY 2027-28)(R22A)

SEMESTER – VII

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22EEExx	**PE-4**	3	-	-	3	40	60	3
2	22EEExx	**PE-5**	3	-	-	3	40	60	3
3	22xxOxx	**OE-2**	3	-	-	3	40	60	3
4	22MBC01	Engineering Economics and Accountancy	3	-	-	3	40	60	3
PRACTICAL									
5	22 EEC29N	Electrical Simulation Lab	-	-	3	3	50	50	1.5
6	22EEC30	Project Part-I	-	-	4	-	50	-	2
Total			**12**	**-**	**7**	**15**	**260**	**290**	**15.5**
Clock Hours Per Week: 19									

L: Lecture **D:** Drawing **CIE:** Continuous Internal Evaluation
T:Tutorial **P:** Practical/ Project Seminar/ Dissertation **SEE:** Semester End Examination

LIST OF PROGRAM ELECTIVES: SEMESTER – VII

S.No	List of Courses Offered in Program Elective-4(PE-4)		List of Courses Offered in Program Elective-5 (PE-5)	
	Course Code	Title of the Course	Course Code	Title of the Course
1	22EEE41	Utilization of Electrical Energy	22EEE51	Introduction to Smart Grid
2	22EEE42	Advanced Control Systems	22EEE52	Embedded System Design
3	22EEE43	Flexible AC Transmission Systems	22EEE53	HVDC Transmission Systems
4	22EEE44	Digital Signal Processing	22EEE54	Electric Vehicles
5	22EEE45	Introduction to Soft Computing Techniques	22EEE55	Advanced Power System Protection

22EE E41

UTILIZATION OF ELECTRICAL ENERGY

(Program Elected-4)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Prior knowledge of Physics and basics of Electrical Engineering.

COURSE OBJECTIVES: This course aims to

1. Understand the adaptability of heating and welding concepts for a given application.
2. Know the necessity of illumination for specified requirement.
3. Know selection of proper traction system and its corresponding drive for industrial applications.

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

1. Acquire knowledge about electric heating concepts for a given application.
2. Understand principles of welding concepts for a given application.
3. Acquire knowledge about principles of illumination concepts and identify the necessity of illumination & luminaries for specified requirement.
4. Identify proper traction system and Familiar with principles of traction system.
5. Estimate energy consumption levels at various modes of operation in electric Traction.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	-	-	2	3	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	2	3	-	-
CO 3	3	3	3	3	-	-	-	-	-	-	-	3	3	-	1
CO 4	3	3	3	3	-	-	-	-	-	-	-	3	3	-	2
CO 5	3	3	3	3	-	-	-	-	-	-	-	3	3	-	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Electric Heating: Introduction, Classification of electric heating, Advantages of electrical heating, Properties of good heating material, Different types of heating material, Causes of failure of heating element, Design of heating element, Numerical Problems.

Power frequency heating Methods: Resistance heating- Direct resistance heating, Indirect resistance heating, Infrared or radiant heating, Electric arc heating- Direct arc heating, Indirect arc heating.

High frequency heating Methods: Induction heating- Direct induction heating, indirect induction heating - Dielectric heating.

UNIT-II

Electric Welding: Introduction, Classification of Welding Processes, Formation and Characteristics of Electric Arc, Electrodes for Metal Arc Welding, Advantages of Coated Electrodes, Types of Joints

Principle of Electric Arc welding: Advantages and disadvantages of electric welding, Electric Arc welding methods: Carbon Arc Welding, Submerged Arc Welding, and Atomic Hydrogen Welding.

UNIT-III

Illumination: Introduction, Terms used in illumination, laws of illumination, Polar Curves of C.P. Distribution – Determination of M.S.C.P and M.H.C.P from Polar Diagrams- Rousseau's construction, Design of Lighting Schemes for different applications- Numerical Problems

Electric Lamps: Incandescent lamps, Fluorescent lamps, Mercury vapor lamps, CFL, LED.

UNIT-IV

Electric Traction-I: Introduction, Systems of electric traction and track electrification- DC system, single phase and 3- phase low frequency and high frequency system, composite system, k and o system, comparison between AC and DC systems- Train Movement-Typical Speed/Time Curve - Factors affecting scheduled speed - Simplified Speed/Time Curve - Average and Schedule Speed- Tractive Effort for Propulsion of a Train - Power Output from Driving Axles - Energy Output from Driving Axles - Numerical Problems.

UNIT-V

Electric Traction-II: Specific Energy Output - Evaluation of Specific Energy Output - Energy Consumption - Specific Energy Consumption - Adhesive Weight – Coefficient of Adhesion – Mechanism of Train Movement – Numerical Problems.

TEXT BOOKS:

1. C L Wadhwa, Generation, "Distribution and Utilization of Electrical Energy"- 3rd Edition New age international publishers, 2015.
2. B.L. Theraja, "A Textbook of Electrical Technology Volume-III Transmission and Distribution", S. Chand Limited, 23rd Edition, 2013.
3. Partab H, "Art and Science of Utilization of Electric power", Dhanpatrai & Sons, 2014

SUGGESTED READING:

1. J.B.GUPTA, "Utilization of Electric Power and Electric Traction"- S.K.Kataria & Sons, 2013.
2. R K. Rajput, "Utilization of Electrical Power", 2nd Edition, Laxmi Publications (p) Ltd, 2016.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108105060
2. https://nitsri.ac.in/Department/DisplayDeptPage.aspx?page=oaiom&ItemID=oamka&nDeptID=g

22EEE42

ADVANCED CONTROL SYSTEMS

(Program Elective-4)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Students should have a prior knowledge of Linear Control Systems and Z-Transforms

COURSE OBJECTIVES: This course aims to

1. Study the concepts of state feed-back controller & observer.
2. Understand the Model based Controller Design and classical approach in designing compensators.
3. Understand the concept of non-linear systems and Study Lyapunov's stability method applicable for linear and non-linear system.

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

1. Design of state feed-back controller and observer for linear time invariant systems.
2. Design of Controller for different models in Time and frequency domain.
3. Design the basic compensators to improve the system response.
4. Analyze Stability of non-linear control systems.
5. Justify the stability study through Liapunov's criteria and construction of Lyapunov function.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	-	-	-	-	-	-	-	3	3	3
CO 2	3	2	1	3	1	-	-	-	-	-	-	-	3	3	3
CO 3	2	3	1	2	1	-	-	-	-	-	-	-	3	3	1
CO 4	3	3	2	2	2	-	-	-	-	-	-	-	3	3	1
CO 5	3	2	2	2	2	-	-	-	-	-	-	-	3	3	-

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

State Feedback Controllers and Observers: Design of state feedback controller through pole placement, Necessary and sufficient conditions, Ackerman's formula. State Observers– Full order and Reduced order observers.

UNIT-II

Model Based Controller Design: Introduction, Control structures and performance measures, Design of controller, Design of controller for SISO system, Controller design for TITO processes, Limitations of PID controllers, PI-PD controller for SISO system, PI and PD controller for Two Input Two Output system, Effects of measurement noise and load.

UNIT-III

Introduction to Compensator Designs: Preliminary considerations of classical design, Realization of basic compensators, cascade compensation in time domain, cascade compensation in frequency domain using bode plots.

UNIT-IV

Nonlinear Systems: Introduction to common physical nonlinearities, phase plane- method, Singular points, stability of non-linear system, Construction of phase trajectories- Isocline's method, δ-method, The Describing Function- basic concepts, Derivation of describing functions - dead zone and saturation.

UNIT- V

Lyapunov Stability Analysis: Introduction, Lyapunov stability criterion, direct method of Lyapunov and the linear system, methods of constructing Lyapunov function for nonlinear systems- Krasovskii's method, Variable gradient method.

TEXT BOOKS:

1. I.J Nagrath, M. Gopal, "Control Systems Engineering", New Age International (P) Limited, 2017.
2. Ogata.K,"DiscreteTimecontrolSystems",PHIPublications,2ndEdition-1 January 2005.

SUGGESTED READING:

1. M. Gopal, "Digital Control and State Variable Methods", Tata McGrawHill, 2/e, 2003.
2. K. Ogata,"ModernControlEngineering",PearsonPublications,5thEdition, 2015.
3. D. Subbaram Naidu, Optimal Control Systems. CRC Press, ISBN: 0849308925
4. S. Majhi,Advanced Control Theory-Relay Feedback Approach, Cengage Asia/India Pvt.Ltd, 2009.
5. A.Johnson and H. Moradi, New Identifications and Design Methods,Springer - Verlag, 2005.
6. Norman S. Nise, Control Systems Engineering, John Wiley & Sons, 2008.

NPTEL Courses:

S.No.	NPTEL Course Name	Instructor	Host Institute
1	Advanced Control Systems https://archive.nptel.ac.in/courses/108/103/108103007/	Prof. S. Majhi	IIT Guwahati

22EEE43

FLEXIBLE AC TRANSMISSION SYSTEMS

(Program Elective-4)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Power Electronics, Power Systems

COURSE OBJECTIVES: This course aims to

1. Understand concepts of various FACTS devices and controllers.
2. Study the various converter topologies used in FACTS
3. Study the principles of operation and control of shunt, series and combined FACTS controllers

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

1. Select the appropriate FACTS device / controller based on the needs of interconnected power transmission systems.
2. Analyze Power Electronic Converters used in FACTS.
3. Analyze the control aspects of shunt FACTS devices.
4. Analyze the control aspects of series FACTS devices.
5. Understand the principle of operation and control aspects of UPFC for P and Q control

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	-	3	-	1	1	1	-	-	-	1	-	2	2
CO 2	3	3	1	-	-	-	-	-	-	-	-	-	-	2	2
CO 3	2	2	-	3	-	1	1	1	-	-	-	1	-	2	2
CO 4	2	2	-	3	-	1	1	1	-	-	-	1	-	2	2
CO 5	1	1	-	1	-	-	-	-	-	-	-	-	-	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

General System Considerations and FACTS: Transmission Interconnections, Flow of Power in an AC System, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, principles of series and shunt compensation, Basic Types of FACTS Controllers, Benefits from FACTS, Application of FACTS.

UNIT-II

Voltage – Source Converters: Basic concept of Voltage – Sourced Converters, single-Phase Full-wave Bridge converter operation, single phase- leg operation, Square-Wave Voltage Harmonics for a single-phase bridge, Three-phase full-wave bridge converter, sequence of valve conduction process in each phase-leg, three-level voltage-sourced converter, Pulse-Width Modulation (PWM) converter, Generalized Technique of Harmonic Elimination and voltage control.

UNIT-III

Shunt Compensators: Objectives of Shunt Compensation, Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, improvement of Transient Stability, Power Oscillation Damping, Static Var Compensators, SVC and STATCOM, The Regulation Slope, Transfer Function and dynamic Performance, Transient Stability Enhancement and Power Oscillation Damping.

UNIT-IV

Series Compensators: Objectives of Series Compensation, concept of series capacitive compensation, voltage stability, improvement of transient stability, power oscillation damping, GTO thyristor controlled series capacitor, Thyristor controlled series capacitor, SSSC.

UNIT-V

Combined Compensators: Introduction, Unified Power Flow Controller (UPFC), basic operating principles, independent real and reactive power flow control, and control structure, basic control system for P and Q control.

TEXT BOOKS:

1. NarainG. Hingorani, Laszlo Gyugyi, 'Understanding FACTS', IEEE press, 1999.
2. Y.H.Song, A.T.Johns, 'Flexible A.C. Transmission System', IEE, London, 1999

SUGGESTED READING:

1. KR Padiyar, 'Facts Controllers In Power Transmission and Distribution', 2nd edition, New Age Publications, 2016.
2. R.Mohan Mathur, Rajiv K.Varma,'Thyristor-Based FACTS Controllers for Electrical Transmission Systems', Wiley Publications
   IEEE Press, 2002
3. Timothy J.E.Miller, 'Reactive Power Control in Electric Systems', 1982.

NPTEL Courses:

S.No.	NPTEL Course Name	Instructor	Host Institute
1	**FACTS Devices** https://onlinecourses.nptel.ac.in/noc23_ee58/preview	By Prof. Avik Bhattacharya	| IIT Roorkee

22EEE44

DIGITAL SIGNAL PROCESSING

(Program Elective-4)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Students should have basic knowledge of Signals and Systems.

COURSE OBJECTIVES: This course aims to

1. Understand the representation of signals mathematically in continuous, discrete time and frequency domain
2. Analyse the discrete time systems using Z-transforms, Discrete-Fourier Transform (DFT) and the FFT algorithms
3. Design IIR and FIR digital filters for various applications.

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

1. Illustrate of signals mathematically in continuous, and discrete-time, and in the frequency domain
2. Analyze discrete-time systems using z-transform
3. Apply Discrete-Fourier Transform (DFT) and FFT algorithms to discrete time signals.
4. Design of digital IIR filters and FIR filters.
5. Understand the Architecture and Features of Digital Signal Processor

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	-	-	-	-	-	1	1	1	1	-
CO 2	2	3	3	2	1	-	-	-	-	-	2	1	1	2	-
CO 3	2	3	3	2	1	-	-	-	-	-	2	2	2	3	1
CO 4	2	2	2	2	1	-	-	-	-	-	2	2	2	1	2
CO 5	2	2	2	1	1	-	-	-	-	-	2	2	2	1	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Discrete-Time Signals and Systems: Sequences, Representation of signals, Representation of discrete systems using difference equations, Sampling and reconstruction of signals, aliasing, Sampling theorem and Nyquist rate.

UNIT-II

Z-transforms: Region of Convergence, Analysis of Linear Shift Invariant systems using z-transform, Properties of Z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms. Implementation of Discrete Time Systems (Direct Form-I, Direct Form-II, Cascade and Parallel).

UNIT-III

Discrete Fourier Transform: Frequency Domain Analysis, The Discrete- Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform (FFT) Algorithms, Problems on Radix-2 DIF-FFT and DIT-FFT Methods

UNIT-IV

IIR Filters: Design of Analog Butterworth and Chebyshey filters, IIR filter design by impulse invariant bilinear transformation, Warping effect and Pre-warping.

UNIT-V

FIR Filters: Characteristics of FIR Digital Filters. Frequency response, comparison of FIR, IIR filters, Window techniques, Design of these filters using Rectangular, Hamming, Bartlet, Kaiser windows, Architecture and features of TMS 320F/2047 and ADSP signal processing chips, Applications of DSP.

TEXT BOOKS:

1. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
2. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.
3. P. VenkataRamani, M.Bhaskar, "Digital Signal Processo1, Architecture, Programming & Application",
4. Tata McGraw Hill-2004

SUGGESTED READING:

1. Anandkumar A, Digital Signal Processing, Second edition PHI learing, 2015
2. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall,1992.
3. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
4. D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons,1988.
5. J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Prentice Hall, 1997.

NPTEL Courses:

S.No.	NPTEL Course Name	Instructor	Host Institute
1	Digital Signal Processing	Prof. C.S. Ramalingam	IIT Madras

22EEE45

INTRODUCTION TO SOFT COMPUTING TECHNIQUES

(Program Elective-4)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Optimization techniques, Power Systems

COURSE OBJECTIVES: This course aims to

1. Understand the concepts of conventional techniques and genetic algorithm
2. Introduce Cuckoo search, Firefly, Ant and Bee techniques.
3. Study Multi-objective optimization and applications to various real-world problems.

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

1. Understand the conventional optimization techniques and Genetic Algorithms.
2. Analyze Cuckoo search and Firefly soft computing techniques in order to solve problems effectively and efficiently.
3. Apply Ant and Bee optimization algorithms.
4. Analyze multi-objective optimization techniques.
5. Apply soft computing techniques to solve test functions and electrical problems

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	-	1	-	-	-	-	1	-	2	3	3	1
CO 2	3	3	1	-	1	-	-	-	-	1	-	2	3	3	1
CO 3	3	3	1	-	1	-	-	-	-	1	-	2	3	3	1
CO 4	3	3	1	-	1	-	-	-	-	1	-	2	3	3	1
CO 5	3	3	1	-	1	-	-	-	-	1	-	3	3	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Basics of Optimization: Decision variables, Constraints, Objective function, Variable bounds, Distinction between Linear programming and Nonlinear programming problems. Genetic algorithm, Selection, Crossover, Mutation, Different types of Crossover and Mutation operators, Advantages and Disadvantages of GA, Differences between GA and Traditional methods.

UNIT -II

Cookoo Search and Firefly Algorithms:

Cookoo Search Algorithm: Cuckoo search, Special cases of Cuckoo Search, Global convergence: Brief mathematical analysis, Applications

Firefly Algorithm: Firefly algorithm, Parameter settings, Algorithm complexity, Special cases of FA, Variants of Firefly algorithm, Attraction and Diffusion, Applications.

UNIT -III

Ant and Bee Algorithms:

Ant Algorithm: Behaviour of Ants, Ant Colony optimization, Double bridge problem, Virtual Ant algorithm.

Bee Algorithms: Behavior of Honey Bees, Honey Bee algorithm, Virtual Bee algorithm, Artificial Bee Colony optimization

UNIT -IV

Multi-objective Optimization Problems: Linear and Nonlinear, Convex and Non-convex optimization, Principles of Multi-objective optimization, Dominance and Pareto-optimality.

Classical methods: Weighted sum methods, e-Constraint Method, Weighted metric methods.

UNIT -V

Applications of Optimization Algorithms: Implementation of Genetic Algorithm, Cookoo search and Firefly, Ant and Bee algorithms with Sphere function, Booth function, Himmelblau's functions and Economic load dispatch.

TEXT BOOKS:

1. Deb Kalyanmoy, "Optimization for Engineering Design: Algorithms and Examples", PHI Learning, 2012
2. Xin She Yang, "Cuckoo Search and Firefly Algorithm: Theory and Applications", Studies in Computational Intelligence 516, Springer International Publishing, 2014.
3. Kalyanmoy Deb, "Multi objective optimization using evolutionary algorithms", Wiley Publications, 2013

SUGGESTED READING:

1. Singiresu S.Rao, "Engineering Optimization Theory and Practice", 4th edition, 2009
2. Xin She Yang, "Engineering Optimization An Introduction with Metaheuristic Applications", Wiley, 2011.
3. D.E.Goldberg, "Genetic Algorithms", 4th Impression, Pearson Education Inc., 2009.

ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_me43/preview
2. https://archive.nptel.ac.in/courses/106/105/106105173/
3. https://onlinecourses.nptel.ac.in/noc23_ch04/course

22EEE51

INTRODUCTION TO SMART GRID

(Program Elective-5)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Power System and Power Electronics.

COURSE OBJECTIVES: This course aims to
1. Study the importance of smart grid and components of smart grid
2. Understand the communication technologies, infrastructure required for smart metering
3. Know various functions of distribution automation and operation of micro grid.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Discuss the components and operation of Smart Grid at transmission and distribution level
2. Select the communication technology required for smart grid applications
3. Illustrate components and operation of smart metering
4. Analyze the different types of micro grid, storage systems and communication infrastructure
5. Explain the equipment used in distribution automation

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	3	-	-	3	3	2	-	-	-	3	3	3	-
CO 2	2	1	3	-	-	-	3	1	-	-	-	2	3	3	-
CO 3	2	1	3	-	1	2	3	1	-	-	-	3	3	-	-
CO 4	2	2	3	-	1	3	3	1	-	-	-	3	3	3	-
CO 5	2	1	3	-	1	-	3	1	-	-	-	3	3	-	-

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Smart Grid: Conventional grid versus Smart Grid, Drivers of Smart grid, Functionalities and key components of smart grid for Transmission system and Distribution systems (elementary analysis), Smart grid vision and road map to India, Policies, Standards, Regulations, National smart grid mission framework.

UNIT-II

Communication Technologies: Dedicated and Shared communication channels, Switching techniques, Communication channels: Wired communication, Twisted pair, Optical fiber, Radio communication, Ethernet, Wireless LAN, Bluetooth, WiMAX.

UNIT -III

Smart Metering Infrastructure: Evolution of electricity metering, Benefits of smart metering, Components of Smart metering, Hardware requirements, Communication infrastructure and protocols for smart metering: Home area network, Neighborhood area network, Data concentrator, Meter data management system,

UNIT-IV

Micro Grids: Introduction, Mini/Micro grids, Architecture of micro grid, Types of micro grid, DC micro grid, AC micro grid, AC-DC micro grid, Communication to monitor real time network status, Energy storage in micro grids, Benefits of Distributed generation and Energy storage in micro grid systems.

UNIT-V

Distribution Automation: Substation automation equipment: Current transformers, Voltage transformers, Relay IED, Faults in distribution system: Components for fault isolation and restoration, Voltage regulation.
Applications: Network reconfiguration, Volt/Var control, Outage management system.

TEXT BOOKS:

1. Janaka Ekanayake, Liyanage, Wu, Akihiko Yokoyama, Jenkins, Smart Grid, Wiley Publications, 2012
2. Stuart Borlas'e, "Smart Grid: Infrastructure, Technology and solutions" CRC Press.

SUGGESTED READING:

1. James Momoh, "Smart Grid Fundamentals of Design and Analysis" IEEE Press, Wiley Publications, 2012
2. Smart grid Hand Book for Regulators and policymakers, Nov 2017 published by India Smart Grid Forum
3. Bharat Modi, Anuprakash, Yogesh Kumar, "Fundamentals of Smart grid Technology", Katson publishers, 2015.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108107113

22EEE52

EMBEDDED SYSTEM DESIGN

(Program Elective -5)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Students should have basic knowledge of Microprocessors and Microcontrollers

COURSE OBJECTIVES: This course aims to

1. Learn about fundamentals of the embedded systems
2. Understand the hardware and software details of the embedded systems.
3. Acquire knowledge on the serial, parallel and network communication protocols.

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

1. Understand the fundamentals of the embedded systems
2. Illustrate the concepts of Real Time Operation
3. Interpret the scheduling of tasks in Embedded system
4. Analyze the hardware and software components of the embedded systems.
5. Apply embedded programming approach for design applications.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	-	-	-	-	-	-	-	1	1	-
CO 2	2	3	3	2	1	-	-	-	-	-	-	-	1	2	-
CO 3	2	3	3	2	1	-	-	-	-	-	-	-	1	3	1
CO 4	2	2	2	2	1	-	-	-	-	-	-	-	1	1	1
CO 5	1	2	2	1	1	-	-	-	-	-	-	-	1	1	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction To Embedded Systems : Introduction to Embedded Systems –Structural units in Embedded processor , Microcontrollers with intense hardware focus, Handling GPIOs, Analog I/Os, Memory usage, interfacing etc. Micro controller peripherals usage - Timers, Real Time Clock Watchdog Timer, Counters, Interrupts and its sources, Inner-Processor Communications.

UNIT-II

Fundamentals of Real Time Operating System: Concept of Real Time, Real Time operating System, Characteristics of Real-Time operation system, Hard and Soft Real Time Systems. Structure of RTOS, RTOS Kernel, Kernel Objects, Services of Scheduler. Task, Task structure, Creation of task, types of task, Task Control block, context, States of task and FSM, idle task, Priority, Static and dynamic priority, Resources, Sharing of resources, ISR, Task Management.

UNIT -III

Scheduling Algorithm: Task scheduling Algorithm, pre-emption, FIFO, Round Robin scheduling, priority based pre-emptive scheduling. Priority Inversion, Software and hardware time Ticks, context switching. Simple programs based on Tiny RTOS kernel.

Task Synchronization : Concept of Sharing of data and resources, Round Robin, Race condition, Critical condition, deadlocks, spinlocks, Concept of semaphore, Binary semaphore, Counting semaphore, Semaphore management, Concept of mutex, mutex management, Inter-task Communication, Messages, Queues, Mailboxes

UNIT-IV

Design and development of Embedded Applications: ARM based architecture for Embedded system, Exception handling- ARM processor exceptions and modes, vector table, exception priorities, link register offsets. Interrupts- assigning interrupts, interrupt latency, IRQ and FIQ exceptions with example- code for enabling and disabling IRQ and FIQ exceptions, Comparison between exception and interrupts.

UNIT-V

Programming Concepts in Embedded C: Register allocation – Function calls – Pointer aliasing, structure arrangement, bit fields, unaligned data and endianness, inline functions and inline assembly, portability issues, Binding & Running Embedded C program in Keil IDE, Embedded system for Measurement of Humidity, wind velocity, temperature and illumination. Development of instrumentation for Agricultural applications, Measurement and monitoring in solar and wind power applications

TEXT BOOKS:

1. RajKamal,"EmbeddedSystems-Architecture,ProgrammingandDesign",3/e,McGrawHillEducation,2015.
2. J.W.Valvano,"EmbeddedMicrocomputerSystem:RealTimeInterfacing",Brooks/Cole,2000.
3. Andrew N Sloss, D. Symes and C. Wright, "ARM system developers guide", Morgan Kauffman/ Elsevier, 2006.

SUGGESTED READING:

1. Steve Furber, "ARM Systems-on-Chip architecture" Addison Wesley, Reprint, 2012 3. Michael J. Pont, "Embedded C", Pearson Education, 2007
2. David Seal, "ARM Architecture Reference Manual", Pearson Education, 2007.
3. Jivan S. Parab, Vinod Shelake.G, Rajanish Kamot.K, and Gourish Naik.M, "Exploring C for Microcontrollers- A Hands on Approach", Springer, 2007.

ONLINE LEARNING:

1. https://nptel.ac.in/courses/108102045
2. https://onlinecourses.nptel.ac.in/noc20_cs14/preview

22EEE53

HVDC TRANSMISSION SYSTEMS
(Program Elective-5)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basic Knowledge of Power Electronics and Power Systems

COURSE OBJECTIVES: This course aims to
1. Study the basics of HVDC and comparison between HVDC and HVAC and multi-terminal DC systems and their control methods.
2. To comprehend different converter circuits used in HVDC.
3. To familiarize with the control methods and protection methods of HVDC and its filter design techniques.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Understand the different HVDC systems, incorporating economic insights and current trends for global power transmission solutions.
2. Analyze HVDC converters, voltage source and bridge converters' principles, and apply grid control for optimal rectification and inversion performance.
3. Analyze diverse HVDC control methods, managing operational features and efficiently starting and stopping the DC link.
4. Understand the converter faults, protection measures, harmonics, and AC filter design for optimal HVDC system operation.
5. Understand the MTDC systems, distinguishing types, comparing configurations, and basic system control for practical applications.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	2	2	-	-	-	-	-	-	-	-	1	3	-	1
CO 2	2	2	2	1	-	-	-	-	-	-	-	1	3	-	2
CO 3	2	2	2	1	-	-	-	-	-	-	-	1	3	3	2
CO 4	2	2	2	1	1	-	-	-	-	-	2	1	3	3	1
CO 5	2	2	2	1	1	-	-	-	-	-	2	1	3	3	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I
Basic Concepts: Necessity of HVDC systems, Economics and Terminal equipment of HVDC transmission systems, Types of HVDC Links, Apparatus required for HVDC Systems, Comparison of AC and DC Transmission, Application of DC Transmission System, Planning and Modern trends in D.C. Transmission.

UNIT-II
Analysis of HVDC Converters: Choice of Converter Configuration, Analysis of Graetz circuit, Characteristics of 6 Pulseand12Pulseconverters,Cases of two 3 phase converters in Y/Y mode – their performance. HVDC-voltage Source converters: Principle and operation.
Converter Circuits: Properties of Converter circuits, Different kinds of arrangements, Analysis of Bridge converters with grid control, with and without overlap angle, Equivalent circuit of rectifier. Inversion: Operation as Inverter, Equivalent circuit of Inverter.

UNIT-III
Control: Basic means of control, Limitations of manual control, Desired features of control, Combined characteristics of rectifier and inverter, Power reversal, constant minimum angle, Ignition angle control, Constant current control, Constant Extinction angle control. Starting and stopping of DC link.

UNIT-IV

Converter Faults and Protection: Short circuit current, Arc-back, Commutation failure, Bypass valves, DC reactors, DC circuit breakers, Protection against over voltages,

Harmonics: Generation of Harmonics, Characteristics harmonics, calculation of AC Harmonics, Non Characteristics harmonics, adverse effects of harmonics, Calculation of voltage and Current harmonics, Effect of Pulse number on harmonics. Minimum cost tuned AC filters.

UNIT-V

Multi-terminal DC Systems: Application of MTDC systems, Types of MTDC systems, Comparison of series and parallel MTDC systems, Control of MTDC system (Basics).

TEXT BOOKS:

1. Padiyar KR., "HVDC Power Transmission Systems", Newage, 2017
2. S.Kamakshaiah and V.Kamaraju., "HVDC transmission", McGrawHill 2017.

SUGGESTED READING:

1. KimbarkE.W., "Direct Current Transmission" Vol-I, JohnWtley, 1971. 1990.
2. Arrillaga J., "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., London, Pergamon Press, 1983.
3. "S. Rao", EHVAC and HVDC Transmission Engineeringand Practice, Khanna publications, 3rd Edition 1999.
4. "E. Uhlmann", Power Transmission byDirectCurrent,B.S.Publications,2009

NPTEL Courses:

S.No.	NPTEL Course Name	Instructor	Host Institute
1	High Voltage DC Transmission	Prof. S. N. Singh	Department of Electrical Engineering Indian institute of Technology, Kanpur

22EEE54

ELECTRIC AND HYBRID VEHICLES

(Program Elective -5)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basic knowledge of Electrical & Mechanical Engineering, Engines, Machines, Batteries and Circuit analysis.

COURSE OBJECTIVES: This course aims to

1. Understand the concept Electric and Hybrid vehicles, and their advantages and disadvantages
2. Understand the Performance Characteristics of various types of hybrid electric vehicles, Knowledge of various energy storage systems of EV and EHV and energy management.
3. Develop and Optimise the design of propulsion motors for EV applications and knowledge of charging technologies.

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

1. Comprehend the models of describing Electric and hybrid vehicles their performance and future technology.
2. Asses the tractive effort required for EHV and EV with different vehicle parameters and optimization of powertrain.
3. Design optimization of Electric power train and implementation of charging technology.
4. Analyze the different possible ways of energy storage and battery selection.
5. Illustrate the principle of Hybrid Electric Vehicle, Battery Electric Vehicle and Plug-in EHV and able to prepare a business plans.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	1	-	-	-	3	1	1	1	2	2	-	-	1
CO 2	2	1	1	1	1	2	-	-	-	-	2	-	3	-	2
CO 3	2	2	1	1	2	-	2	1	2	2	3	2	3	3	2
CO 4	2	1	1	1	3	2	3	1	-	-	1	1	2	3	2
CO 5	3	-	1	1	-	2	3	1	2	2	-	2	2	3	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction: Conventional Vehicles: Basics of vehicle performance, Four Stroke and 2 Stroke IC Engine and their construction and operating principle, measures to improve IC Engine performance, vehicle power source characterization, transmission characteristics using clutch and gear box, gear ratio, Transmission Efficiency, Air pollution, global warming and climate change, EV Advantages, Introduction to Battery Electric Vehicle (BEV), Components and systems of Electric Vehicle, Performance of EVs , Govt. Policies and guidelines for implementation of electric mobility, Trends and challenges of implementation of electric mobility and startup opportunities.

UNIT-II

Hybrid Electric Vehicles: Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, Vehicle Mechanics, impact of modern drive-trains on energy supplies and Vehicle to grid (V2G) fundamentals. Electric Vehicle Modeling – Consideration of Rolling Resistance– Consideration of Vehicle Mass – Tractive Effort – Vehicle Acceleration –Selection and Sizing of the propulsion motor , Modeling Electric Vehicle Range, Plug-in electric vehicles, Hybrid electric drive for ship propulsion and military application, Hydrogen use in IC Engine vehicle . Operation of Hydrogen based IC Engine.

UNIT-III

Electric and Hybrid Power Trains: Basic concept of hybrid traction, introduction to various hybrid drive train topologies, concept of Series Hybrid, Parallel Hybrid and Series-Parallel Hybrid Vehicle model, different modes of operation, Basic concept of electric traction, Components and systems of HEV, Regenerative braking fundamentals, drive system efficiency. Vehicle to Grid(V2G)fundamentals, Self-driving Autonomous vehicle, Business plan preparation for EV/EHV start-up.

UNIT-IV

Energy Storage and Charging Technology: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage, basics of construction and chemical reactions in Lead-acid battery , Nickel-Cadmium, Nickel-Metal Hydride, Lithium based batteries, basics of Metal Air batteries, battery sizing, Fuel Cell based energy storage system, Super Capacitor based energy storage , Hybridization of energy storage batteries with Capacitor based energy storage devices, Different types of EV charging stations for battery charging, Wireless charging technology,

UNIT-V

Design, Analysis, Testing & Qualification of Propulsion Motor: PM Materials (NdFeB, SmCo, Ferrite and Alnico) .Properties of NdFEB, SmCo and Ferrite material w.r.t EV/EHV Requirements), Basic concepts of Design, Construction and analysis of water cooled/ Air-cooled PM Motor for EV and HEV, Outer rotor PM Motor drive, Permanent Magnet assisted Hybrid Reluctance Motor of EV, Basics of Axial Flux PM Motor Basic Design and construction Aspects of Induction Motors for EV and HEV, Qualification Testing methods and standards, basics of EMI & EMC applicable to EHV, Use of electromagnetic Software for design optimization of PM and Induction motor for EV/EHV.

TEXT BOOKS:

1. C. Mi, M. A. Masrur, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons, 2011.
2. S.Onori, L.Serrao and G.Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.
3. Mehrdad Ehsani, YiminGao, AliEmadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals”, CRC Press,2 010.

SUGGESTED READING:

1. James L arminie, “Electric Vehicle Technology Explained”, John Wiley & Sons, 2003
2. T.Denton,“Electric and Hybrid Vehicles”, Rout ledge, 2016
3. Allen Fuhs,”Hybrid Vehicles and the future of personal transportation”, CRC Press,2011.
4. XiZhang, ChrisMi,”Vehicle Power Management: Modeling, Control and Optimization”, Springer, 2011.
5. National Electric Mobility Mission Plan 2020 Released by DHI, Govt. of India.
6. Zero Emission Vehicles(ZEV) Towards a Policy Framework, NITI Aayog.
7. IEC and different IS and Eclectic Mobility Standards.
8. Hydrogen for future Thermal Engines by Efstathios - AI tingas edinliurgh UK.

22EEE55

ADVANCED POWER SYSTEM PROTECTION

(Program Elective - 5)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Prior knowledge of Power system protection and Mathematical background.

COURSE OBJECTIVES: This course aims to
1. Convey the operating principles and application aspects of static relays
2. Disseminate general principles of pilot protection and travelling wave relays.
3. Provide the architecture and the required mathematical background and algorithms for the design and development of digital relays

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Analyze the need and architecture of static relays
2. Comprehend different static relay principles used in power system protection
3. Distinguish various types of pilot protection schemes and their adaptability
4. Recognize the application of mathematics in power system protection.
5. Apply various algorithms used for the digital protection of power system.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	-	-	-	-	-	-	-	2	2	3	1
CO 2	2	2	1	1	-	-	-	-	-	-	-	2	2	3	1
CO 3	2	2	1	1	-	-	-	-	-	-	-	2	2	3	1
CO 4	3	3	1	1	-	-	-	-	-	-	-	2	2	3	1
CO 5	3	3	1	1	-	-	-	-	-	-	-	2	2	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT -I

Static Relays: Advantages and disadvantages, Comparators, Amplitude and Phase comparison schemes, Duality between Amplitude and Phase comparators, General equation for comparators for different types of relays, Static comparators, Coincidence circuits, Phase splitting methods, Hall effect comparators, Operating principles, Use of level detectors, Time delay circuits, Filters, Thyristors, Triggering circuits and DC power supplies.

UNIT -II

Static Relay Hardware: Operating principles, Static time current relays, Differential relays, Distance relays, Quadrilateral relay, Elliptical relay, Relay response, Principle of R-X diagram, Loss of synchronism and its effect on distance relays.

UNIT -III

Pilot Wire and Carrier Protection: Circulating current scheme, Balanced voltage scheme, Translay scheme, Half wave comparison scheme, Phase comparison carrier current protection, Carrier transfer scheme, Carrier blocking scheme, Digital protection of EHV/ UHV transmission line based upon Traveling wave phenomena.

UNIT -IV

Digital Relays, Mathematical Background: Finite difference techniques, Forward, Backward and Central difference interpolation, Numerical differentiation, Curve fitting and Smoothing, Fourier analysis, Walsh function analysis.

UNIT -V:

Digital Relay Algorithms: Sinusoidal wave based algorithms-Sample, First and Second derivative techniques, Least Squares-based algorithm: Integral LSQ fitting, Power series LSQ fitting, Multi-variable series LSQ

TEXT BOOKS:

1. S.R.Bhide "Digital Power System Protection" PHI Learning Pvt.Ltd.2014.
2. Madhavarao T.S., 'Power System Protection Static relays with microprocessor applications', Tata McGraw Hill, 2001

SUGGESTED READING:

1. A.T. Johns and S. K. Salman, "Digital Protection of Power Systems", IEEE Press,1999
2. Rebizant, Waldemar, Janusz Szafran, and Andrzej Wiszniewski, "Digital signal processing in power system protection and control" Springer, 2011.
3. A.G. Phadke and J. S. Thorp, "Computer Relaying for Power Systems", Wiley/Research studies Press, 2009.
4. Badriram and Viswakarma D.N., 'Power System Protection and Switchgear', Tata McGraw Hill, April, 2001.

22MBC01

ENGINEERING ECONOMICS & ACCOUNTANCY

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None

COURSE OBJECTIVES: This course aims to
1. To demonstrate the importance of Managerial Economics in Decision Making.
2. To explain the concept of Accountancy and provide basic knowledge on preparation of Final accounts.
3. To understand the importance of Project Evaluation in achieving a firm's Objective.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Apply fundamental knowledge of Managerial Economics concepts and tools.
2. Analyze various aspects of Demand Analysis, Supply and Demand Forecasting.
3. Understand Production and Cost relationships to make best use of resources available.
4. Apply Accountancy Concepts and Conventions and preparation of Final Accounts.
5. Evaluate Capital and Capital Budgeting decision based on any technique.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	3	1	1	1	1	1	1	1	-	-	1	1	3
CO 2	2	2	2	2	-	1	1	1	-	1	-	1	2	2	2
CO 3	1	2	1	2	2	-	2	1	-	1	-	-	1	2	1
CO 4	2	2	1	2	2	1	1	3	-	1	-	-	2	2	1
CO 5	1	3	1	2	1	1	2	-	-	1	2	1	1	3	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT - I

Introduction to Managerial Economics: Introduction to Economics and its evolution - Managerial Economics - its Nature and Scope, Importance, Relationship with other Subjects. Its usefulness to Engineers, Basic concepts of Managerial economics - Incremental, Time perspective, Discounting Principle, Opportunity Cost, Equimarginal Principle, Contribution, Negotiation Principle.

UNIT - II

Demand and Supply Analysis: Demand Analysis - Concept of Demand, Determinants, Law of demand - Assumptions and Exceptions, Elasticity of demand - Price, Income and Cross elasticity - simple numerical problems, Concept of Supply - Determinants of Supply, Law of Supply, Demand Forecasting - Methods.

UNIT - III

Production and Cost Analysis: Theory of Production - Production function - Isoquants and Isocosts, MRTS, Input-Output Relations, Laws of returns.

Cost Analysis: Cost concepts – Types of Costs, Cost-Output Relationship – Short Run and Long Run, Market structures – Types of Competition, Features of Perfect Competition, Price Output Determination under Perfect Competition, Features of Monopoly Competition, Price Output Determination under Monopoly Competition Break-even Analysis – Concepts, Assumptions, Limitations, Numerical problems.

UNIT - IV

Accountancy: Book-keeping, Principles and Significance of Double Entry Bookkeeping, Accounting Concepts and Conventions, Accounting Cycle, Journalization, Ledger accounts, Trial Balance concept and preparation of Final Accounts with simple adjustments.

UNIT - V

Capital and Capital Budgeting: Capital and its Significance, Types of Capital, Estimation of Fixed and Working capital requirements, Methods and sources of raising finance. Capital Budgeting, Methods: Traditional and Discounted Cash Flow Methods - Numerical problems.

TEXT BOOKS:

1. Mehta P.L."Managerial Economics: Analysis, Problems and Cases", Sultan Chand & Son's Educational publishers, 2016.
2. Maheswari S.N. "Introduction to Acco untancy", Vikas Publishing House, 12th Edition, 2018.

SUGGESTED READING:

1. Panday I.M. "Financial Management", 11th edition, Vikas Publishing House, 2016.
2. Varshney and K L Maheswari, "Managerial Economics", Sultan Chand, 2014.
3. M. Kasi Reddy and S. Saraswathi, "Managerial Economics and Financial Accounting", Prentice Hall of
4. India Pvt Ltd, 2007.
5. A.R. Aryasri, "Managerial Economics and Financial Analysis", McGraw-Hill, 2018.

22EEC29

ELECTRICAL SIMULATION LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisites: Prior Knowledge of "Electrical Circuit Analysis, Control Systems, Power Systems and Artificial Intelligence Techniques" is expected from students.

COURSE OBJECTIVES: This course aims to

1. Understand the given control system's time response, frequency response and effects of various controllers.
2. Perform the load flows, transient stability studies, economic load dispatch and load frequency control in Power system.
3. Execute Mathematical Modelling of the Transmission Lines and to attempt the power systems economic operation using soft computing techniques.

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

1. Analyze the simulation of electrical circuits and access stability of control systems.
2. Accomplish the performance analysis of transmission lines and fault analysis of the power system.
3. Compute the system's time response and study the effects of various controllers.
4. Perform frequency response, stability studies, load flow analysis and optimal control.
5. Realize the power system operations using Artificial Neural Networks (ANNs) and heuristic techniques.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	1	-	-	-	-	-	-	-	1	3	3	2
CO 2	3	3	1	1	-	-	-	-	-	-	-	1	3	3	2
CO 3	3	3	1	1	-	-	-	-	-	-	-	1	3	3	2
CO 4	3	3	1	1	-	-	-	-	-	-	-	1	3	3	2
CO 5	3	3	1	1	-	-	-	-	-	-	-	1	3	3	2

1 - Slightly, 2 - Moderately, 3 - Substantially

LIST OF EXPERIMENTS:

1. Verification of Thevenin's and Norton's theorems using a simple network.
2. Simulation of time response of RLC circuits.
3. Determination of power angle diagram for salient and non-salient pole synchronous machine.
4. Time-domain analysis of second order LTI systems
5. Analysis of the effects of PID controllers on a given system.
6. Stability analysis of unity feedback control systems using Bode & Root Locus plots.
7. Computation of transmission line parameters for different conductor structures.
8. Performance analysis of various transmission lines.
9. Evaluate the load flow studies by the Gauss-Seidal and Newton-Raphson methods.
10. Analysis of various faults for a simple power system network.
11. Estimation of the critical clearing angle and fault clearing time of a simple power system.
12. Execute the economic load dispatch of three generating units by the lambda iteration method.
13. Simulation of load frequency control model of single-area system.
14. Formulation of a suitable ANN for load flow analysis using a given power system.
15. Solution to economic load dispatch using particle Swarm optimization.

Note: At least TEN experiments should be conducted in the Semester

22EEC30

PROJECT PART-I

Instruction	4P Hours per week
CIE	50 Marks
Credits	2

Prerequisites: Knowledge of preparing slides by using power point presentations, Capable of searching for suitable literature and Presentation skills.

COURSE OBJECTIVES: This course aims to

1. The student takes up investigative study in the broad field of Engineering / Technology, either fully theoretical / practical or involving both theoretical and practical.
2. The work to be assigned by the Department on an individual basis or two / three students in a group, under the guidance of a supervisor.
3. This is expected to provide a good initiation for the student(s) towards R&D.

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

1. List the various approaches to the selected problem.
2. Interpret the advantages and disadvantages of various approaches.
3. Apply the selected approach for simulating / modeling /designing the problem.
4. Analyse and write a report on the results of the simulation / modeling of the problem selected.
5. Justify and present the results of the simulation / modeling / design before the departmental committee.

The objective of Project Part-1is to enable the student take up investigative study in the broad field of Engineering / Technology, either fully theoretical / practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two / three students in a group, under the guidance of a supervisor. This is expected to provide a good initiation for the student(s) towards R&D. The work shall include:

1. Survey and study of published literature on the assigned topic,
2. Working out a basic approach to the Problem relating to the assigned topic,
3. Conducting a preliminary Analysis / Modelling / Simulation / Experiment / Design / Feasibility,
4. Preparing a Written Report on the Study conducted for Presentation to the Department,
5. Final Seminar, as oral Presentation before the departmental Committee.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	2	2	2	2	3	3	2	2	2			
CO 2	2	2	2	2	2	1	1	2	1	1	1	2			
CO 3	3	2	2	2	3	1	1	2	2	2	2	2			
CO 4	3	3	3	2	2	2	2	2	2	2	2	2			
CO 5	3	3	2	3	3	2	1	2	2	3	2	3			

1 - Slightly, 2 - Moderately, 3 - Substantially

Guidelines for the Award of Marks: Max. Marks: 50

Evaluation by	Max. Marks	Evaluation Criteria / Parameter
Supervisor	20	Project Status / Review
	5	Report
Departmental Committee	5	Relevance of the Topic
	5	PPT Preparation
	5	Presentation
	5	Question and Answers
	5	Report Preparation

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
(Inline with AICTE Model Curriculum with effect from AY 2027-28)(R22A)

SEMESTER – VIII

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22EEExx	**PE-6**	3	-	-	3	40	60	3
2	22xxExx	**OE-3**	3	-	-	3	40	60	3
PRACTICAL									
5	22EEC31	Technical Seminar	-	-	2	-	50	-	1
6	22EEC32	Project Part-II	-	-	8*	-	100	100	4
Total			**6**	**-**	**10**		**230**	**220**	**11**
Clock Hours Per Week: 16									

L: Lecture **D:** Drawing **CIE:** Continuous Internal Evaluation
T:Tutorial **P:** Practical/ Project Seminar/ Dissertation **SEE:** Semester End Examination

*****180 hrs for the students working on the paid internship during VIII SEM

List of Program Electives: SEMESTER – VIII

S.No	List of Courses Offered in Program Elective-6 (PE-6)	
	Course Code	**Title of the Course**
1	22EEE61	Electricity and Safety Measures
2	22EEE62	Electrical Estimation and Costing
3	22EEE63	DC Microgrid
4	22EEE64	Big Data Analytics for Smart Grid
5	22EEE65	Energy auditing and management

22EEE61

ELECTRICITY AND SAFETY MEASURES

(Program Elective-6)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basic knowledge in Basic Electrical Engineering

COURSE OBJECTIVES: This course aims to

1. Understand the Electricity standards and its safety
2. Understand use of fire extinguishers in different applications
3. Understand the specification of electrical plants

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

1. Demonstrate the Indian power sector organization and Electricity rules.
2. Evaluate the electrical safety in residential, commercial, agriculture, hazardous areas and use of fire extinguishers.
3. Realize the electrical safety during installation, testing and commissioning procedure.
4. Understanding the specification of electrical plants and classification of safety equipment for various hazardous locations.
5. Analyze various fire extinguishers and their classification.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	-	-	-	-	-	-	-	-	-	1	3	-	2
CO 2	2	2	1	-	-	-	-	-	-	-	-	1	3	-	-
CO 3	2	3	1	-	-	-	-	-	-	-	-	-	3	3	2
CO 4	2	2	1	-	-	-	-	-	-	-	-	1	2	-	2
CO 5	2	2	1	-	-	-	-	-	-	-	-	1	2	-	-

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction To Electrical Safety, Shocks And Their Prevention: Terms and definitions, objectives of safety and security measures, Hazards associated with electric current and voltage, who is exposed, principles of electrical safety, Approaches to prevent Accidents, scope of subject electrical safety. Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, residential buildings and shop.

UNIT-II

Electrical Safety in Residential, Commercial and Agricultural Installations: Wiring and fitting –Domestic appliances –water tap giving shock –shock from wet wall –fan firing shock –multi-storied building – Temporary installations – Agricultural pump installation –Do's and Don'ts for safety in the use of domestic electrical appliances.

UNIT-III

Electrical Safety during Installation, Testing and Commissioning, Operation and Maintenance: Preliminary preparations –safe sequence –risk of plant and equipment –safety documentation –field quality and safety -personal protective equipment –safety clearance notice –safety precautions –safeguards for operators – safety.

UNIT-IV

Electrical Safety in Hazardous Areas: Hazardous zones –class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements – Specifications of electrical plants, equipment's for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours – classification of equipment/enclosure for hazardous locations.

UNIT-V

Fire Extinguishers: Fundamentals of fire-initiation of fires, types, extinguishing techniques, prevention of fire types of fire extinguishers, fire detection and alarm system, CO_2 and Halogen gas schemes, foam schemes.

TEXT BOOKS:

1. Rao, S. and Saluja, H.L., "Electrical Safety, Fire Safety Engineering and Safety Management", Khanna Publishers, 1988.
2. Cooper.W.F, "Electrical safety Engineering", Newnes-Butterworth Company, 1978.

SUGGESTED READING:

1. John Codick, "Electrical safety hand book", McGraw Hill Inc., New Delhi, 2000.
2. Nagrath, I.J. and Kothari, D.P., "Power System Engineering", Tata McGraw Hill, 1998.
3. Wadhwa, C.L., "Electric Power Systems", New Age International, 2004.Suggested Reading:

22EEE62

ELECTRICAL ESTIMATION AND COSTING

(Program Elective-6)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: The student should have prior knowledge on basic electrical engineering, switchgear and protection

COURSE OBJECTIVES: This course aims to

1. Emphasize the estimation and costing aspects of all electrical installation and designs.
2. Discuss the estimation of overhead transmission and distribution system and its components.
3. Discuss types of substations, main components, and estimation of substation.

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

1. Explain general principles of estimation and major applicable I.E. rules.
2. Understand the concepts related to electrical wiring and wiring accessories.
3. Estimate electrical installation and costing for internal wiring.
4. Understand the components and estimate the materials required to Design Electrical Installation of Substation, Transmission and Distribution lines.
5. Identify and design the various types of light sources for different applications.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	-	-	-	3	-	2	-	-	-	1	3	-	1
CO 2	2	1	-	-	-	3	1	-	-	-	-	1	3	-	1
CO 3	2	2	1	1	-	3	1	2	-	-	-	1	3	-	1
CO 4	2	2	1	1	-	3	1	2	-	-	-	1	3	-	1
CO 5	2	2	1	1	-	3	1	2	-	-	-	1	3	-	1

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT -I:

General Principles of Estimating: Estimating, Purpose of Estimating and Costing, Electrical schedule, Catalogues, Market Survey and Source Selection, Recording of Estimates, Determination of Required Quantity of Material, Labour Conditions, Determination of Cost Material and Labour, Contingencies, Overhead Charges, Profit, Purchase System, Purchase Enquiry and Selection of Appropriate Purchase Mode, Comparative Statement, Purchase Orders, Payment Of Bills, Tender Form. General Idea about IE Rule, Indian Electricity (IE) Act and IE Rules -29,30,45,46,47,50,51,54,55,77 and79.

UNIT -II:

Wiring Systems: Introduction, Systems of Distribution of Electrical Energy, Methods of wiring, Systems of Wiring, Choice of Wiring Systems.

Wiring Materials and Accessories: Wire and Cable, Conductor Materials used in Cables, Insulating Materials, Types of Cables used in internal wiring, Multi strand Cables, Voltage grading of Cables, General Specifications of Cables, Main Switch, Distribution Boards, Conduits, Conduit Accessories and Fittings, Lighting Accessories and Fittings, Important Definition, Determination of size of Fuse Wire, Earthing Conductors.

UNIT -III:

Internal Wiring Estimation: General Rules for Wiring, Determination of number of points (Light, Fan, Socket Outlets), Determination of total load, determination of number of sub circuits, determination of ratings of main switch and Distribution Board, Determination of size of conductor, approximate current density for

determination of size of cable for internal wiring for Indian Conditions keeping in view of the reasonable voltage drop. Layout and Problems

UNIT -IV:

Estimation Of Overhead Transmission & Distribution Lines: Introduction, Typical AC electrical power system, Main components of overhead lines, Line supports-Factors governing height of pole, Determination of size of conductor for overhead transmission line, Conductors configuration, spacing and clearances, Span lengths, Points to be considered at the time of erection of overhead lines, Erection of supports, setting of stays, fixing of cross arms, and insulators, Conductor erection, Repairing and jointing, Dead end clamps, Positioning of conductors and attachment to insulators Jumpers, Tee-offs, Earthing of transmission lines. Guarding of overhead lines, Clearances of conductor from ground Spacing between conductors. Testing and commissioning of overhead distribution lines, some important specifications.

UNIT -V:

Estimation of Substations: Introduction, Types of substations, Outdoor substation – Pole mounted type, Indoor substations, Floor mounted type, Equipment for Substations and Switchgear Installations. Preparing an estimate for substation Material Design of Illumination Schemes: Introduction, Terminology in illumination, laws of illumination, various types of light sources, estimation and costing of lighting schemes.

TEXT BOOKS:

1. "K. B. Raina, S. K. Bhattacharya", "Electrical Design Estimating and Costing", New Age International Publisher, 2018
2. Er. V. K. Jain, Er. Amitabh Bajaj", "Design of Electrical Installations", University Science Press.
3. Gupta J. B., Katson, Ludhiana", "Electrical Installation, estimating and costing", S. K. Kataria and sons, 2013.
4. "Surjit Singh", "Electrical Estimation and Costing". Dhanpatrai & Co. second edition, 2001.

SUGGESTED READING:

1. Code of practice for Electrical wiring installations (System voltage not exceeding 650 volts), Indian Standard Institution, IS: 732-1983.
2. Guide for Electrical layout in residential buildings, Indian Standard Institution, IS: 4648-1968.
3. Electrical Installation buildings Indian Standard Institution, IS: 2032.

22EEE63

DC MICROGRID

(Program Elective-6)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Power electronics, Power system and Control system

COURSE OBJECTIVES: This course aims to:

1. Study the basics of AC and DC Microgrid systems in real time power systems.
2. Familiarize with different converter modeling's, operation and standards.
3. Analyze the dynamics, Architecture control and stability of Microgrid system

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

1. Understand the basics of Conventional vs. Microgrid power system and difference in AC and DC Microgrid
2. Analyze the modeling of converters in Microgrid power system with different topologies
3. Apply the Microgrid Operation Modes, Standards and Power Electronic Converters in Microgrid Applications
4. Explain the different Microgrid control Architecture and Energy Management in Microgrid System
5. Analyze the Control of DC Microgrid System and different DC Microgrid stabilization strategies

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	-	-	-	-	-	-	-	-	1	3	-	2
CO 2	3	1	1	-	-	-	-	-	-	-	-	1	3	-	2
CO 3	3	2	1	-	-	-	-	-	-	-	-	1	3	-	2
CO 4	3	2	1	-	-	-	-	-	-	-	-	1	3	-	2
CO 5	2	2	1	-	-	-	-	-	-	-	-	1	3	-	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Overview of Microgrid: Overview of Microgrid , Concept of Microgrid , Microgrid and distributed generation, Microgrid vs Conventional Power System , AC and DC Microgrid with Distributed Energy Resources.

UNIT-II

Modeling of Converters in Microgrid: Modeling of converters in Microgrid power system (AC /DC and DC/AC Converters Modeling), Modeling of Power Converters in Microgrid Power System (DC/DC Converter Modeling and Control) , Modeling of Renewable Energy Resources (Modeling of Wind Energy System, Photovoltaic System), Modeling of Energy Storage System

UNIT-III

Microgrid Operation Modes and Standards: Microgrid Dynamics and Modeling, Microgrid Operation Modes and Standards, Power Electronics for Microgrid, Power Electronic Converters in Microgrid Applications

UNIT-IV

Microgrid Control Architecture: Microgrid Control Architectures, Intelligent Microgrid Operation and Control, Energy Management in Microgrid System, DC Microgrid System Architecture and AC Interface, DC Microgrid Dynamics and Modeling

UNIT-V

Control and Stability Analysis of DC Microgrid: Control of DC Microgrid System, Applications of DC micro grids, Stability in Microgrid, Stability Analysis of DC Microgrid, DC Microgrid stabilization strategies (passive damping method, Impedance, Admittance stability criteria), DC Microgrid stabilization using nonlinear Techniques, General Summary of DC micro grids

TEXT BOOKS:

1. Nikita Gupta, Mahajan Sagar Bhaskar, Sanjeevi kumar Padmanaban, Dhafer Almakhles, "DC Microgrids: Advances, Challenges, and Applications", Wiley Publications, 2022
2. Hassan Bevrbani, Bruno François , ToshifumiIse, "Microgrid Dynamica and Control", Wiley Publications, 2017

SUGGESTED READING:

1. Vivek Agarwal, Prajof Prabhakaran, M. Nawaz Hussin, "Introduction to DC Microgrids", IEEE Press, 2023

ONLINE RESOURCES:

1. https://archive.nptel.ac.in/noc/courses/noc21/SEM2/noc21-ee96/

22EEE64

BIG DATA ANALYTICS FOR SMART GRID

(Program Elective-6)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Power systems, Machine Learning, Smart Grid.

COURSE OBJECTIVES: This course aims to:

1. Explore the challenges and opportunities presented by the proliferation of data in various domains, focusing on Smart Grid applications.
2. Familiarize students with the lifecycle of Big Data analytics, including data discovery, preparation, modelling, and result communication.
3. Provide insights into clustering techniques and their application in Smart Grid analytics.

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

1. Understand the fundamentals of Big Data in Smart Grid.
2. Develop proficiency in Big Data analytics lifecycle stages and statistical inference techniques.
3. Demonstrate proficiency in applying clustering techniques to Smart Grid data sets.
4. Apply data science concepts such as stream computing and graph analytics to Smart Grid analytics.
5. Apply reinforcement learning methods to optimize control strategies in power distribution systems.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	1	1	1	2	2	2	-	-	1	3	2	3
CO 2	3	2	2	2	1	1	1	2	2	-	-	1	3	1	2
CO 3	2	2	2	1	1	1	1	1	1	-	-	1	3	1	1
CO 4	2	2	1	2	1	1	1	1	2	-	-	1	3	1	1
CO 5	1	2	1	1	2	2	1	1	1	-	-	1	3	1	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Big Data: Basics and need of Big Data, Data explosion, Best practices for Big data Analytics, Big Data characteristics, validating the promotion of the value of Big Data, perception and Quantification of value, understanding big data storage, Applications of Big Data in Smart Grid,

UNIT-II

Big Data Analytics Life cycle: Sources of Big Data, Benefits of Big Data processing, Big data challenges, Data Analytic life cycle: phase-1: Discovery, phase-2: Data Preparation, Phase-3: Model Planning, Phase-4: Model Building, Phase-5: Communicate Results, Phase-6: Operationalize, Statistical Inference: Hypothesis: Testing, Null and alternative Hypothesis, Chi-square tests, Decision Tree algorithms: ID3 algorithm, CART, Evaluating Decision Tree, Applications: Predictive Maintenance of Power System Equipment.

UNIT -III

Clustering and Its Application in Smart Grid: Overview of clustering, classification, K-means Clustering, Determining the number of clusters, Advantages and Disadvantages of clustering, centroid –based clustering, Hierarchical clustering, Density based cluster analysis, Distribution –based clustering and Principal Component Analysis (PCA), Baye's Theorem, Naïve Bayes classifier, Clustering application in Smart Grid.

UNIT-IV

Data Science Pertaining to Smart Grid Analytics: Introduction to streams concepts, Data streaming Management system, stream computing, Advantages and limitations of stream computing, Real Time Analytics Platform (RTAP), Graph Analytics, Application: Solar Generation Forecasting, Application: Electricity Price

Forecasting.

UNIT-V

Reinforcement Learning Methods: Elements of Reinforcement learning, Task, Q-learning, Non-deterministic rewards and actions of Q-learning, Finite Markov Decision Process, Tabular Solution Methods, Approximate Solution Methods, Temporal difference learning, Advantages and Disadvantages of Reinforcement learning methods, Reinforcement Learning based Control in Power Distribution Systems.

TEXT BOOKS:

1. James A. Momoh, "Smart Grid: Fundamentals of Design and Analysis", 1st Edition, Wiley- IEEE Press.
2. John Zelle and Michael Smith, "Python Programming", 3rd Edition, , Franklin Beedle & Associates Inc.
3. Andreas C. Mueller and Sarah Guido, "Introduction to Machine Learning with Python", O'Reilly Media, Inc.

SUGGESTED READING:

1. Phuong Vo.T.H, Martin Czygan, Ashish Kumar and Kirthi Raman, "Python: Data Analytics and Visualization", Packt Publishing Limited, 2017.
2. Alvaro Fuentes, "Become a Python Data Analyst: Perform exploratory data analysis and gain insight into scientific computing using Python", Packt Publishing Limited,2018
3. Rajkumar Viral, Divya Asija, Surender Salkuti, "Big Data Analytics Framework for Smart Grids", CRC Press, 2023.

ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc24_ee37/preview.
2. https://onlinecourses.swayam2.ac.in/arp20_ap10/preview

22EEE65

ENERGY AUDITING AND MANAGEMENT

(Program Elective-6)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Students should have prior knowledge on different Electrical Energy Generation systems, measuring instruments and basics of power systems

COURSE OBJECTIVES: This course aims to

1. Know the concept of Energy auditing
2. Understand various loads involved based on power consumption for auditing
3. Know about different audit instruments used in practice.

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

1. Demonstrate the ability to perform energy audit for buildings and commercial spaces.
2. Analyse energy conservation opportunities in electrical systems.
3. Apply energy-saving tips in domestic and office environments.
4. Identify potential energy savings in industrial and agricultural equipment
5. Apply computer-based tools for energy management.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	2	-	-	-	-	1	1	1	1	-
CO 2	2	1	3	2	1	2	-	-	-	-	1	1	1	2	-
CO 3	2	1	3	2	1	2	-	-	-	-	2	2	1	2	1
CO 4	2	1	2	2	1	2	-	-	-	-	2	2	1	1	1
CO 5	1	1	2	1	1	2	-	-	-	-	2	2	1	1	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Energy Auditing: Need for Energy Auditing, Types and objectives, Energy Auditing methodology, Energy Auditing for Buildings, Energy Auditing form for commercial buildings, Case study.

UNIT-II

Energy Audit of Electrical Equipment: Evaluation of energy conservation opportunities and environmental management- Preparation and presentation of energy audit reports, case studies for Induction motors, Transformers, Cables, Lighting, AC systems, Pumps, Capacitor banks and potential energy savings.

UNIT-III

Energy Conservation Aspects: Energy Conservation - Needs and Objectives, Energy Conservation in domestic sector, Energy Conservation tips in the kitchen and other domestic House, Energy Conservation opportunities in office,-Commercial buildings –ECO followed by various - Energy Conservation Organizations

UNIT-IV

Energy Conservation in Industrial and Agricultural Sector: Instrumentation: Energy Conservation in industrial Sector, Energy Conservation opportunities in HVAC system,

Energy saving potential in Industries–Boiler- Air compressors–Refrigeration System–Heat Exchanger–Electrical Drives–Pumps–Fans and Blowers-, Energy Conservation in Agricultural Sector, Energy Conservation opportunities in Pumps used in Agricultural Sector, Energy Conservation Tips for Agricultural applications.

UNIT-V

Energy Management Technology: Role of computers in Energy Management, Simulation as a Design Tool, Energy and Facility Management Software, Industrial Power Management System, Application Terminologies, Power & Energy Management Tools & Equipment

TEXT BOOKS:

1. Umesh Rathore , "Energy Management", S.K. Kataria & sons, 2nd edition.
2. KV Sharma & P. Venkataseshaiah, "Energy Management and Conservation", IK International Publishing House Pvt. Ltd.2011

SUGGESTED READING:

1. Tanuj Kumar Bishat. "SCADA and Energy Management system",2nd Edition S.K. Kataria& sons.
2. Giovanni Petrecca,"Industrial Energy Management: Principles and Applications", The Kluwer international series -207, 1999
3. Anthony J. Pansini, Kenneth D. Smalling, "Guide Electric Load Management". Pennwell Pub, 1998.
4. Howard E. Jordan, "Energy-Efficient Electric Motors and Their Applications", Plenum Pub Corp, 1994, 2nd Edition

ONLINE RESOURCES:

1. https://www.udemy.com/topic/energy-management/
2. https://www.udemy.com/course/tools-for-energy auditors/?utm_source=adwords&utm_medium=udemyads&utm_campaign=DSA_Catchall_la.EN_cc.INDIA&utm_content=deal4584&utm_term=_._ag_82569850245_._ad_533220805574_._kw__._de_c_._dm__._pl__._ti_dsa-41250778272_._li_9062143_._pd__.&matchtype=&gad_source=1&gclid=Cj0KCQjw8J6wBhDXARIsAPo7QA-xSK3NrdJaj-_2RyiJD3KTuCW1kN27TD8Hfd1zRPIQpRqDK24ntYIaAhUbEALw_wcB&couponCode=IND21PM

22EEC31

TECHNICAL SEMINAR

Instruction	2P Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1

Prerequisites: Student must have completed Project Part-I

COURSE OBJECTIVES: This course aims to
1. Introduce students to critical reading, understanding, summarizing, explaining and preparing report on state-of-the-art topics in a broad area of his/her specialization.
2. Seminar topics maybe chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.
3. Documenting the seminar report in a prescribed format.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Collect Organize, Analyze and Consolidate information about emerging technologies from the literature.
2. Exhibit effective communication skills, stage courage and confidence.
3. Demonstrate intra-personal skills.
4. Explain new innovations / inventions in the relevant field.
5. Prepare and experience in writing the Seminar Report in a prescribed format.

The goal of a seminar is to introduce students to critical reading, understanding, summarizing, explaining and preparing report on state-of-the-art topics in a broad area of his/ her specialization. Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

This seminar must be clearly structured and the power point presentation shall include following aspects:
1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:
1. Submit a one-page synopsis of the seminar talk for display on the notice board.
2. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for10 minutes.
3. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the department.

Seminars are to be scheduled from 3rdweek to the last week of the semester and any change in schedule shall be discouraged.

For the award of sessional marks, the students are judged by three (3) faculty members and are based on oral and written presentations as well as their involvement in the discussions during the oral presentation.

22EEC32

PROJECT PART-II

Instruction	12P Hours per week
Duration of SEE	Viva Voce
SEE	100 Marks
CIE	100 Marks
Credits	4

Prerequisites: Student must have earned the credit of 'Project: Part - 1'.

COURSE OBJECTIVES: This course aims to

1. Enable the student extend further the investigative study, either fully theoretical / practical or involving both theoretical and practical work.
2. The work shall be carried out under the guidance of a Supervisor from the Departmental one or jointly with a Supervisor drawn from R&D laboratory/Industry.
3. Preparing an Action Plan for conducting the investigation, including team work,

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

1. Recall the details of the approach for the selected problem.
2. Interpret the approach to the problem relating to the assigned topic.
3. Determine the action plan to conduct investigation.
4. Analyze and present the model/simulation / design as needed.
5. Evaluate, present and report the results of the analysis and justify the same.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	2	2	2	1	2	3	3	2	2	3	3	2
CO 2	3	3	3	3	3	2	2	3	3	3	2	2	3	3	3
CO 3	2	3	3	3	3	2	2	2	2	3	3	2	2	3	3
CO 4	3	3	3	2	2	2	2	2	2	2	2	2	3	3	3
CO 5	3	3	3	2	2	1	2	3	3	3	3	2	3	3	3

1 - Slightly, 2 - Moderately, 3 - Substantially

The objective of 'Project: Part-2' is to enable the student extend further the investigative study taken up, either fully theoretical / practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In depth study of the topic assigned,
2. Review and finalization of the Approach to the Problem relating to the assigned topic,
3. Preparing an Action Plan for conducting the investigation, including team work,
4. Detailed Analysis / Modelling / Simulation / Design / Problem Solving / Experiment as needed,
5. Final development of product / process, testing, results, conclusions and future directions,
6. Preparing a paper for Conference presentation / Publication in Journals, if possible,
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar presentation before the Departmental Committee.

Guide lines for awarding marks in CIE: (**Max.Marks:100**)

Evaluation by	**Max. Marks**	**Evaluation Criteria/Parameter**
Department Review Committee	10	Review1
	15	Review2
	25	Submission
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	10	Quality of the work which may lead to publications
	10	Report Preparation
	10	Analytical / Programming / Experimental Skills

Guidelines for awarding marks in **SEE**: (**Max.Marks:100**)

Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
External and Internal Examiners together	20	Power Point Presentation
	40	Thesis Evaluation
	20	Quality of the project • Innovations • Applications • Live Research Projects • Scope for future study • Application to society
	20	Viva-Voce

OPEN ELECTIVES OFFERED BY OTHER DEPARTMENTS

List of Open Elective Courses offered by other Departments under R22A Regulation to EEE department students.

S.No	Open Elective-1		
	Course Code	**Title of the Course**	**Offering Department**
1	22CSO02	Introduction to Data Base Management Systems	CSE
2	22ITO01	Object Oriented Programming Using JAVA	IT
3	22MEO01	Principles of Design Thinking	Mechanical
4	22EGO03	Indian Traditional Knowledge	English

S.No	Open Elective-2		
	Course Code	**Title of the Course**	**Offering Department**
1	22CSO01	Introduction to Web Technologies	CSE
2	22CIO03	Basics of Cyber Security	CET
3	22CHO01	Fuel Cells and Batteries	Chemical
4	22EGO01	Technical Writing Skills	English

S.No	Open Elective-3		
	Course Code	**Title of the Course**	**Offering Department**
1	22CEO02	Disaster Risk Reduction and Management	CIVIL
2	22CHO04	Environmental and Sustainable Development	Chemical
3	22PHO01	History of Science & Technology	Physics
4	22EGO02	Gender Sensitization	English

22CSO02

INTRODUCTION TO DATA BASE MANAGEMENT SYSTEMS

(Open Elective-1)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None

COURSE OBJECTIVES: This course aims to

1. Learn data models, conceptualize and depict a database system using E-R diagrams.
2. Understand the internal storage structures in a physical DB design.
3. Learn the fundamental concepts of transaction processing techniques.

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

1. Classify the difference between FMS and DBMS; describe the roles of different users and the structure of the DBMS. Design the database logically using ER modelling
2. Outline the schema of the relational database and key constraints. Develop queries using DDL, DML and DCL of SQL.
3. Identify the inference rules for functional dependencies and apply the principles of normal forms to decompose the relations in a database.
4. Summarize the concepts of dense, sparse, ISAM and B+ tree indexing and get familiar with states and properties of transactions.
5. Interpret the locking, time stamp, graph and validation-based protocols for concurrency control.
6. Summarize log-based recovery techniques to increase the robustness of the database, identify to resolve the deadlocks in the transactions.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	3	-	1	-	-	-	-	-	-	-	2			
CO 2	3	2	1	2	-	-	-	-	-	-	-	1			
CO 3	3	2	1	1	-	-	-	-	-	-	-	1			
CO 4	3	3	1	2	-	-	-	-	-	-	-	1			
CO 5	3	2	1	2	2	-	-	-	-	-	-	2			
CO 6	3	3	1	2	-	-	-	-	-	-	-	2			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction: Database System Applications, Purpose of Database Systems, View of Data, Database Languages, Database Users and Administrators Database System Architecture, Application Architectures.

Database Design and E-R Model: Basic concepts, Constraints, E-R Diagrams, E-R Design Issues, Extended E-R Features, Specialization and Generalization.

UNIT-II

Relational Model: Structure of Relational Databases, Database Schema, Keys.

Structured Query Language: Overviews, SQL Data Types, SQL Queries, Data Manipulation Language Set Operations, Aggregate Functions, Data Definition Language, Integrity Constraints, Null Values, Views, Join Expression.

UNIT-III

Relational Database Design: Undesirable Properties in Relational Database Design, Functional Dependencies, Trivial and Nontrivial Dependencies, Closure of Set of Functional Dependencies, Closure of Set of Attributes,

Irreducible Set of Functional Dependencies, Normalization – 1NF, 2NF, and 3NF, Dependency Preservation, BCNF, Comparison of BCNF and 3NF.

UNIT-IV

Indexing: Basic concepts, Dense and Sparse Indices, Secondary Indices, Tree-Structured Indexing, Indexed Sequential Access Method (ISAM), B+ Tree Index Files.

Transaction Management: Transaction Concept – ACID Properties, States of Transaction, Implementation of Atomicity and Durability, Serializability, Recoverability.

UNIT-V

Concurrency Control: Introduction, Lock-Based Protocols, Timestamp-Based Protocols.**Deadlocks Handling:** Deadlock Detection and Prevention. **Recovery System:** Failure Classification, Storage Structure, Recovery and Atomicity, Log-Based Recovery.

TEXT BOOKS:

1. Abraham Silberschatz, Henry F Korth, S Sudarshan, "Database System Concepts", Sixth Edition, McGraw-Hill International Edition, 2011.
2. Date CJ, Kannan A, Swamynathan S, "An Introduction to Database Systems", Eight Edition, Pearson Education, 2006.

SUGGESTED READING:

1. Raghu Ramakrishnan, JohnnesGehrke, "Database Management Systems", Third Edition, McGraw Hill, 2003.
2. Ramez Elmasri, Durvasul VLN Somayazulu, Shamkant B Navathe, Shyam K Gupta, "Fundamentals of Database Systems", Fourth Edition, Pearson Education, 2006.

22ITO01

OBJECT ORIENTED PROGRAMMING USING JAVA

(Open Elective-1)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None

COURSE OBJECTIVES: This course aims to

1. Familiarize with fundamentals of object-oriented programming paradigm.
2. Impart the knowledge of string handling, interfaces, packages and inner classes.
3. Acquaint with Exception handling mechanisms and Multithreading.
4. Gain knowledge on collection framework, stream classes.
5. Familiarize web application environment using Servlets and JSP

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

1. Understand fundamentals of object-oriented programming paradigm.
2. Apply knowledge of string handling, interfaces, packages and inner classes.
3. Implement Exception handling mechanisms and Multithreading.
4. Demonstrate knowledge on collection framework, stream classes.
5. Develop web applications using Servlets and JSP.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	2	1	-	-	-	-	-	-	1	-	-			
CO 2	-	2	1	1	-	-	-	-	-	-	-	-			
CO 3	-	1	1	1	-	-	-	-	-	-	3	-			
CO 4	1	2	1	1	-	-	-	-	-	-	3	1			
CO 5	1	2	1	2	3	-	-	1	3	-	3	1			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

OOP concepts: Data abstraction, encapsulation, inheritance, benefits of inheritance, polymorphism, classes and objects, Procedural and object oriented programming paradigms.

Introduction to Java: Java's Magic: The Byte code, The Java Buzzwords, Simple Java Programs, Java Primitive Types, Arrays: How to create and define arrays, Basic Operators, Control statements.

Introducing Classes: Declaring objects, methods, Constructors, this keyword, Method Overloading and Constructor Overloading, Objects as parameters, Returning objects, Use of static and final keywords.

UNIT-II

Inheritance: super and subclasses, Member access rules ,super keyword**,** Method overriding, Dynamic method dispatch , Abstract classes, using final with inheritance , Introduction to Object class.

Packages: Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages.

Interfaces: Defining and implementing interfaces, Nested Interfaces. **Strings Handling:** String & StringBuffer classes, StringTokenizer class and Wrapper classes and conversion between Objects and primitives.

Inner classes in Java: Types of inner classes, Creating static / non-static inner classes, Local and anonymous inner classes.

UNIT-III

Exception Handling in Java: what are Exceptions? Exception types**,** Usage of try, catch, throw, throws and finally clauses, writing your own exception classes. **Multi-threading in Java:** The java Thread Model, How to create threads, Thread class in java, Thread priorities, Thread synchronization.

Generics: What are Generics? Generic classes, bounded types, Generic methods and interfaces.

UNIT-IV

Collections Framework: Overview of Collection Framework, Commonly used Collection classes – Array List, Linked List, Hash Set, LinkedHashSet, Tree Set, Collection Interfaces –Collection, List, Set, Sorted Set, Accessing a collection via an Iteration, Storing user-defined classes in collections, Map Interfaces and Classes, Using a comparator. Legacy classes – Vector, Hash table, The Enumeration interface.

Input/Output : How to read user input (from keyboard) using scanner class,Stream classes, InputStream, OutputStream, FileInputStream, FileOutputStream, Reader and Writer, FileReader, FileWriter classes. File class.

UNIT-V

Java Servlets: Overview of Java Servlet API, Servlet Implementation, Servlet Configuration, Servlet Exceptions, Servlet Life cycle, Request and Response methods, Approaches to Session tracking, Servlet Context, Servlet Collaboration.

JSP Basics: Introduction to JSP, Directives, Scripting Elements, Standard Actions.

Databases: Connect servlet to MySQL, Connect JSP to MySQL.

TEXT BOOKS:

1. Herbert Schildt, "Java: The Complete Reference", 8th Edition, Tata McGraw Hill Publications, 2011.
2. Kathy Sierra, Bryan Basham, Bert Bates, ―Head First Servlets and JSP‖, 2nd Edition, O'Reilly Media, Inc, 2008.

SUGGESTED READING:

1. E Balagurusamy "Programming with JAVA", 6th Edition, Tata McGraw-Hill Publishing company Ltd,2019.
2. Sachin Malhotra & Saurabh Choudhary, "Programming in Java", 2nd Edition, Oxford University Press, 2014.
3. C. Thomas Wu, "An introduction to Object-oriented programming with Java", 4th Edition, Tata McGraw-Hill Publishing company Ltd., 2010. 4. Kathy Sierra, Bert Bates, "Head First Java: A Brain-Friendly Guide"2nd Edition, O'Reilly,2005

ONLINE RESOURCES:

1. https://www.cse.iitb.ac.in/~nlp-ai/javalect_august2004.html.
2. http://nptel.ac.in/courses/106106147/
3. https://ocw.mit.edu/courses/electrical-engineering-and-computerscience/6-092-introduction-to-programming-in-java-january-iap-2010/lecture-notes/

22MEO01

PRINCIPLES OF DESIGN THINKING

(Open Elective-1)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None

COURSE OBJECTIVES: This course aims to

1. Create awareness of design thinking approaches
2. Identify a systematic approach for defining/identifying a problem
3. Create design thinking teams and conduct design thinking sessions collaboratively
4. Apply both critical thinking and design thinking in parallel to solve problems
5. Motivate to apply design thinking concepts to their real life scenarios

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

1. Understand design thinking and its phases as a tool of innovation
2. Empathize on the needs of the users
3. Define the problems for stimulating ideation
4. Ideate on problems to propose solutions by working as a design thinking team
5. Prototype and test the proposed solutions focusing on local or global societal problems

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	1	1	1	2	2	2	2	2	2	2			
CO 2	1	1	2	1	2	2	2	2	1	2	2	2			
CO 3	1	1	2	2	1	2	2	2	1	2	2	1			
CO 4	2	1	2	2	1	2	2	2	1	2	2	2			
CO 5	2	1	2	2	1	2	2	2	1	2	2	2			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Engineering & Thinking: Engineering for social and economic development; impact of science/engineering. Thinking and behaviour; Types of thinking – Linear thinking, lateral thinking, systems thinking, design thinking.

Introduction to Design Thinking: Importance of Design Thinking & Human centric approach – Phases in design thinking process, five-stage model as iterative method, applications of design thinking in various domains.

UNIT-II

Empathize phase: Understanding the unique needs of the user, empathize with the users, steps in empathize phase, developing empathy towards people, assuming a beginner's mind-set (what? why?), steps in immersion activity, body storming; Case studies.

UNIT-III

Define phase: Define the problem and interpret the result, analysis and synthesis, Personas – Four different perspectives on Personas, steps to creating personas, problem statement, affinity diagrams, empathy mapping; Point of View – "How might we" questions, Why-how laddering; Case studies.

UNIT-IV

Ideation phase: What is ideation, need, uses, ideation methods; Brainstorming, rules for brainstorming; Mind maps, guidelines to create mind maps; Ideation games; Six Thinking Hats; Doodling, use of doodling in expressing creative ideas; Case studies.

UNIT-V

Prototyping phase: Types of prototyping, guidelines for prototyping, storytelling, characteristics of good stories, reaching users through stories, importance of prototyping in design thinking; Value proposition, guidelines to write value proposition; Case studies.

Testing phase: Necessity to test, user feedback, conducting a user test, guidelines for planning a test, how to test, desirable, feasible and viable solutions, iterate phase.

TEXT BOOKS:

1. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires, 1st Edition, HarperCollins, 2009.
2. Michael Luchs, Scott Swan, Abbie Griffin, Design thinking: New product development essentials from the PDMA. John Wiley & Sons, 2015.
3. Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solv ing, Penguin Random House India Private Limited, 2020.

SUGGESTED READING:

1. Jeanne Liedtka, Andrew King, Kevin Bennett, Solving problems with design thinking: Ten stories of what works. Columbia University Press, 2013.
2. Bala Ramadurai, Karmic Design Thinking - A Buddhism-Inspired Method to Help Create Human-Centered Products & Services, Edition 1, 2020.

22EGO03

INDIAN TRADITIONAL KNOWLEDGE

(Open Elective-1)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Knowledge of Indian Culture.

COURSE OBJECTIVES: This course aims to
1. Get knowledge in Indian Culture.
2. Know Indian Languages and Literature and the fine arts in India
3. Explore the Science and Scientists of Medieval and Modern India.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Understand philosophy of Indian culture.
2. Distinguish the Indian languages and literature.
3. Learn the philosophy of ancient, medieval, and modern India.
4. Acquire the information about the fine arts in India.
5. Know the contribution of scientists of different eras.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	2	1	1	2	3	3	2	2	1	2	1	1	1
CO 2	1	1	2	1	1	2	3	3	2	2	1	2	2	1	2
CO 3	1	1	2	1	1	2	3	3	2	2	1	2	1	1	1
CO 4	1	1	2	1	1	2	3	3	2	2	1	2	1	1	2
CO 5	1	3	2	1	1	2	3	3	2	2	2	3	2	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Culture and Civilization: Culture, Civilization and heritage, general characteristics of culture, importance of culture in human life, Cultural diversity, Aesthetics, Women seers, Indus culture, Indian Cuisine, Martial arts.

UNIT-II

Education System: Education in ancient, medieval and modern India, aims of education, subjects, Languages, Science and Scientists of ancient. Medieval and modern India, Concepts of Sciences in Indian Knowledge Systems.

UNIT-III

Linguistic Wealth: Indian languages and Literature: The role of Sanskrit, Morphology and brevity of Sanskrit, Concepts of NLP in IKS. Paleography, Fundamentals of Vedic Mathematics, Significance of scriptures to current society, Indian semantics and lexicography, Darshanas.

UNIT-IV

Art, Technology & Engineering: Sculpture, Painting and Handicrafts, Indian Music, Dance Drama and Theatre, introduction to Mayamatam, Iron and Steel technology, Use of metals in medicinal preparations.

UNIT-V

Science and Logic: Heliocentric system, Sulbasutras, Katapayadi, Engineering in Vedas, Adaptability of Sanskrit in Computer languages, Related commands Hindu calendar, 6 Pramanas in Indian logic, Scientific method applied to therapeutics, Fallacies, Tarka- Induction and deduction, Ayurvedic biology, Definition of health.

TEXT BOOKS:

1. B. Madhavan, Nagendra Pavana, Vinayak Rajat Bhat, "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning, June 2022.
2. Kapil Kapoor, "Text and Interpretation: The Indian Tradition", D K Print World Ltd., 2005.
3. Samskrita Bharati, "Science in Sanskrit",2017.
4. Satya Prakash, "Founders of sciences in Ancient India", Govindram Hasanand, 1986.

SUGGESTED READING:

1. Brajendranath Seal, "The Positive Sciences of the Ancient Hindus", Motilal Banarasidass, 2016.
2. Kancha Ilaiah, "Turning the Pot, Tilling the Land: Dignity of Labour in Our Times", Navayana, 2019.
3. Balram Singh and others, "Science & Technology in Ancient Indian Texts", D.K. Print World Ltd, 1st edition, 2012.
4. Smt. Kalpama Paranjepe, "Ancient Indian insight and Modern Science", Bhandarkar Oriental Research Institute, 1996.
5. Pradeep Parihar, "Vedic World and Ancient Science", World House Book Publishing, 2021.

22CSO01

INTRODUCTION TO WEB TECHNOLOGIES

(Open Elective-2)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Knowledge on a programming language.

COURSE OBJECTIVES: This course aims to

1. Acquire knowledge on HTML, Java Script and XML to develop client side web applications.
2. Learn developing web applications using Django.

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

1. Understand the technologies required for developing web application.
2. Identify and choose HTML tags, CSS and java scripts to develop well-structured and easily maintained web pages.
3. Design and Develop interactive and innovative web pages using various platforms/technologies like HTML, CSS, XML, JAVASCRIPT.
4. Create and deploy web applications in web server by using Django concepts.
5. Evaluate different web applications to implement optimal solutions for real time problems

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	3	2	2	1	1	1	1	2	3	1	3			
CO 2	2	3	2	2	1	1	1	1	2	3	1	3			
CO 3	2	3	2	2	1	1	1	1	2	3	1	3			
CO 4	2	3	2	2	1	1	1	1	2	3	1	3			
CO 5	2	3	3	2	1	1	1	1	2	3	1	3			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Web Basics: WWW Browsers, Web Servers, URL, MIME, HTTPS.

Introduction HTML5: basic tags, Images, Tables, Lists, Forms, Layout, Graphics, span and div tags. Grid, Cascading Style Sheets.

UNIT-II

The Basics of Java script: Primitive operations and Expressions, Arrays, Functions, Pattern Matching Using Regular Expressions, Document Object Model, Element Access in JavaScript, Events and Event Handling, Handling Events from Body, Button, Text Box and Password Elements.

Dynamic Documents with Java Script: Positioning Elements, Moving Elements, float and clear.

UNIT-III

XML: Introduction, uses of XML, the Syntax of XML, XML Document Structure, Namespaces, XML schemas, displaying Raw XML Documents, displaying XML documents with CSS, JSON, XML vs JSON.

UNIT-IV

Django: Introduction, Models, Templates, supported data bases, URL configuration. Templates, Modifying and Improving the Templates, Creating a Form.

UNIT-V

Applications: Introduction to Ajax, Node.js and.

Bootstrap: Introduction to Bootstrap, bootstrap grid, bootstrap components.

Web Application Frameworks: React JS, JQuery.

TEXT BOOKS:

1. HTML5 Black Book (Covers CSS3, JavaScript, XML, XHTML, AJAX, PHP, jQuery), Dreamtech, 2017.
2. Adrian Holovaty and Jacob Kaplan-Moss" The Definitive Guide to Django Web Development Done Right", après-2009
3. P. J. Deitel - Deitel, H. M. Deitel - Deitel, "Internet & World Wide Web How To Program", 5th Edition, Prentice Hall, 2007.
4. Miguel Grinberg , "Flask Web Development", First edition-2014.

SUGGESTED READING:

1. Web Technologies, Uttam K Roy, Oxford University Press
2. Chris Bates, "Web Programming, building internet applications", 2nd edition, John Wiley & Sons, 2010.
3. JavaScript for Modern Web Development: Building a Web Application Using HTML, CSS, and JavaScript, by Alok Ranjan, Abhilasha Sinha, Ranjit Battwad, BPB, 2020.

ONLINE RESOURCES:

1. https://www.w3.org/standards/webdesign/
2. https://www.w3schools.com/angular/
3. https://www.w3schools.com/jquery/default.asp
4. https://www.tutorialspoint.com/flask/index.htm
5. https://www.tutorialspoint.com/web2py/index.htm
6. https://www.tutorialspoint.com/fuelphp/index.htm

22CIO03

BASICS OF CYBER SECURITY

(Open Elective-2)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basic knowledge on computer hardware and software components.

COURSE OBJECTIVES: This course aims to

1. Describe the foundational concepts of cybersecurity, including the CIA triad (Confidentiality, Integrity, Availability), and explain their importance in information security practices.
2. Demonstrate understanding of various cyber offenses by explaining the methods used by criminals to plan and execute cyber-attacks.
3. Understand the legal perspective of Cyber Security.
4. Collect, process, analyse and present Computer Forensics Evidence.
5. Understand organizational implications of Cyber Security.

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

1. Demonstrate an understanding of cybersecurity by effectively analysing and evaluating the security implications of various scenarios.
2. Identify and describe different types of cyber offenses, understand the techniques used by cybercriminals, and analyse the potential impact of these attacks on individuals, organizations, and society.
3. Analyse and evaluate the legal framework of cyber laws in India.
4. Analyse the significance of digital evidence in cyber forensics.
5. Evaluate the organizational implications of cyber security by assessing the costs associated with cybercrimes.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	2	2	2	3	1	3	3	3	2	3			
CO 2	2	3	2	2	3	3	1	3	3	3	2	3			
CO 3	1	2	2	2	1	3	1	3	2	3	3	3			
CO 4	2	2	2	2	3	3	1	3	3	3	3	3			
CO 5	2	2	2	2	2	3	1	3	3	3	3	3			

1 - Slightly, 2 - Moderately, 3 – Substantially

UNIT-I

Introduction to Cyber Crime: Cyber Crime: Definition and Origins of the Word, Cybercrime and Information Security, Classification of Cyber Crimes.

Cyber Security Fundamentals: Definition and importance of cybersecurity, CIA triad: Confidentiality, Integrity, Availability, Security design principles: defence-in-depth, least privilege, separation of duties.

UNIT-II

Cyber Offenses: Introduction, How Criminals plan the Attacks, Social Engineering, Cyber stalking, Cyber Cafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector.

Tools and Methods Used in Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Password Managers, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow

UNIT-III

Cyber Laws: The Legal Perspectives, Need of Cyber laws: the Indian Context, The Indian IT Act, Amendments of Indian IT Act, Challenges to Indian Law and Cyber Crime Scenario in India.

UNIT-IV

Understanding Cyber Forensics: Need for Computer Forensics, Cyber Forensics and Digital Evidence, Forensics Analysis of Email, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Cyber Forensics Investigation, Challenges in Computer Forensics.

UNIT-V

Cyber Security Organizational Implications: Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications, Social media marketing: Security Risks and Perils for Organizations.

Capstone Project: Group project: analyse a real-world cyber-attack, develop a mitigation strategy, and present findings to the class.

TEXT BOOKS:

1. Sunit Belpre and Nina Godbole, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley India Pvt.Ltd, 2011.
2. William Stallings," Cryptography and Network Security - Principles and Practice", Pearson Education, 6th Edition,2013.
3. Whitman, M., & Mattord, H."Principles of information security" (6th ed.). CENGAGE Learning Custom Publishing, 2017.

SUGGESTED READING:

1. Alfred Basta, Nadine Basta, Mary Brown, Ravinder Kumar, "Cyber Security and Cyber Laws", Paperback – 2018.
2. Kevin Mandia, Chris Prosise, "Incident Response and computer forensics", Tata McGraw Hill, 2006.

ONLINE RESOURCES:

1. https://www.coursera.org/courses?query=cybersecurity&productDifficultyLevel=Beginner
2. https://onlinecourses.swayam2.ac.in/nou19_cs08/preview

22CHO01

FUEL CELL AND BATTERIES

(Open Elective-2)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None

COURSE OBJECTIVES: This course aims to

1. Create awareness about alternate clean fuel available.
2. Evaluate the concepts and chemistry of fuel cell
3. Examine the details of fuel used in fuel cell technology
4. Explain the application of fuel cell in different sectors
5. Evaluate the fuel cell system balance plant and future opportunities

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

1. Apply know-how of thermodynamics, electrochemistry and principle of fuel cell
2. Understand the different types of fuel cell
3. Understand the components of hydrogen-based fuel cell
4. Explain the application of fuel cell in transport, stationary and portable sector
5. Understand the impact of this technology in a global and societal context

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	-	-	2	3	-	-	-	1	2	3	2	
CO 2	3	3	3	-	-	2	2	-	-	-	1	2	3	3	
CO 3	3	3	3	-	-	2	2	-	-	-	1	2	3	3	
CO 4	3	3	3	-	-	2	2	-	-	-	1	2	3	2	
CO 5	3	3	3	-	2	2	3	-	-	-	1	2	3	2	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction: Electrochemical Systems and Fuel Cell, Fuel Cell Fundamentals and Basic Concepts, Fuel Cell Degradation, Fuel Cell Operation, Types Of Fuel Cell And Its Applications: Direct Carbon Fuel Cell, Solid Oxide Fuel Cell, Polymer Electrolyte Fuel Cell, Alkaline Fuel Cell, Phosphoric Acid Fuel Cell, Molten Carbonate FuelCell, Fuel Cell Thermodynamics - Heat, Work Potentials, Prediction of Reversible Voltage, Fuel Cell Efficiency.

UNIT-II

Fuels and Fuel Processing: Introduction, Feedstock for H_2 production: Natural gas, Liquefied petroleum gas, Liquid hydrocarbon Fuels: Gasoline and Diesel, Alcohols- Methanol and Ethanol, Ammonia, Biomass, Fuel processing for fuel cell applications: Desulfurization, fuel reforming, water gas shift reaction, Carbon monoxide Removal.

UNIT-III

Fundamental and Components of Portable Hydrogen Fuel Cell: Introduction, PEM Fuel cell Components and their properties: Membrane, Electrode, Gas diffusion layer, Bipolar plates, Stack design principles, system design, performance analysis, current/voltage, voltage efficiency and power density, ohmic resistance, direct methanol and other non-hydrogen fuel cells, biofuel cell

UNIT-IV

Application of Fuel Cell: Hydrogen fuel cell use in transport, stationary Fuel cell characterization: - in-situ and ex- situ characterization techniques, i-V curve, frequency response analyses; Fuel cell modelling and system integration:- 1D model - Analytical solution and CFD models.

UNIT-V

Balance of plant and commercialization issues, Future Opportunities, obstacles and challenges associated in fuel cellsystems, impact of this technology in a global and societal context

TEXT BOOKS:

1. Nigel M. Sammes ,Fuel Cell Technology, Reaching Towards Commercialization, Springer London, 2006.
2. David A Berry, Dushyant Shekhawat, J.J. Spivey, Fuel Cells: Technologies for FuelProcessing, , Elsevier Science, 2011.

SUGGESTED READING:

1. Shigenori Mitsushima, Viktor Hacker Fuel Cells and Hydrogen, From Fundamentals to Applied Research, Elsevier Science, 2018.

22EGO01

TECHNICAL WRITING SKILLS
(Open Elective-2)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Language proficiency and the ability to simplify complex technical concepts for a diverse audience.

COURSE OBJECTIVES: This course aims to
1. Process of communication and channels of communication in general writing and technical writing in particular.
2. Learn Technical Writing including sentence structure and be able to understand and use technology specific words.
3. Write business letters and technical articles.
4. Write technical reports and technical proposals.
5. Learn to write agenda, record minutes of a meeting, draft memos. Understand how to make technical presentations.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Communicate effectively, without barriers and understand aspects of technical communication.
2. Differentiate between general writing and technical writing and write error free sentences using technology specific words.
3. Apply techniques of writing in business correspondence and in writing articles.
4. Draft technical reports and technical proposals.
5. Prepare agenda and minutes of a meeting and demonstrate effective technical presentation skills.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	2	1	1	-	1	1	2	3	3	2	3	1	2	1
CO 2	-	1	-	1	-	-	-	1	2	2	1	2	-	1	1
CO 3	-	2	-	2	-	1	1	1	2	3	2	2	1	1	2
CO 4	2	2	1	3	-	2	2	1	3	3	2	2	1	2	2
CO 5	1	1	1	1	-	1	1	1	3	3	2	2	1	2	2

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I
Communication – Nature and process.
Channels of Communication – Downward, upward and horizontal communication. Barriers to communication.
Technical Communication – Definition, oral and written communication. Importance and need for Technical communication. Nature of Technical Communication. Aspects and forms of Technical communication. Technical communication Skills – Listening, Speaking, Reading & Writing.

UNIT-II
Technical Writing – Techniques of writing. Selection of words and phrases in technical writing. Differences between technical writing and general writing. Abstract and specific words. Sentence structure and requisites of sentence construction. Paragraph length and structure.

UNIT-III
Business correspondence – Sales letters, letters of Quotation, Claim and Adjustment letters.
Technical Articles: Nature and significance, types. Journal articles and Conference papers, elements of technical articles.

UNIT-IV

Technical Reports: Types, significance, structure, style and writing of reports. Routine reports, Project reports.
Technical Proposals: Definition, types, characteristics, structure and significance.

UNIT-V

Mechanics of Meetings: Preparation of agenda, participation, chairing and writing minutes of a meeting. Memorandum. Seminars, workshops and conferences.
Technical Presentations: Defining purpose, audience and locale, organizing content, preparing an outline, use of Audio Visual Aids, nuances of delivery, importance of body language and voice dynamics.

TEXTBOOKS:

1. Meenakshi Raman & Sangeeta Sharma, "Technical Communications-Principles and Practice", Oxford University Press, Second Edition, 2012.
2. M Ashraf Rizvi, "Effective Technical Communication", Tata McGraw Hill Education Pvt Ltd, 2012.

SUGGESTED READING:

1. Kavita Tyagi & Padma Misra, "Basic Technical Communication", PHI Learning Pvt Ltd, 2012.
2. R.C Sharma & Krishna Mohan, "Business Correspondence and Report Writing", Tata McGraw Hill, 2003

ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc18_mg13/preview
2. https://www.technical-writing-training-and-certification.com/
3. https://academy.whatfix.com/technical-writing-skills

22CE O02

DISASTER RISK REDUCTION AND MANAGEMENT

(Open Elective-3)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None

COURSE OBJECTIVES: This course aims to

1. Equip the students with the basic knowledge of hazards, disasters, risks and vulnerable profile of India.
2. Impart knowledge in students about the nature, causes, consequences and mitigation measures, community involvement and construction techniques.
3. Introduce the concepts of emergency procedures, awareness creation and stress management.
4. Equip the students with the knowledge of the impact of disaster, chronological phases in a disaster management cycle and to create awareness about the disaster management framework and legislations in the context of central and state Level Authorities.
5. Enable the students to understand the structural and Non-structural measures for capacity building, disaster management 2005 regional and local issues.

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

1. Explain the fundamental concepts of disaster management.
2. Demonstrate the principles and practices of disaster risk reduction management.
3. Identify stress and its management during disaster.
4. Outline institutional frame work at different levels of administration.
5. Evaluate disaster management study including data search, analysis and presentation as a case study.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	-	-	-	-	2	3	-	-	-	-	1	-	-	-
CO 2	2	-	-	-	-	2	3	-	-	-	-	1	-	-	-
CO 3	2	-	-	-	-	2	3	-	-	-	-	1	-	-	-
CO 4	2	-	-	-	2	2	3	-	-	-	-	1	-	-	-
CO 5	2	-	-	-	-	2	3	-	-	-	-	1	-	-	-

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Fundamental concepts in disaster management: Hazard and disaster-concepts, vulnerability and risk, Hazard and disaster type – Natural, Water- related, pandemic and Human induced hazards disasters. Causes and Impacts of disasters – Impacts on natural eco systems: physical, psychological and social impact. Disaster and financial resilience. Disaster vulnerability profile of India –Specific to geographical regions and states (as per regional significance)

UNIT-II

Disaster Management Cycle: Rescue, Relief, Rehabilitation, Prevention, Mitigation and Preparedness. Disaster risk reduction (DRR). Community based DRR, institutions concerned with safety, disaster mitigation and construction techniques as per Indian standards and Early warning systems

UNIT-III

Disaster Impacts Management: Trauma and stress management, First aid and emergency procedures Awareness generation strategies for the community on safe practices in disaster (as per regional significance)

UNIT-IV

Institutional framework of disaster management in India: NDMA-SDMA, NDRF, civic volunteers, and NIDM. Phases of disaster/risk management and post-disaster responses. Compensation and insurance Applications of remote sensing & GIS in disaster management. Components of disaster management. Preparedness of rescue and relief, mitigation, rehabilitation & reconstruction. Institutional frame work of disaster management in India

UNIT-V

Capacity building for disaster/damage mitigation: Structural and Nonstructural measures forcapacity building for disaster/damage mitigation. Disaster risk reduction strategies and national disaster management guidelines. Disaster management Act -2005. Regional issues as per regional requirement/university can take minimum two topics as per high powered committee

TEXT BOOKS:

1. Singh, R. (2017), "Disaster management Guidelines for Earth quakes, Landslides, Avalanches and Tsunami". Horizon Press publications.
2. Taimpo (2016), "Disaster management and preparedness". CRC Press Publications

SUGGESTED READING:

1. Nidhi, G.D. (2014), "Disaster management preparedness" .CBS Publications Pvt. Ltd.
2. Gupta, A.K.,Nair, S.S., Shiraz, A. and Dey, S. (2013), "Flood Disaster Risk Management-CBS Publications Pvt Ltd.
3. Singh, R. (2016), "Disaster management Guidelines for Natural Disasters" Oxford University Press Pvt. Ltd

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/124107010
2. https://onlinecourses.swayam2.ac.in/cec19_hs20/preview

22CH O04

ENVIRONMENTAL AND SUSTAINABLE DEVELOPMENT

(Open Elective-3)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None

COURSE OBJECTIVES: This course aims to

1. Have an increased awareness on issues in areas of sustainability
2. Understand the role of engineering & technology within sustainable development
3. Know the methods, tools and incentives for sustainable product service system development
4. Establish a clear understanding of the role and impact of various aspects of engineering decisions on environmental, societal and economic problems.
5. Communicate results related to their research on sustainable engineering

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

1. Understand the concept of sustainable engineering and its significance in addressing contemporary environmental challenges.
2. Explore the 4R concept of solid waste management and examine various tools and methodologies to assess and mitigate the environmental impacts of engineering activities.
3. Be aware of the principles and requirements of environmental management standards and their application in promoting environmental sustainability.
4. Analyze the challenges and opportunities associated with promoting sustainable habitats such as sustainable cities, sustainable transport, sustainable sources of energy conventional and sustainable materials for green buildings
5. Understand and evaluate the industrial processes through the principles of industrial ecology and industrial symbiosis.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	3	1	1	2	3	2	1	1	1	3	2	2	
CO 2	2	2	3	2	1	2	3	2	1	1	1	3	2	2	
CO 3	2	1	3	1	2	2	3	2	1	2	1	3	2	2	
CO 4	3	1	3	3	1	3	3	2	2	1	1	3	2	3	
CO 5	3	3	3	1	2	2	3	2	1	1	2	3	3	3	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction of sustainability- Need and concept of Sustainable Engineering, Social-environmental and economic sustainability concepts, Sustainable development and challenges, Sustainable Development Goals, Environmental acts and protocols – Clean Development Mechanism (CDM).

UNIT-II

Economic and social factors affecting sustainability, Effects of pollution from natural sources, Solid waste-sources, impacts, 4R (Reduce, Reuse, Recycling, Recover) concept, Ozone layer depletion, Global warming, Tools used to ensure sustainability in engineering activities such as environmental management systems and environmental impact assessment studies.

UNIT-III

Global, Regional and Local environmental issues, Carbon credits and Carbon trading, Carbon foot print, Environmental management standards, ISO 14000 series, Life cycle Analysis (LCA)-scope and goal, Procedures of EIA (Environment Impact Assessment) in India.

UNIT-IV

Basic concept of sustainable habitat-Sustainable cities, Sustainable transport, Sustainable sources of energy conventional and renewable sources, Green Engineering: Green buildings, Green materials for sustainable design, Methods for increasing energy efficiencies of buildings**.**

UNIT-V

Technology and sustainable development, Sustainable urbanization, Industrialization and poverty reduction, Social and Technological change, Industrial processes-material selection, Pollution prevention, Industrial ecology, Industrial symbiosis.

TEXT BOOK:

1. Rag R. L., Introduction to Sustainable Engineering, 2nd Ed, PHI Learning Pvt Ltd, 2016.
2. Allen D. T and Shonnard D. R., Sustainability Engineering Concepts, Design and Case Studies, 1 st Ed, Prentice Hall, 2011.

SUGGESTED READING

1. Bradley A. S, Adebayo A. O and Maria. P., Engineering Applications in Sustainable Design and Development, 1st Ed, Cengage Learning, 2016.
2. Krishna R. Reddy, Claudio Cameselle, Jeffrey A. Adams., Sustainable Engineering,1st Ed, Wiley, 2019.

22PYO01

HISTORY OF SCIENCE AND TECHNOLOGY

(Open Elective-3)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None

COURSE OBJECTIVES: This course aims to

1. Gain the knowledge about origin of science in the Stone Age and its progress during Antiquity period.
2. Familiar with scientific views in the Medieval period and during the Industrial revolution.
3. Aware of modern scientific developments from 19th century onwards.

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

1. Demonstrate the process of beginning of science and civilization, knowledge acquisition and philosophical approach of science and its advancements in the Stone Ages and Antiquity period.
2. Illustrate the advancements in science and technology in the medieval period across Asia and Arab countries and decline and revival of science in Europe.
3. Explain the scientific approach and its advances of the Europeans and how the role of engineer during the industrial revolution and the major advancements.
4. Make use of the advancements in the field of science and technology by adopting new philosophies of 19th and first half of 20th century in finding ethical solutions to the societal problems.
5. Interpret the changes in specializations of science and the technology and build the relation between information and society from second half of 20th century onwards.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	1	1	1	2	2	1	1	2	1	2			
CO 2	3	1	2	1	2	2	2	1	2	2	2	2			
CO 3	2	2	1	1	1	1	1	1	1	2	1	2	1	1	
CO 4	3	2	2	2	2	2	2	1	1	2	1	2	1	1	
CO 5	3	2	2	2	2	1	2	2	1	2	1	2	1	1	

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-1

Science – The Beginning (through 599 BCE): The Stone Ages, Knowledge among hunter gatherers, Agricultural Revolution and other revolutions, Civilizations, Major advance.

Science in Antiquity (600 BCE – 529 CE) : Philosophy- a precursor to science, Hellenistic world and the Roman Empire, other cultures of the period, Major advances.

UNIT-II

Medieval Science (530 CE – 1452 CE) : The decline of science in Europe, Science in China, Science and mathematics in India, Arab Science, Revival of science in Europe, Technology revolution of the Middle ages, Major advances.

The Renaissance and the Scientific Revolution (1453 CE-1659 CE) : Renaissance, Scientific Revolution, Technology, Major advances.

UNIT-III

Scientific Method: Measurement and Communication (1660 CE-1734 CE): Europe domination, the scientific method, Major advances.

The Industrial Revolution (1735 CE-1819 CE) : Industrial Revolution, Rise of the engineer, Major Advances.

UNIT-IV

Science and Technology in the 19th Century (1820 CE - 1894 CE) : Philosophical basis of 19th century science, Science and the public, Science and technology, Major advances.

Rise of Modern Science and Technology (1895 CE - 1945 CE): The growth of 20th century science, Ne philosophies, Quantum reality, Energy sources, Electricity : a revolution in technology, Major advances.

UNIT-V

Big Science and the Post-Industrial Society (1946 CE- 1972 CE) : Big science, specialization and changing categories, technology changes society, Major advances.

The Information Age: (1973 CE-2015 CE): Information and society, Globalization, The post-industrial society, Problems of the Information Age, Major Advances.

TEXT BOOKS:

1. Bryan Bunch and Alexander Hellemans, "The History of Science and Technology", Houghton Miffin Company (New York), 2004
2. JD Bernal, "Science in History", 4 Volumes, Eklavya Publishers, 2012

SUGGESTED READING:

1. Kara Rogers, "The 100 Most Influential Scientists of All Time", Britannica Educational Publishing, 2010
2. Alberto Hemandez, "A Visual History of Science and Technology", The Rosen Publishing Group, 2016.

22EGO02

GENDER SENSITIZATION

(Open Elective-3)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: No specific prerequisite is required

COURSE OBJECTIVES: This course aims to

1. Sensibility regarding issues of gender in contemporary India.
2. A critical perspective on the socialization of men and women.
3. Popular debates on the politics and economics of work while helping them reflect critically on gender violence.

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

1. Understand the difference between "Sex" and "Gender" and be able to explain socially constructed theories of identity.
2. Recognize shifting definitions of "Man" and "Women" in relation to evolving notions of "Masculinity" and "Femininity".
3. Appreciate women's contributions to society historically, culturally and politically.
4. Analyze the contemporary system of privilege and oppressions, with special attention to the ways in which gender intersects with race, class, sexuality, ethnicity, ability, religion, and nationality.
5. Demonstrate an understanding of personal life, the workplace, the community and active civic engagement through classroom learning.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	1	-	-	2	2	1	1	-	-	1	1	2	-
CO 2	-	-	1	-	-	2	2	1	1	-	-	1	1	2	-
CO 3	-	-	1	-	-	2	2	2	2	1	1	1	-	1	-
CO 4	-	-	1	-	-	3	2	2	2	1	1	1	1	2	-
CO 5	-	-	1	-	-	2	2	2	3	1	1	1	1	2	-

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Understanding Gender:

Gender: Why Should We Study It? (Towards a World of Equals: Unit -1)

Socialization: Making Women, Making Men (Towards a World of Equals: Unit -2)

Introduction, Preparing for Womanhood, Growing up Male, First lessons in Caste, Different Masculinities.

UNIT-II

Gender and Biology:

Missing Women: Sex Selection and Its Consequences (Towards a World of Equals: Unit -4)

Declining Sex Ratio. Demographic Consequences.

Gender Spectrum: Beyond the Binary (Towards a World of Equals: Unit -10)

Two or Many? Struggles with Discrimination.

UNIT-III

Gender and Labour:

Housework: the Invisible Labour (Towards a World of Equals: Unit -3)

"My Mother doesn't Work." "Share the Load."

Women's Work: Its Politics and Economics (Towards a World of Equals: Unit -7)

Fact and Fiction. Unrecognized and Unaccounted work. Additional Reading: Wages and Conditions of Work.

UNIT-IV
Issues of Violence
Sexual Harassment: Say No! (Towards a World of Equals: Unit -6)
Sexual Harassment, not Eve-teasing- Coping with Everyday Harassment- Further Reading: "Chupulu".
Domestic Violence: Speaking Out (Towards a World of Equals: Unit -8)
Is Home a Safe Place? -When Women Unite [Film]. Rebuilding Lives. Additional Reading: New Forums for Justice.
Thinking about Sexual Violence (Towards a World of Equals: Unit -11)
Blaming the Victim-"I Fought for my Life…." - Additional Reading: The Caste Face of Violence.

UNIT-V
Gender: Co - Existence
Just Relationships: Being Together as Equals (Towards a World of Equals: Unit -12)
Mary Kom and Onler. Love and Acid just do not Mix. Love Letters. Mothers and Fathers.
Additional Reading: Rosa Parks-The Brave Heart.

TEXT BOOK:
1. A. Suneetha, Uma Bhrugubanda, Duggirala Vasanta, Rama Melkote, Vasudha Nagaraj, Asma Rasheed, Gogu Shyamala, Deepa Sreenivas and Susie Tharu "Towards a World of Equals: A Bilingual Textbook on Gender"**,** Telugu Akademi, Hyderabad, 2015.

SUGGESTED READING:
2. Menon, Nivedita. "Seeing like a Feminist", Zubaan-Penguin Books, New Delhi, 2012.
3. AbdulaliSohaila,"I Fought For My Life…and Won", Available online at: http://www.thealternative.in/lifestyle/i-fought-for-my-lifeand-won-sohaila-abdulal/

ONLINE RESOURCES:
1. https://aifs.gov.au/publications/gender-equality-and-violence-against-women/introduction
2. https://theconversation.com/achieving-gender-equality-in-india

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OPEN ELECTIVES OFFERED BY EEE DEPARTMENT

List of Open Elective Courses offered by EEE Department under R22A Regulation to other departmental students.

S. No	Course code	Title of the course
1.	22EEO01	Energy Management System
2.	22EEO02	Energy Conservation
3.	22EEO03	Energy Resources, Economics and Environment
4.	22EEO04	Engineering Materials
5.	22EEO05	Energy Auditing
6	22EEO06	Waste Management
7	22EEO07	Fundamentals of Electric vehicles

22EEO01

ENERGY MANAGEMENT SYSTEM

(Open Elective)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None.

COURSE OBJECTIVES: This course aims to

1. Know the concept of Energy Management.
2. Understand the formulation of efficiency for various Engineering Systems
3. Enable the students to develop managerial skills to assess feasibility of alternative approaches and drive strategies regarding Energy Management

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

1. Know the current Energy Scenario and importance of Energy Conservation.
2. Understand the concepts of Energy Management, Energy Auditing.
3. Interpret the Energy Management methodology, Energy security and Energy Strategy.
4. Identify the importance of Energy Efficiency for Engineers and explore the methods of improving Energy Efficiency in mechanical systems, Electrical Engineering systems
5. Illustrate the Energy Efficient Technologies in Civil and Chemical engineering systems

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	-	-	1	-	1	2	1	-	-	-	1			
CO 2	2	1	1	1	-	1	2	1	-	-	-	1			
CO 3	2	2	2	1	-	1	2	1	-	-	-	1			
CO 4	2	2	1	2	2	1	2	1	-	-	-	1			
CO 5	1	1	2	1	1	1	2	2	-	-	-	1			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Various forms of Energy and its features: Electricity generation methods using different energy sources such as Solar energy, wind energy, Bio-mass energy, and Chemical energy such as fuel cells. Energy Scenario in India, Impact of Energy on economy, development, and environment sectors of national and international perspective.

UNIT-II

Energy Management-I: Defining Energy Management, need for Energy Management, Energy management techniques, importance of Energy Management, managing the Energy consumption, Energy Audit and Types, Energy Audit Instruments.

UNIT-III

Energy Management-II: understanding Energy costs, bench marking, Energy performance, matching energy use to requirement, optimizing the input, fuel & Energy substitution, material and Energy balance diagrams, Energy pricing, Energy and Environment, Energy Security

UNIT-IV

Energy Efficient Technologies-I: Importance of Energy Efficiency for Engineers, Energy Efficient Technology in Mechanical engineering: Compressed Air System, Heating, ventilation and air- conditioning, Fans and blowers, Pumps and Pumping Systems,

Energy Efficient Technology in Electrical engineering: Automatic Power Factor Controllers, Energy Efficient Motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic

ballast, occupancy sensors, energy efficient lighting controls, space cooling, energy efficiency of lifts and escalator, energy saving potential of each technology.

UNIT-V

Energy Efficient Technologies-II: Energy Efficient Technology in Civil Engineering: Intelligent Buildings, And Various Energy Efficiency Rating Systems for Buildings, Green Buildings Energy Efficiency: management of green buildings, importance of embodied energy in selection of sustainable materials, green building design, waste reduction/recycling, rainwater harvesting, maintenance of the green buildings, green building certification, Renewable energy applications.

Energy Efficient Technology in Chemical Engineering: Green chemistry, Low carbon cements, recycling paper.

TEXT BOOKS:

1. Umesh Rathore, 'Energy Management', Kataria publications, 2nd ediiton, 2014.
2. G Hariharaiyer, “Green Building Fundamentals”, Notion press.com
3. K V Shama, P Venkataseshaiah, "Energy management and conservation", I. K. International Publishing agency pvt. ltd., 2011, ISBN: 978-93-81141-29-8

SUGGESTED READING:

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects
2. Hargroves, K., Gockowiak, K., Wilson, K., Lawry, N., and Desha, C. (2014) An Overview of Energy Efficiency Opportunities in Mechanical/civil/electrical/chemical Engineering, The University of Adelaide and Queensland Universityof Technology.
3. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

22EEO02

ENERGY CONSERVATION
(Open Elective)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None

COURSE OBJECTIVES: This course aims to
1. Know the concept of Energy conservation
2. Understand the formulation of efficiency for various engineering systems
3. Explore the different ways to design various technologies for efficient engineering systems.

COURSE OUTCOMES: After the completion of this course, the student will be able to
1. Know the current Energy Scenario and importance of Energy Conservation. [EC].
2. Understand the necessity of EC in domestic sector.
3. Comprehend the significance of EC in Industrial sector.
4. Explore the Energy Efficient Technologies in Mechanical and Civil Engineering domain.
5. Explore the Energy Efficient Technologies in Electrical and Chemical Engineering domain.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	2	-	2	-	-	-	-	-	-			
CO 2	3	2		3	-	1	-	-	-	-	-	-			
CO 3	3	3	2	3	2	2	-	-	-	-	-	-			
CO 4	3	2	2	2	2	1	-	-	-	-	-	-			
CO 5	2	2	1	2	2	1	-	-	-	-	-	-			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Basics of various Energy forms : Overview of Engineering elements , Solar energy, Electricity generation methods using Solar energy, PV cell, elements of wind energy, electricity generation using wind energy, sources of chemical energy, fuel cells; Hydrogen Cell , Energy Scenario in India.

UNIT-II

Energy Conservation-I: Domestic Sector: Energy conservation needs and objectives, Energy Conservation strategies in domestic sector, Energy Conservation tips in the kitchen, other energy saving tips in the domestic house, Energy Conservation measures in office, energy conservation processes/activities for a building. HVAC (heating, ventilation, air conditioning), components of HVAC, energy conservation opportunities in HVAC systems.

UNIT-III

Energy Conservation-II: Industrial Sector: Energy Conservation in Indian industrial sector, Energy saving potential in industry: boiler, furnaces, air compressors, refrigeration systems, heat exchanger, heat pump, turbines, electric drives, pumps, cooling towers, fans and blowers. Energy Conservation in agriculture sector: Energy Conservation opportunities in pumps used in agriculture sector**.**

UNIT-IV

Energy Efficient Technologies-I: Importance of Energy Efficiency for engineers**,**
Energy Efficient Technology in Mechanical Engineering: Heating, ventilation and air-conditioning, boiler and steam distribution systems. Energy

Efficient Technology in Civil Engineering: future of roads, harnessing road and transport infrastructure; Energy Efficient Technology in Agriculture: IoT and Drone Technology.

UNIT-V

Energy Efficient Technologies-II:

Energy Efficient Technology in Electrical Engineering: Electricity billing, Electrical load management and, power factor improvement and its benefit, selection and location of capacitors ;

Energy Efficient Technology in Chemical Engineering: green chemistry, low carbon cements, recycling paper. Green buildings concept, introduction to SCADA

TEXT BOOKS:

1. Umesh Rathore,'energy management', Katarina publications, 2nd edition, 2014.
2. G Harihara Ayer, “Green Building Fundamentals”, Notion press.com
3. S. C. Tripathy, “Utilization of Electrical Energy and Conservation”, McGrawHill, 1991

SUGGESTED READING:

1. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)
2. Guidebooks for National Certification Examination for Energy Manager/Energy Auditors Book-1, General Aspects

ONLINE RESOURCES:

1. https://publicservice.vermont.gov/efficiency/energy-saving-resources
2. https://www.graygroupintl.com/blog/energy-conservation

22EEO03

ENERGY RESOURCES: ECONOMICS & ENVIRONMENT

(Open Elective)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None

COURSE OBJECTIVES: This course aims to

1. Impart the significance of non-conventional energy sources in the Indian and global energy mix, and analyze their potential contribution to energy security and sustainability
2. Disseminate the emerging technologies in the field of energy, including hydrogen energy systems, fuel cells, and biofuels, and assess their potential applications.
3. Provide the environmental aspects related to Electrical energy generation

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

1. Know the various energy resources and its national and international scenario.
2. Understand the emerging technologies that prevail in energy sector.
3. Comprehend the impact of various generation methods on environment.
4. Understand impact of energy resource on global climate change.
5. Know the various economic evaluation strategies.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	2	-	2	-	-	-	-	-	-			
CO 2	3	2		3	-	1	-	-	-	-	-	-			
CO 3	3	3	2	3	2	2	-	-	-	-	-	-			
CO 4	3	2	2	2	2	1	-	-	-	-	-	-			
CO 5	2	2	1	2	2	1	-	-	-	-	-	-			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT – I

Energy Resources – National and Global Scenario: Electric energy from conventional source -Thermal plants (coal fuelled), Nuclear power- Nuclear fission, Nuclear fusion, Energy reserves of India- Coal, oil, Natural gas, Energy parameters- Energy intensity, Cogeneration, Indian and Global Energy Resources- Significance of Non-Conventional, Energy Policy in India, World Energy Status, Indian Energy Scenario.

UNIT – II

Introduction to Emerging Technologies In Energy Domain: Rational Use of Energy, Energy Efficiency and Conservation, New Technologies-Hydrogen Energy Systems, Fuel Cells, Biofuels, Distributed Energy Systems and Dispersed Generation.

UNIT – III

Environmental Aspects of Electric Energy generation: Introduction, Atmospheric Pollution, Oxides of Sulphur (SO2) ,Oxides of Nitrogen (NO_2) , Oxides of Carbon (CO, CO_2) , Thermal Pollution , Hydroelectric Projects, Nuclear Power Generation and Environment, Disposal of Nuclear Waste.

UNIT – IV

Global Climate Change Impact of energy resource: Introduction, Environmental Studies—A Multidisciplinary Approach, Air Pollution ,Water Pollution, Prominent Climate Change, Vulnerability and Impacts in India, Water Management in India-Clarion Call to Address Climate Change- Kyoto protocol

UNIT – V

Economic Evaluation: Basic Terms and Definitions, Calculations for -the Case of Single Payment (or Receipt), Uniform Series of Payments (or Receipt), Uniform Gradient Series of Payments (or Receipt) and Geometric Gradient Series of Payments (or Receipt) , Effect of Inflation on Cath Flows, Comparative Economic Evaluation of Alternatives, Effect of Depreciation and Tax on Cash Flows **.**

TEXT BOOKS:

1. B.H.Khan, "Non-Conventional Energy Resources", MCGrawHill Education (India) Pvt.Ltd.,2015
2. D.P.Kothari, K.C. Singal, Rakesh Ranjan, " Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt.Ltd, 2014.

SUGGESTED READING:

1. G.S.Sawhney, "Non-Conventional Energy Resources", PHI Learning Pvt.Ltd, 2012.

ONLINE RESOURCES:

1. https://elearn.nptel.ac.in/shop/nptel/energy-resources-economics-and-environment/?v=c86ee0d9d7ed

22EEO04

ENGINEERING MATERIALS

(Open Elective)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None

COURSE OBJECTIVES: This course aims to

1. Analyze the mechanical, magnetic and the electrical properties of materials.
2. Select materials for various engineering application to establish how failures occur in materials.
3. Observe the changes in behavior of the material while subjected to stress and to know the economic aspects of a design.

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

1. Classify the given material based on its properties.
2. Understand the concepts of superconductors & optical fibers.
3. Select a proper material for a given application.
4. Experiment on materials in order to test its adaptability.
5. Compare and contrast the characteristics of the materials to assess the changes in properties.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	1	-	-	-	2	-	-	-	-	1			
CO 2	2	1	1	-	-	-	2	-	-	-	-	1			
CO 3	1	1	1	-	1	-	2	-	-	-	-	1			
CO 4	1	1	2	-	1	-	3	-	-	-	-	1			
CO 5	1	1	2	-	2	-	3	-	-	-	-	1			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT- I

Conducting Materials: Electrical conducting Materials, High conductivity materials, Materials of High Resistivity, Materials used for precision work, rheostats, heating devices, Super conductivity, Special types of alloys, Applications &Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale integration techniques (VLSI).

UNIT -II

Superconductors & Optical fibers: Properties of Materials: Superconductivity-working-engineering applications- properties-classifications-superconducting transmission cables-optical Fibers.

UNIT- III

Insulating Materials: Classification of Insulting materials, temperature rise, electrical properties of insulating materials used for wires-laminations- machines and their applications, Ceramics, Plastics, DC electrical properties, AC electrical properties, Dielectric properties of insulators, Dielectric materials used for various electrical applications, suitability.

UNIT- IV

Magnetic Materials: Magnetic parameters, the three types of magnetic material, measuring magnetic materials, Application of soft magnetic materials, Magnetic recording media, Hard (permanent) magnets, Ferrites, Samarium, Cobalt alloys, Neodymium Iron Boron (Nd Fe B).

UNIT –V

Materials for Direct Energy Conversion Devices: Solar cells, equivalent circuit of a solar cell, fuel cell, MHD generators, storage of hydrogen, thermoelectric generators, Nano applications in Electrical Engineering.

TEXT BOOKS:

1. G.K Benergy, "Electrical and Electronic Engineering Materials", PHI, 2014
2. Ian P. Jones, "Materials Science for Electrical and Electronic Engineers",Oxford University Press, 2008.
3. R. K Sukhla, "Electrical Engineering Materials", McGraw Hill Education,2013.

SUGGESTED READING:

1. Dhir, "Electronic Components & Materials", McGraw Hill Education,2012.
2. "Electrical Engineering Materials", McGraw Hill Education, TTTI Madras, 2014

22EEO05

ENERGY AUDITING

(Open Elective)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None.

COURSE OBJECTIVES: This course aims to

1. Know the concept of Energy auditing
2. Understand the formulation of efficiency for various engineering systems
3. Explore the different ways to design various technologies for efficient engineering systems.

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

1. Apply knowledge of energy forms to real-world engineering scenario.
2. Perform Energy audits using appropriate methodologies.
3. Implement Energy-saving measures in commercial buildings.
4. Identify the proper location of Capacitor for PF improvement
5. Apply Green concepts on different areas to minimize environmental impact.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	2	-	-	-	-	1	1			
CO 2	2	1	3	2	1	2	-	-	-	-	1	1			
CO 3	2	1	3	2	1	2	-	-	-	-	2	2			
CO 4	2	1	2	2	1	2	-	-	-	-	2	2			
CO 5	1	1	2	1	1	2	-	-	-	-	2	2			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Basics of Energy and its various forms: Overview of **-Energy -**elements Solar energy, electricity generation methods using solar energy, PV cell, elements of wind energy, electricity generation using wind energy, sources of Chemical energy, fuel cells, **World energy Scenario** ,Energy Scenario in India

UNIT-II

Energy Auditing-I: Introduction, Need for energy audit, types of energy audit: Preliminary audit, General/mini Audit, Investment-grade/ Comprehensive audit. Major energy consuming equipment and systems, Energy audit team, energy Auditing methodology: preliminary and detailed**,** Energy Audit report format

UNIT-III

Energy Auditing-II: For buildings: Energy Auditing Instruments, Energy Efficiency, Energy Auditing for buildings- and model analysis. Energy audit form of commercial buildings, such as Hotel, Energy Audit Case studies

UNIT –IV

Energy Efficient Technologies-I: Energy Efficient Technology in Mechanical Engineering**:** Heating, ventilation, and air-conditioning; Evaporative coolers, Air conditioners -types such as Portable; Central AC, Window AC and Split AC

Energy Efficient Technology in Electrical Engineering: Electricity billing, Power Factor Improvement-Regenerated Energy in Lifts and Escalators

UNIT-V

Energy Efficient Technologies-II: Energy Efficient Technology in Civil Engineering: Green building-features--Green construction -Net Zero Energy Building - Energy Efficient Technology in Chemical Engineering: Green chemistry, - Battery Management systems – Green Chemistry topologies.

TEXT BOOKS:

1. Umesh Rathore, 'energy management', Kataria publications, 2nd ediiton, 2014.
2. G.Hari hara Iyer : Green Building– Fundamentals, Notion Press .com2022

SUGGESTED READING:

1. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)
2. Guide books for National Certification Examination for Energy Manager / EnergyAuditorsBook-1, General Aspects
3. Hargroves, K., Gockowiak, K., Wilson, K., Lawry, N., and Desha, C. (2014) An Overview of Energy Efficiency Opportunities in Mechanical/civil/electrical/chemical Engineering, The University of Adelaide and Queensland Universityof Technology

ONLINE RESOURCES:

1. https://www.udemy.com/course/tools-for-energy-auditors/?utm_source=adwords&utm_medium=udemyads&utm_campaign=DSA_Catchall_la.EN_cc.INDIA&utm_content=deal4584&utm_term=_._ag_82569850245_._ad_533220805574_._kw__._de_c_._dm__._pl__._ti_dsa41250778272_._li_9062143_._pd__._&matchtype=&gad_source=1&gclid=Cj0KCQjw8J6wBhDXARIsAPo7QA-xSK3NrdJaj-_2RyiJD3KTuCW1kN27TD8Hfd1zRPIQpRqDK24ntYIaAhUbEALw_wcB&couponCode=IND21PM

22EEO06

WASTE MANAGEMENT

(Open Elective)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: None.

COURSE OBJECTIVES: This course aims to

1. Provide the concept of effective utilization of any scrap
2. Dispense the processes of all disciplines of engineering.
3. Impart the technique of connectivity from waste to utility.

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

1. Categorize the waste based on the physical and chemical properties.
2. Explain the hazardous waste management and treatment process.
3. Illustrate the environmental risk assessment, methods, mitigation and control.
4. Interpret the biological treatment of solid and hazardous waste.
5. Identify the waste disposal options; describe the design and construction, operation, monitoring, closure of landfills.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
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CO 2	2	1	2	-	-	2	1	-	-	-	-	1			
CO 3	2	1	3	-	-	2	1	-	-	-	-	1			
CO 4	2	3	3	-	-	2	1	-	-	-	-	1			
CO 5	2	3	3	-	-	2	1	-	-	-	-	1			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT -I

Introduction to Waste Management and Municipal Solid Waste Management: Classification of waste, Agro based, Forest residue, Industrial waste, e-Waste, Municipal Solid Waste Management, Fundamentals Sources, Composition, Generation rates, Collection of waste, Separation, Transfer and Transport of waste, Treatment and disposal options.

UNIT -II

Hazardous Waste Management and Treatment: Hazardous waste identification and classification, Hazardous waste management: Generation, Storage and collection, Transfer and transport, Processing, Disposal, Hazardous waste treatment: Physical and chemical treatment, Thermal treatment, Biological treatment, Pollution prevention and waste minimization, Hazardous wastes management in India.

UNIT -III

Environmental Risk Assessment: Defining risk and environmental risk, Parameters for toxicity quantification, Types of exposure, Bio-magnifications, Effects of exposure to toxic chemicals, Risk analysis and Risk matrix, Methods of risk assessment, Mitigation and control of the risk, Case studies.

UNIT -IV

Biological Treatment: Solid and hazardous waste composting, Bioreactors, Anaerobic decomposition of solid waste, Principles of biodegradation of toxic waste, Inhibition, Co-Metabolism, Oxidative and reductive processes, Slurry phase bioreactor, In-situ-remediation.

UNIT -V:

Waste Disposal: Key issues in waste disposal, Disposal options and selection criteria, Sanitary landfill principle, Landfill processes, Landfill gas emission: Composition and properties, Hazards, Migration, Control, Leach ate Formation: Composition and properties. Leach ate migration, Control, Treatment, Environmental effects of landfill, Landfill operation issues, Design and construction, Operation, Monitoring, Closure of landfills-Landfill remediation, National and International waste management programs.

TEXT BOOKS:

1. John Pichtel, Waste Management Practices CRC Press, Taylor and Francis Group 2005.
2. LaGrega, M.D.Buckingham, P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, NewYork, 1994
3. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, NewYork, 1997.

SUGGESTED READING:

1. Basics of Solid and Hazardous Waste Mgmt. Tech. by KantiL.Shah 1999, Prentice Hall.
2. Solid and Hazardous Waste Management 2007 by S.C.Bhatia Atlantic Publishers & Dist.

22EEO07

FUNDAMENTALS OF ELECTRIC VEHICLES

(Open Elective)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: None.

COURSE OBJECTIVES: This course aims to know

1. Basics of Electric Vehicle history and components.
2. Various types of Electric Vehicles.
3. Different storage methods.

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

1. Understand the basics of electric vehicle and environmental impact.
2. Understand the various types of Electric Vehicles and their properties
3. Understand the functioning of BEV.
4. Understand the difference between HEV and FCEV.
5. Understand the various methods of energy storage.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	1	-	-	2	3	-	2	1	2	1			
CO 2	1	1	1	-	-	2	3	-	2	1	2	1			
CO 3	1	1	1	-	-	2	3	-	2	1	2	1			
CO 4	1	1	1	-	-	2	3	-	2	1	2	1			
CO 5	1	1	1	-	-	2	3	-	2	1	2	1			

1 - Slightly, 2 - Moderately, 3 - Substantially

UNIT-I

Introduction to Electric vehicles: Present scenario of electric vehicles, Need of Electric Vehicles, Economic and environmental impacts of using Electrical vehicles. Challenges faced by electric vehicles to replace ICE. Major requirements of electric vehicles.

UNIT-II

Types of Electric Vehicle and their challenges: Types of Electric Vehicle - Pure Electric Vehicle (PEV): Battery Electric Vehicle (BEV), Fuel Cell Electric Vehicle (FCEV), and Hybrid Electric Vehicle (HEV). Challenges of Battery Electric Vehicle, Hybrid Electric Vehicle and Fuel Cell Electric Vehicle

UNIT -III

Battery Electrical Vehicle: Components of BEV drive train, The electric propulsion subsystem - Driving wheels , Suspension system, Driveshaft, Mechanical transmission , Electric Motor. The energy source subsystem -Battery pack with Battery Management System, On board charger, The auxiliary subsystem -Power steering unit, Common parts between ICE drive train and EV drive train, Differences (modifications/parts to be removed/added) between ICE and EV drive train.

UNIT-IV

Hybrid Electrical Vehicle and Fuel Cell Electric Vehicle: Hybrid Electric vehicle (HEV) -Basic architecture of hybrid drive trains, Components of HEV drive train system. Classification of HEV: Grid -Able HEV (Plug in hybrid, Range extended).Fuel efficiency in HEV. Fuel Cell Electric Vehicle (FCEV) - Basic architecture of FCEV. Components of FCEV drive train system.

UNIT-V

Energy Storage: Battery based energy storage, Overview of batteries, Battery Parameters, Battery Charging, regenerative braking, alternative novel energy sources-solar photovoltaic cells, fuel cells, super capacitors, and flywheels.

TEXT BOOKS:

1. A.K. Babu, "Electric & Hybrid Vehicles" , Khanna Publishing House, New Delhi, 2018.
2. Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals" , CRCPress, Second Edition, 2011.

SUGGESTED READING:

1. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.
2. Mehrdad Ehsani,Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.
3. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2000.