Under Graduate Programme

B. Tech.

in

Electrical Engineering

Curriculum of 2nd Year

(as per NEP With Effect From batch 2023-24)

सरदार वल्लभभाई राष्ट्रीय प्रोद्योगिकी संस्थान, सूरत

SARDAR VALLBHBHAI NATIONAL INSTITUTE OF TECHNOLOGY, SURAT

विधुत इंजीनियरिंग विभाग

DEPARTMENT OF ELECTRICAL ENGINEERING

SARDAR VALLABHBHAI NATIONAL INSTITUTE OF TECHNOLOGY, SURAT

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Course Structure and Scheme of Evaluation (Semester wise)
B. Tech. Electrical Engineering (2nd Year Scheme)

S. No.	Subjects	Code	Scheme L-T-P	Credits (Min.)	Notional hours of Learning (Approx.)
Third Semester (2nd year of UG)					
1.	Electrical Machines I	EE201	3-1-2	5	100
2.	Signals & Systems	EE203	3-1-0	4	70
3.	Electromagnetic theory	EE231	3-1-0	4	70
4.	Digital Circuits	EC209	3-0-2	4	85
5.	Elective	EE2AA	3-X-X	3/4	55/70/85
			Total	**20-21**	**380-410**
Fourth Semester (2nd year of UG)					
1.	Electrical Machines – II	EE202	3-1-2	5	100
2.	Elements of Power Systems	EE204	3-1-2	5	100
3.	Numerical Methods and Applications to Electrical Engineering	EE232	3-1-2	5	100
4.	Professional Ethics, Economics and Business Management	MG210	3-1-0	4	70
5.	Elective	EE2BB	3-X-X	3/4	55/70/85
			Total	**22-23**	**425-455**
6.	Minor/Honor/ (M/H#1)	EE2CC	3-X-X	4	70/85
7.	Vocational Training/ Professional Experience (optional) (Mandatory for Exit)	EEV04/ EEP04	0-0-10	5	200 (20x10)

Sr. No.	**Optional Core**	Code	Scheme L-T-P
1.	Electromagnetic Theory	EE231	3-1-0
2.	Numerical Methods and Applications to Electrical Engineering	EE232	3-1-2

Sr. No.	**Electives**	Code	Scheme L-T-P
B. Tech. II year (EE2AA, EE2BB)			
III Semester (EE2AA)			
1.	Renewable Energy Sources	EE251	3-0-0
2.	Modern Material for Electrical Engineering	EE252	3-0-0
3.	Object oriented programming and Data structure	EE253	3-0-0
4.	Principles and applications of electrochemistry	CY251	3-0-0
IV Semester (EE2BB)			
5.	Special Electrical Machines	EE254	3-0-0
6.	Digital Signal Processing	EE255	3-0-0
7.	Power Plant Engineering	EE256	3-0-0
8.	Energy Audit and Management	EE257	3-0-0

Sr. No.	**for B.Tech. (CE, ME, ChE, IndChe, MaC) students (Minor in Electrical Engineering)**	Code	Scheme L-T-P
1.	Electrical Circuits (IV semester)	EE281	3-1-0

Sr. No.	**for B.Tech. (AI, CSE, ECE, ECVLSI, EnggPhy) students (Minor in Electrical Engineering)**	Code	Scheme L-T-P
1.	Electrical Machines (IV semester)	EE282	3-0-2

Sr. No.	**B.Tech. in Electrical Engineering with Honors** (Any one from following subjects)	Code	Scheme L-T-P
1.	Modeling of Electrical Machines (IV semester)	EE291	3-1-0
2.	Computer Methods for Power Systems (IV semester)	EE292	3-1-0
3.	Industrial Automation and Control (IV semester)	EE293	3-1-0

Note: Throughout this scheme structure, the notations L, T, P, C denote lecture, tutorial, practical and credit respectively for the related subject.

B. Tech. II year, Semester III

ELECTRICAL MACHINES – I

EE201

L	T	P	Credit
3	1	2	05

Scheme

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	explain the construction and principle of operation of the transformers and induction motors.
CO2	perform tests on the transformers and induction motors
CO3	analyze the performance of the transformers and induction motors
CO4	compare the performance of different types of transformers and induction motors
CO5	select the machines for different real world applications
CO6	communicate effectively through laboratory report writing, presentation and perform task as an efficient team member

2. Syllabus

- **TRANSFORMERS** **(06 Hours)**
  Review of equivalent circuits and vector diagram, circuit parameter determination, per unit impedance, regulation, losses, efficiency, magnetic inrush and effect of saturation, parallel operation.
- **POLYPHASE TRANSFORMERS** **(09 Hours)**
  Standard connections phase angle difference, harmonic analysis, open delta connection, Scott connections, three-phase to six-phase conversion, three winding transforms and parallel operation.
- **AUTO TRANSFORMERS** **(03 Hours)**
  Construction, voltage and current ratios, phasor diagram and equivalent circuit.
- **TESTS ON TRANSFORMERS** **(04 Hours)**
  OC- SC tests, Polarity test, Back to back Sumpner’s test
- **THREE-PHASE INDUCTION MOTORS** **(08 Hours)**
  Review of equivalent circuit and vector diagram, performance analysis, torque-speed characteristics,no load and blocked rotor tests, circle diagram.
- **STARTING, BRAKING AND SPEED CONTROL** **(07 Hours)**
  Double cage motors, starting problems, methods of starting, speed control methods, cascade connections, cogging and crawling, regenerative braking, plugging, ac and dc dynamic (rheostatic) braking.

- **INDUCTION GENERATORS AND REGULATOR** **(04 Hours)**
  Principle of operation, performance analysis, application.
- **SINGLE PHASE INDUCTION MOTORS** **(04 Hours)**

  Principle of operation, revolving field theory, cross field theory, equivalent circuit and performance analysis, determination of circuit parameters by no- load and blocked rotor test, starting methods, unbalanced operation of three phase induction motor.

Total Hours: 45

Tutorials will be conducted separately for 15 hours

3. List Of Experiments

1. Determination of efficiency & regulation of single- phase transformer from Open circuit and short circuit test.
2. Determination of efficiency & regulation of single- phase transformer from Sumpner's test.
3. Scott connection of 1-phase transformers.
4. Open delta connection of three single-phase transformers.
5. Standard connections for three-phase transformer.
6. Load test on three-phase Induction Motor.
7. Load test on three-phase Induction Generator.
8. Determination of the equivalent circuit parameters from No-Load and Blocked rotor tests of three-phase Induction Motor.
9. Determination of the equivalent circuit parameters from No-Load and Blocked rotor tests of 1-phase Induction Motor.
10. Determination of the performance parameters of three-phase induction motor from circle diagram.
11. Induction regulator.
12. Unbalanced operation of three-phase Induction Motor.

4. Books Recommended:

1. I. J. Nagrath and D. P. Kothari, Electric Machines, Tata McGraw Hill, New Delhi, 2005.
2. M. G. Say, The performance and design of alternating current machines, CBS Publishers and Distributors, Delhi, 1983.
3. Fitzgerald, Kingsley and Umans, Electric Machinery, Tata McGraw Hill, New Delhi, 2003
4. S. K. Sen, Electrical Machinery, Khanna Pub., Delhi, 2012.
5. Mukherjee and Chakravorty, Electrical Machines, Dhanpat Rai Pub., New Delhi, 2005.

B. Tech. II year, Semester III

SIGNALS AND SYSTEMS

L	T	P	Credit
3	1	0	04

EE203 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	classify various signals and their mathematical representation
CO2	develop insights into discrete-time systems and their realization
CO3	analyse the characteristics of LTI systems with the help of impulse response and convolution
CO4	design the system properties in frequency domain
CO5	analyse random signals and justify their usefulness in engineering systems

2. Syllabus:

- **SIGNALS AND THEIR PROPERTIES** **(08 Hours)**
  Classification of Signals, continuous-time and discrete-time signals, deterministic and random signals, periodic signals, even and odd signals, exponential and sinusoidal signals, unit step and unit impulse signals, systems with and without memory, time-varying, time-invariant, stationarity, causality, homogeneity, linearity, stability of systems.
- **LINEAR TIME INVARIANT SYSTEMS** **(08 Hours)**
  Properties of linear time-variant systems, continuous-time LTI systems, relationship between linear differential equations with constant coefficients, transfer function, state space models, convolution integrals from transfer function and state space models, discrete-time LTI systems, relationship between linear difference equations with constant coefficients, pulse transfer function, discrete-time state space models, convolution sum from transfer function and state space models, connections between time-invariance, causality, stationarity.
- **FOURIER SERIES REPRESENTATION AND FOURIER TRANSFORM** **(08 Hours)**
  Fourier series representation of continuous-time periodic signals, Parseval formula for continuous-time periodic signals, continuous time Fourier transform, discrete-time Fourier transforms, connection between the Fourier transform and Laplace transform, connection between the z-transform and discrete-time Fourier transform.
- **THE LAPLACE TRANSFORMATION TECHNIQUE** **(06 Hours)**
  Definition of the Laplace transformation, the need of the Laplace transformation, region of the convergence of the Laplace transform of signals, properties of the Laplace transform, the Laplace transforms of test signals and practically useful signals, unilateral Laplace transform and bilateral Laplace transforms.

- **THE Z-TRANSFORMATION TECHNIQUE** **(06 Hours)**
  Definition of the z- transformation, the need of the z- transformation, region of the convergence of the z- transform of signals, pulse transfer function, stability of systems using the z-transform. The z-transforms of test signals and practically useful signals, unilateral z transform and bilateral z transforms

- **FEEDBACK CONCEPTS** **(09 Hours)**
  Physical representation of network, general restrictions on physical network characteristics Feedback, mathematical definition of feedback, stability and feedback realizability, contour integration and Nyquist criterion for stability, physical representation of network, general restrictions on physical network characteristics

Total Hours: 45

Tutorials will be conducted separately for 15 hours

3. Books Recommended:

1. A. V. Oppenheim, A. S. Wilsky and S. H. Nawab, Signals and Systems, Pearson India Education Services Private limited India, 2nd Edition, 2016.
2. R. A. Gabel and R. A. Robert, Signals and Linear Systems, John Wiley and Sons, 3rd Edition, 1987.
3. B. P. Lathi, Principles of Linear Systems and Signals, Oxford University Press, 2nd Edition, 2009.
4. C. T. Chen, Systems and Signal Analysis - A Fresh Look, Oxford University Press India, 3rd Edition, 2004.
5. S. T. Alan, Introduction to Signals and Systems, Thomson India Edition, 1st Edition, 2007.

B. Tech. II year, Semester III

ELECTROMAGNETIC THEORY

L	T	P	Credit
3	1	0	04

EE231 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	describe various theorems related to vector analysis and their application to determine Maxwell's equations
CO2	differentiate different types of coordinate systems and use them for solving the problems of electromagnetic field theory
CO3	explain concepts, theories and laws of electrostatics, magnetics, electromagnetics, electromagnetic wave propagation and transmission lines
CO4	analyze problems of electrostatics, magnetics, electromagnetics and electromagnetic wave propagation
CO5	apply theories and laws of electrostatics, magnetics and electromagnetics to solve electrical engineering problems
CO6	deduce the electromagnetic wave propagation from Maxwell's equations and apply the wave propagation for transmission line

2. Syllabus

- **COORDINATE SYSTEMS AND VECTOR CALCULUS** **(08 Hours)**
  Scalar and Vector Fields, Review of basic vector operations, Overview of Coordinate systems (Rectangular, Cylindrical, Spherical and their transformations), curvilinear systems, Vector Calculus: Integral and Differential Vector Calculus (Gradient, Divergent, Curl, Laplacian, Divergence and Stokes Theorem).
- **ELECTROSTATICS** **(12 Hours)**
  Coulomb's law, Electrical filed intensity, electric flux density, electric field due to point, line, sheet, spherical charge distributions, Gauss' law and its applications, Divergence and curl of electrostatic field, electric potential, potential due to point, line, spherical charge distributions, potential gradient, Electric dipole, Dipole moment, potential and electric field due to an electric dipole, Energy in electrostatic field, Electric fields in material space (properties of materials, convection and conduction current, polarization in dielectrics, continuity equation and relaxation time), boundary conditions, Poisson's and Laplace' equations, Uniqueness theorem, resistance, capacitance calculation.
- **MAGNETOSTATICS** **(10 Hours)**
  Biot-Savart's law, magnetic flux density, magnetic field intensity, magnetic field due to straight wire, surface, solenoid, toroid carrying steady current Ampere's Law and its applications, Divergence and curl of Magnetic field, Comparison of magnetostatics and electrostatics,

Magnetic scalar and vector potentials, Lorentz force, inductance, self and mutual inductance of solenoid, toroidal and other simple configurations, conductors, magnetic materials, energy in magneto static fields, boundary conditions.

- **MAXWELLS EQUATIONS FOR TIME VARYING FIELDS** **(06 Hours)**
  Faraday's law, Lenz's law, transformer emf and motional emf, inconsistency of Ampere's law, displacement current, Maxwell's equations in Final forms (Time Varying and Time Harmonic Fields).
- **ELECTROMAGNETIC WAVE AND TRANSMISSION LINES** **(06 Hours)**
  Waves in General, Wave equations, wave propagation in lossy dielectrics, plane waves in free space, plane waves in good conductors, Power and Poynting theorem, Transmission line Parameters, Line equations, input impedance, standing wave ratio and power, some applications of Transmission lines.

Total Hours: 45

Tutorials will be conducted separately for 15 hours

3. Books Recommended:

1. William H. Hayt Jr., John A. Buck, and M Jaleel Akhtar, Engineering Electromagnetics, McGraw Hill, 2020, 9th Edition.
2. Matthew Sadiku and S.V. Kulkarni, Elements of Electromagnetics, Oxford University Press, 2015, 6th Edition.
3. Nathan Ida, Engineering Electromagnetics, Springer, 2021, 4th Edition.
4. David J. Griffiths, Introduction to Electrodynamics, 4th Edition, PHI, 2013.
5. S. P. Seth, Elements of Electromagnetic Fields, Dhanpat Rai & Co., 4th Edition, 2012.
6. Engineering Electromagnetics, C. L. Wadhwa, New Age International Publishers, 3rd Edition, 2012.
7. Electromagnetic Fields Theory, Rakesh Singh Kshetrimayum, Cengage Learning, First Impression, 2012.

B. Tech. II year, Semester III

DIGITAL CIRCUITS

L	T	P	Credit
3	0	2	04

EC209 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	Understand Boolean algebra, Postulates and theorems of binary logic, and logic gates.
CO2	Formulate combinational logic problems and solve using truth table and optimize using K-map and other equivalent techniques.
CO3	Design and analyse various sequential logic circuits using flip-flops
CO4	Explain the operation of counters, registers, and memory
CO5	Describe digital hardware using VHDL statements and simulate logic circuit
CO6	Realize circuits for ALU, Shifter, and Control unit architectures

2. Syllabus

- **BOOLEAN ALGEBRA AND SIMPLIFICATION** **(08 Hours)**
  Basic Logic Operation and Logic Gates, Truth Table, Basic Postulates and Fundamental Theorems of Boolean Algebra, Standard Representations of Logic Functions- SOP and POS Forms, Simplification of Switching Functions-K-Map and Quine-Mccluskey Tabular Methods, Synthesis of Combinational Logic Circuits.
- **COMBINATIONAL LOGIC CIRCUITS** **(08 Hours)**
  Binary Parallel Adder, BCD Adder, Encoder Priority Encoder, Decoder, Multiplexer and Demultiplexer Circuits, Implementation of Boolean Functions using Decoder and Multiplexer, Arithmetic and Logic Units, BCD-To-Segment Decoder, Common Anode and Common Cathode, Random Access Memory, Read Only Memory and Erasable Programmable ROMs, Programmable Logic Arrays(PLA) and Programmable Array Logic(PAL)
- **LATCHES AND FLIP-FLOPS** **(06 Hours)**
  Cross Coupled SR Flip-Flop Using NAND or NOR Gates, Clocked Flip-flops, D-Types and Toggle Flip-flops, Truth Tables and Excitation Tables for Flip-flop. Master Slave Configuration, Edge Triggered and Level Triggered Flip-flop, Flip-flop with Preset and Clear
- **SEQUENTIAL LOGIC CIRCUIT** **(09 Hours)**
  Introduction to State Machine, Mealy and Moore Model, State Machine Notation, State Diagram, State Table, Transition Table, Table Excitation, Table and Equation, Basic Concepts of Counters and Register, , Shift Left and Right Register, Registers with Parallel Load, Serial-in-Parallel-Out(SIPO) and Parallel-In-Serial-Out(PISO), Register Using Different Types of Flip-flop,

Binary Counters, BCD Counters, Up Down Counter, Johnson Counter, Module-N Counter, Design of Counter using State Diagrams and Tables, Sequence Generators.

- **PROCESSOR LOGIC DESIGN** **(08 Hours)**
  Arithmetic, Logic and Shift Micro-Operation, Arithmetic Shifts, Design of Arithmetic Logic Unit (ALU), Control Unit Organization – Hard-Wired.
- **INTRODUCTION TO VHDL** **(06 Hours)**
  Introduction, Data Type, Operators and Operands, Signal Assignment Statements (Concurrent, Conditional and Selected), Structural Modeling, Process Statement and Behavioral Modeling, HDL code for Registers, Flip-flop, Multiplexer, Adder/Subtractors.

Total Hours: 45

3. List Of Experiments

(The following practicals are to be performed using discrete components)

1. Introduction to the variety of logic gates and digital ICs
2. Latches using NAND/ NOR Gate.
3. Flip-flops using NAND/ NOR Gate
4. Half-Adder/Half-subtractor Circuits using a serial Input.
5. Full-Adder/Full-subtractor Circuits using a serial Input.
6. Parity checker and parity generator circuit
7. 4-Bit Gray to Binary/ Binary to Gray Code converter using Select input.
8. Boolean function implementation using MUX
9. (a) Mod 5 ripple up counter using JK flip flops (b) Mod 5 ripple down counter using JK flip flops

(The following practicals are to be performed on a CPLD/FPGA kit using VHDL)

10. Adders: (a) 1-bit Full adder (b) 4-bit Ripple carry adder using structural modeling
11. 4x1 MUX implementation using concurrent signal assignment statements
12. D and JK Flip flops with synchronous reset.
13. 4-Bit Shift Left/Right Register.
14. 4-bit Ripple counter with Asynchronous Reset.

4. Books Recommended:

1. Mano Morris, “Digital Logic and Computer Design”, Pearson Education, 2019 Edition.
2. Anand Kumar, “Fundamentals of Digital Circuits”, 4th Ed., PHI, 2016.
3. Jain R. P. and Anand M. H. S., “Digital Electronics Practices using Integrated Circuits”, 1st Ed., TMH, 2004.
4. Lee Samuel, “Digital Circuits and Logic Design”, PHI Learning, 2009.
5. Floyed Thomas L. and Jain R. P., “Digital Fundamentals”, 8th Ed., Pearson Education, 2006.

5. Reference Books:

1. Brown S. and ZvonkoVranesic, “Fundamental of Logic with Verilog Design”, 1st Ed., Tata McGraw Hill, 2003.

B. Tech. II year, Semester III

RENEWABLE ENERGY SOURCES

L	T	P	Credit
3	0	0	03

EE251 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	Understand the limits of the conventional energy sources and present scenario of renewable energy conversion.
CO2	Explain the working principle of wind energy conversion and identify the suitable turbine and power electronic interfaces.
CO3	Acquire the knowledge of the solar thermal energy conversion and associated applications.
CO4	Explain the working principle of solar energy conversion, maximum power tracking algorithms and power electronics interface.
CO5	Understand the basic operation of the other renewable energy sources.

2. Syllabus

- **PRESENT WORLD AND INDIAN ENERGY SCENARIO** **(04 Hours)**
  Conventional sources of energy, their availability and limitations, alternative sources of energy, their advantages and present status.
- **WIND ENERGY** **(10 Hours)**
  Introduction, types of wind turbines and their characteristics, wind data and energy estimation, site selection, basic components of wind electric conversion system, types of electrical machines suitable for wind energy conversion, maximum power extraction, power electronics interface for wind turbine.
- **SOLAR THERMAL ENERGY** **(06 Hours)**
  Introduction, Solar energy storage systems, thermal storage, sensible heat storage, latent heat storage, solar pond, non-conductive solar pond, Extraction of Thermal energy, Applications of Solar pond, solar thermal electric conversion.
- **SOLAR PHOTOVOLTAIC ENERGY** **(12 Hours)**
  Basics of p-n junction, p-n junction exposure to light, photovoltaic cell/module characteristics and effects of light intensity and temperature variations, maximum power point tracking algorithms, power electronics interface for solar photovoltaics, PV applications (domestic loads, battery storage, and irrigation), and different thin film PV technologies.
- **BIO ENERGY** **(06 Hours)**
  Introduction to biomass, Biomass conversion technologies, wet process and dry process, Biogas generation, classification of biogas plants, continuous & batch types, The dome and the drum

types, Different variations in the drum type, Types of Biogas plants, Floating gas holder, Fixed dome digester, Biogas from plant wastes, Community biogas plants, Materials used for biogas generation, selection of site for biogas plant, Methods of maintaining Biogas generation, starting a biogas plant, Fuel properties of biogas, utilization of biogas, methods of obtaining energy from Biomass Combustion.

- **OTHER SOURCES OF RENEWABLE ENERGY (07 Hours)**
  Geothermal energy, classifications and prime movers used for geothermal energy, fuel cell technologies, different types of fuel cells, OTEC energy conversion.

Total Hours: 45

3. Books Recommended:

1. J. K. Nayak and S. P. Sukhatme, "Solar Energy - Principles of thermal collection and storage", TMH, 2008.
2. J. Twidell and T. Weir, "Renewable Energy Resources", E & F N Spon Ltd, London, 1999.
3. Bent Sørensen, "Renewable Energy: physics, engineering, environmental impacts, economics & planning", 4th Edition, Academic Press, Gurgaon, 2011.
4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamental, Technologies and Applications", 2nd Edition, PHI Learning Pvt. Limited, New Delhi, 2011.
5. Gary L. Johnson, "Wind Energy Systems", Prentice Hall Inc., 1985.
6. Klouse Jägar, et al., "Solar Energy: Fundamental, Technology and Systems", Delft University of Technology, Netherlands, 2014.

B. Tech. II year, Semester III

MODERN MATERIALS FOR ELECTRICAL ENGINEERING

EE252

L	T	P	Credit
3	0	0	03

Scheme

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	Understand the properties of liquid, gaseous and solid insulating materials.
CO2	Appreciate properties of magnetic materials.
CO3	Explain semiconductor material technology.
CO4	Acquire knowledge on materials used in electrical engineering and applications.
CO5	Evaluate insulating, conducting and magnetic materials used in electrical machines.
CO6	Appreciate usefulness of special purpose materials.

2. Syllabus

- **DIELECTRIC MATERIALS** **(10 Hours)**
  Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, liquid dielectric, Electric conductivity in solid, liquid and gaseous dielectrics, Properties of ferroelectric materials in static fields, Spontaneous polarization, Curie point, Anti-ferromagnetic materials, Piezoelectric and Pyroelectric materials.
- **MAGNETIC MATERIALS** **(10 Hours)**
  Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic anisotropy, magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets, factors effecting permeability and hysteresis.
- **SEMICONDUCTOR MATERIALS** **(08 Hours)**
  Method of semiconductor material preparation, Purification and Doping, Introduction to process of Manufacturing Semiconductor Devices, Transistors, Integrated Circuits. Monolithic Diodes, Integrated Resistors and Integrated Capacitor.
- **MATERIALS FOR ELECTRICAL APPLICATIONS** **(08 Hours)**
  Materials used for resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials. Solid, liquid and gaseous insulating materials. Effect of moisture on insulation.
- **SPECIAL PURPOSE MATERIALS** **(09 Hours)**
  Refractory Materials, Structural Materials, Radioactive Materials, Galvanization and Impregnation of materials, Processing of electronic materials, insulating varnishes and coolants, Properties and applications of mineral oils, Testing of Transformer oil as per ISI.

Total Hours: 45

3. Books Recommended:

1. Dekkar, A.J., ``Electrical Engineering Materials, Reprint Edition”, 2009, Prentice Hall Publications Co.
2. Kasap S.O., ``Principle of Electronic Materials and Devices”, Second Edition, Tata McGraw- Hill.
3. Indulkar C, ``Introduction to Electrical Engineering Materials’’, 2004, S. Chand & Company Ltd-New Delhi.
4. S.P. Seth, P.V. Gupta, `` A course in Electrical Engineering Materials”, Dhanpat Rai & Sons.
5. T.K. Basak, ``A course in Electrical Engineering Materials”, 2009, New Age Science Publications.

B. Tech. II year, Semester III

OBJECT ORIENTED PROGRAMMING AND DATA STRUCTURE

L	T	P	Credit
3	0	0	03

EE253 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	Explain the fundamentals of object-oriented programming
CO2	Classify various functions and variables used in object-oriented programming
CO3	Develop programs for implementing linear data structures
CO4	Asses various tree and graph traversing techniques
CO5	Compare various sorting techniques by using time and space complexity analysis

2. Syllabus

- **INTRODUCTION TO OBJECT-ORIENTED PROGRAMMING AND OVERVIEW OF C++** **(10 Hours)**
  Basic concepts of object-oriented programming (OOP), Benefits and Applications of OOP. Classes and Objects, Defining and Accessing member functions and variables, Static variables and static functions, Friend function, Dynamic memory allocation, Constructors and Destructors, Overloading – Function and operator overloading
- **INHERITANCE & POLYMORPHISM** **(08 Hours)**
  Base Classes and Derived Classes, Public, Protected and Private Inheritance, Multilevel, Multiple, Hierarchical and Hybrid Inheritances, Constructors and Destructors in derived Classes, Virtual base classes and abstract classes. Pointers in C++, This pointer, Types of polymorphisms: static and run-time polymorphism and Virtual functions.
- **LINEAR DATA STRUCTURES** **(10 Hours)**
  Introduction to data structures, Arrays, Linked Lists – Singly linked, doubly linked lists. Implementation of Stack and Queue by using Arrays and linked lists. Analysis of Algorithms, Big – O Notation.
- **NON-LINEAR DATA STRUCTURES** **(08 Hours)**
  Trees, Binary Trees, Binary tree representation and traversals, Application of trees, Graph and its representations – Graph Traversals – Representation of Graphs, Breadth-first search, Depth-first search.
- **SORTING AND SEARCHING** **(09 Hours)**
  Sorting algorithms: Bubble, Insertion, Selection, Quick and Merge sorts Searching: Linear search –Binary Search

Total Hours: 45

3. **Books Recommended:**

1. Bjarne Stroustrup, C++ Programming Language, Fourth Edition, Addison-Wiley Publications.
2. Ulla Kirch-Prinz, Peter Prinz, A Complete Guide to Programming in C++, 1st Edition, Jones And Bartlett Publishers
3. E Balaguruswamy, "Object Oriented Programming with C++", 7th Edition, Tata McGraw Hill publication
4. Trembley & Sorenson: "An Introduction to Data Structures with Applications", 2/E, TMH, 1991.
5. Tanenbaum & Augenstein: "Data Structures using C and C++", 2/E, Pearson, 2007

B. Tech. II year, Semester III

PRINCIPLES AND APPLICATIONS OF ELECTROCHEMISTRY

L	T	P	Credit
3	0	0	03

CY 251 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	Acquire knowledge about basic concepts of electrochemistry in the elementary level such as different type of cells, laws of electrolysis, theory of conduction of electricity in solution, etc.
CO2	Understand about electrochemical kinetics and mechanism
CO3	Develop understanding about electrochemical techniques involved in the area of energy conversion and storage
CO4	Differentiate between electrochemical devices
CO5	Accumulate a deep knowledge about electrochemistry concepts applicable in multidisciplinary areas.

2. Syllabus

- **FUNDAMENTALS OF ELECTROCHEMISTRY (07 Hours)**
  Electrochemical cells; Characteristics of electrochemical cells; Importance of electrochemical systems; Scientific units, Constants, Cell conventions; Faraday's law; Faradic efficiencies; Electrochemical cells, Electrochemical series; Electrode types (SHE, Glass, Calomel etc.); Equilibrium cell potentials; Reversibility and Gibb's free energy; Free Energy and Standard cell potentials; Effect of temperature on standard cell potentials; Activity coefficients; EMF and concentration; The Nernst equation; Liquid junction potentials.
- **ELECTROCHEMICAL KINETICS AND CATALYSIS (06 Hours)**
  Electrochemical double layer; Dynamic equilibrium; Rate equation; Arrhenius equation and activation energy; Exchange current density; Interfacial potential; Butler–Volmer equation; Current –overpotential characteristics; Tafel equation.
- **ELECTRODE STRUCTURE AND CONFIGURATIONS (06 Hours)**
  Structure and characterization of porous electrodes; Electrode material type: silicon, carbon based, transition metal, rare earth metals based etc.; Gas-liquid interface in porous electrode; Three-phase electrodes.
- **ELECTROCHEMICAL METHODS (06 Hours)**
  Types of techniques; Detection; current-potential characteristics; A planar microelectrode; Cyclic voltammetry; Electrochemical Impedance; Rotating Disc electrode.
- **ENERGY HARVESTING APPLICATIONS OF ELECTROCHEMISTRY (14 Hours)**
  Batteries: Fundamentals, classification and components of a cell; Cell characteristics and electrochemical performance; Efficiency of cell; Supercapacitors: Introduction, types, advantages and applications; Solar cells: Principle**,** Construction, working and

application of solar cells, crystalline silicon-based and thin-film solar cells: silicon based solar cells, Cadmium telluride solar cells, Dye sensitized solar cells, Copper-indium-gallium-selenide (CIGS) solar cells. Introduction and types of fuel cells; EMF of fuel cell; Current-voltage characteristics and overpotentials, direct alcohol fuel cells; molten carbonate fuel cells; solid oxide fuel cells; proton exchange membrane fuel cell (PEMFC).

- **INDUSTRIAL SIGNIFICANCE OF ELECTROCHEMISTRY (06 Hours)**
  Electrochemical Corrosion; Electrodeposition; Industrial electrolysis; Redox-flow batteries.

Total Hours: 45

3. Books Recommended:

1. S. Glasstone, An Introduction to Electrochemistry, Maurice Press, 2011.
2. Thomas F. Fuller, John N. Harb., "Electrochemical Engineering" Wiley, 2018.
3. Corrosion Engineering: Principles and Practices, Pierre R. Roberge, McGraw Hill, 2008.Corrosion, Vol. I, Edited by L. L. Shreir
4. Allen J. Bard, Larry R. Faulkner., "Electrochemical Methods-Fundamentals and Applications" John Wiley & Sons.
5. Thomas Engel and Philip Reid, Physical Chemistry, Pearson Publication 2006.

4. For further reading:

1. The Elements of Physical Chemistry', P.W. Atkins & Julio de Paula, 8th edition, Oxford University Press, Oxford 2006.
2. P. C. Rakshit, Physical Chemistry, 7th Edition, Sarat Book Distributors, Kolkata, 2004.

B. Tech. II year, Semester IV

ELECTRICAL MACHINES – II

L	T	P	Credit
3	1	2	05

EE202 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	explain the construction and principle of operation of the DC machines and synchronous machines
CO2	perform tests on the DC machines and synchronous machines
CO3	analyze the performance of the DC machines and synchronous machines
CO4	compare the performance of different types of DC machines and synchronous machines
CO5	select the machines for different real world applications
CO6	communicate effectively through laboratory report writing, presentation and perform task as an efficient team member

2. Syllabus

- **STARTING, SPEED CONTROL AND BRAKING OF DC MACHINES** **(07 Hours)**
  Starting problems, methods of starting, starters, methods of speed control, methods of braking.
- **DIRECT CURRENT MACHINES** **(10 Hours)**
  Construction, armature windings, simple lap and wave windings, armature reaction, demagnetizing and cross magnetizing ampere-turns, compensating winding, commutation, commutation time and type, reactance voltage, inter-poles, ampere-turns for inter-poles, self and separate excitations, shunt, series and compound motors and generators, magnetization characteristics, performance characteristicsof DC generators and motors.
- **STARTING, SPEED CONTROL AND BRAKING OF DC MACHINES** **(05 Hours)**
  Swinburne's test, Hopkinson's test, separation of core losses, retardation test, series field test.
- **BRUSHLESS D.C.MACHINE** **(04 Hours)**
  Construction, equivalent circuit, performance analysis.
- **SYNCHRONOUS MACHINES**
  Construction, cylindrical and salient pole type, basic principles, armature windings, distributed winding, full pitched windings, chording, EMF equation, distribution and pitch factors, excitation system **(04 Hours)**
  armature reaction, synchronous machine impedance, SCR, equivalent circuit, phasor diagram, voltage regulations, synchronous impedance method, MMF method, ZPF method, operating characteristics **(05 Hours)**
  'V' and inverted 'V' curves, power angle characteristics, power flow equation for salient and non-salient pole type synchronous machines, salient pole synchronous machine - two reaction model, phasor diagram, **(05 Hours)**
  power angle characteristic, hunting, damper winding, parallel operation of alternators, starting methods of synchronous motors, synchronous condenser, synduction machines **(05 Hours)**

Total Hours: 42

Tutorials will be conducted separately for 15 hours

3. List Of Experiments

1. Speed control of dc shunt motor.
2. Swinburne's test
3. Speed torque characteristic of a D. C. Shunt motor.
4. D. C. Series motor, Speed -torque characteristic.
5. External & Internal characteristics of D. C. separately excited and Shunt generator.
6. Regulation of an alternator by synchronous impedance method
7. 'V' and 'inverted V' curves of a synchronous motor.
8. Regulation of an alternator by zero power factor method
9. Regulation of an alternator by MMF method.
10. Synchronization of an alternator with infinite bus bar.
11. Power factor improvement using synchronous motor.
12. Hopkinson's Test on DC machines.
13. Retardation Test on DC Shunt motor.
14. Separation of core losses of DC machines.

4. Books Recommended:

1. Nagrath and Kothari, "Electric Machines", TMH, New Delhi, 2005.
2. M. G. Say, The performance and design of alternating current machines, CBS Publishers and Distributors, Delhi, 1983.
3. A. E. Clayton and N. M. Hancock, The Performance and Design of Direct Current Machines, CBS Publishers, 2004.
4. P. K. Mukherjee and S. Chakravorty, Electrical Machines, Dhanpat Rai Pub., New Delhi, 2005.
5. Fitzgerald, Kingsley and Umans, Electric Machinery, Tata McGraw Hill, New Delhi, 2003.

B. Tech. II year, Semester IV

ELEMENTS OF POWER SYSTEMS

L	T	P	Credit
3	1	2	05

EE204 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	classify and analyze the electrical power transmission and distribution.
CO2	compute the cost of power generation and the cost of electricity.
CO3	design the transmission line and analyze the performance of transmission lines.
CO4	analyze the performance of the underground cable.
CO5	Simulate/model the power system components in MATLAB/ETAP platforms and analyze the numerical results.

2. Syllabus

- **SUPPLY SYSTEMS** **(04 Hours)**
  AC and DC power supply systems, comparison of ac and dc transmission, advantages of high transmission voltage, various systems of power supply, comparison of conductor materials in overhead system and underground cable system, economic choice of conductor size and economic choice of voltage.

- **D.C. AND A. C. DISTRIBUTION** **(06 Hours)**
  Types of dc distributors, dc distribution calculations, ac distributor, fed at one and fed at both the ends with concentrated loads and uniformly distributed loads, ring distributors with inter connectors, current distribution in three wire and four wire ac systems, overview of distribution automation.

- **ECONOMIC ASPECTS OF POWER SYSTEM** **(06 Hours)**
  Power factor improvement, Tariff structure, ABT, Economic aspects of power generation.

- **UNDERGROUND CABLES** **(05 Hours)**
  Underground cables, construction of cables, classification of cables, cables for three phase services, insulation resistance of a single core cable, capacitance of a single core cable, dielectric stresses in a single core cable, most economical conductor size in a cable, grading of cables, capacitance grading and inter-sheath grading, capacitance of three core cable and measurements of capacitances, dielectric loss and tan(δ) measurement.

- **CALCULATION OF LINE PARAMETERS** **(09 Hours)**
  Conductors, types of conductors in use, bundled conductor, spacing of conductors, symmetrical and unsymmetrical spacing, equivalent spacing, transposition, transmission

line constants, calculation of resistance, inductance and capacitance for simple arrangements and multi-circuit lines, symmetrical and unsymmetrical spacing, concept of self GMD, mutual GMD and their uses in calculations of parameters of overhead lines, skin and proximity effects.

- **CHARACTERISTICS AND PERFORMANCE OF POWER TRANSMISSION LINES** **(12 Hours)**

  Short and medium transmission lines, Line performance, effect of capacitance, charging currents, short and medium lines, calculation by nominal-T, nominal-π and end-condenser method, regulation and efficiency, Concept of ABCD constants, the long transmission line- rigorous solution, evaluation of ABCD constants, interpretation of long line equation, surge impedance and surge impedance loading, the equivalent circuit of a long transmission line, power flow through a transmission line, circle diagrams, Ferranti effect. Reactive power compensation, transmission line transients, concept of travelling waves, reflection and refraction coefficients.

Total Hours: 45

Tutorials will be conducted separately for 15 hours

3. List of Experiments

The experiments are based on the MATLAB/ETAP simulations of power system components and hardware experiments and a substation/power plant visit.

1. Demonstration visit of 66 kV/22 kV SVNIT sub-station.
2. Study of single line diagram of Power System.
3. Power factor improvement of load.
4. Performance calculation of short and medium transmission lines.
5. Performance calculation of long transmission lines.
6. String efficiency calculation of suspension type insulator.

4. Books Recommended:

1. W. D. Stevenson, Element of Power System Analysis, McGraw Hill, 4th Edition 1982.
2. I. J. Nagrath and D. P. Kothari, Power System Engineering, 4th edition, Tata McGraw Hill publishing Company Ltd, 2014.
3. A. Chakrabarti, M. L. Soni, P. V. Gupta and U. S. Bhatnagar, A Text Book on Power System Engineering, Dhanpat Rai & Co., 2nd Edition 2001.
4. Hadi Saadat, Power System Analysis. 5th reprint, TMH publishing Company Ltd, 2004.
5. Arthur R. Bergen, Vijay Vittal, Power Systems Analysis, Prentice-Hall, Inc., 2nd Edition 2000.

B. Tech. II year, Semester IV

NUMERICAL METHODS AND APPLICATIONS TO ELECTRICAL ENGINEERING

L	T	P	Credit
3	1	2	05

EE232 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	understand the need of numerical methods, learn various system of representation of numbers.
CO2	compare the accuracy, convergence rate and computational complexity of various numerical methods.
CO3	solve algebraic and differential equations using numerical methods apply to Electrical Engineering problems.
CO4	model various electrical systems to interpolate, predict and perform regression analysis.
CO5	implement the algorithms through software like on C/C++/MATLAB.

2. Syllabus

- **ERRORS IN NUMERICAL COMPUTATION AND THEIR ESTIMATION (04 Hours)**
  Introduction, Taylor Theorem Revisit, Measuring Errors, Sources of Error, Binary Representation, Floating Point Representation, Propagation of Errors.
  Application: errors in electrical measurements and instrumentation

- **SOLUTION OF TRANSCENDENTAL AND POLYNOMIAL (06 Hours)**
  Bisection method, Secant Method, False position method, Newton Raphson method for Polynomial and transcendental equations, Generalized Newton's method system of nonlinear equations, rate of convergence, conditions for convergence

- **NUMERICAL INTEGRATION (03 Hours)**
  Trapezoidal rule, Simpson's 1/3 and 3/8 rules and Errors
  Applications: average, RMS quantity determination of electrical measuring quantities, load demand calculations.

- **SOLUTION TO SYSTEM OF LINEAR ALGEBRAIC EQUATIONS (08 Hours)**
  Gauss elimination method, Gauss Jordon Method, LU decomposition, Jacobi and Gauss Seidel Iteration methods, conditions for convergence, ill/well-conditioned systems.
  Applications: solution to mesh and nodal analysis of electrical networks, solution to power load flow, operation of different electrical applications

- **INTERPOLATION AND REGRESSION (12 Hours)**
  Direct method of interpolation, Linear interpolation and higher order interpolation using Lagrange's and Newton's forward, backward and divided difference formulae, linear, quadratic, exponential and logarithmic regression, adequacy of regression models.

Applications: prediction of the performance of electrical motors and generators from their practical data, application to load forecasting and generation scheduling, prediction of solar intensity and wind velocity.

- **EQUATIONS SOLUTION TO ORDINARY DIFFERENTIAL EQUATIONS** **(09 Hours)**

  Euler's Method, Modified Euler's Method, Runge-Kutta methods: II and IV order, higher order/coupled differential equations.

  Applications: DC and AC transients of electrical networks, solution for generator oscillations

Total Hours: 45

Tutorials will be conducted separately for 15 hours

3. List Of Experiments

The programmes are to be executed in C++/MATLAB

1. To find the roots of the polynomial using bisection, false position, Newton-Raphson, secant methods
2. To find the solution of set of nonlinear equations using Newton-Raphson method
3. To find the numerical integration suing trapezoidal, Simpson's 1/3 and Simpson's 3/8 method
4. To find the interpolating polynomial using Linear, Lagrangian, Newton's forward, backward and divided difference methods
5. To find the solution to set of linear simultaneous equations using Gauss elimination, Gauss-Jordan, Jacobi and Gauss-Seidel methods
6. To find the solution to ordinary differential equations using Euler's, modified Euler's, Runge-Kutta 2nd order and 4th order methods
7. To regress a given set of data using polynomial, exponential and logarithmic regression formulae

4. Books Recommended:

1. S. S. Shastri, Introductory Methods of Numerical Analysis, Prentice Hall Ltd., 4^{th} Edition, 2005.
2. M. K. Jain, M. K. Iyengar and S.R.K., Jain, Numerical Methods for Scientific and Engineering Computation, 4^{th} Edition, 2003, New Age international Publishers, Pvt. Ltd.
3. S. A. Teukolsky W. T. Vetterling, W. H. Press and B. P. Flannery, Numerical recipes in 'C', 2^{nd} Edition, Foundation Books Pvt. Ltd., 2001.
4. R. S. Salaria, Numerical methods: A computer-oriented approach, BPB Publications, 1996.
5. S. D. Conte and Carl de Boor, Elementary Numerical Analysis- An Algorithmic Approach, 3^{rd} Edition, McGraw-Hill, 1980.

B. Tech. II year, Semester IV

PROFESSIONAL ETHICS, ECONOMICS AND BUSINESS MANAGEMENT

L	T	P	Credit
3	1	0	04

MG210 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	Develop knowledge regarding Professional ethics
CO2	Develop knowledge of Economics in engineering
CO3	Develop managerial skills to become future engineering managers
CO4	Develop skills related to various functional areas of management (Marketing Management, Financial Management, Operations Management, Personnel Management etc.)
CO5	Build knowledge about modern management concepts
CO6	Develop experiential learning through Assignments, Management games, Case study discussion, Group discussion, Group presentations etc.

2. Syllabus

- **PROFESSIONAL ETHICS** **(06 Hours)**
  Introduction, Meaning of Ethics, Approaches to Ethics, Major attributes of Ethics, Business Ethics, Factors influencing Ethics, Importance of Ethics, Ethics in Management, Organizational Ethics, Ethical aspects in Marketing, Mass communication and Ethics - Television, Whistle blowing, Education – Ethics and New Professional, Intellectual Properties and Ethics, Introduction to Professional Ethics, Engineering Ethics
- **ECONOMICS** **(08 Hours)**
  Introduction To Economics, Applications & Scopes of Economics, Micro & Macro Economics, Demand Analysis, Demand Forecasting, Factors of Production, Types of Cost, Market Structures, Break Even Analysis
- **MANAGEMENT** **(15 Hours)**
  Introduction to Management, Features of Management, Nature of Management, Development of Management Thoughts – Scientific Management by Taylor & Contribution of Henry Fayol, Coordination & Functions Of Management, Centralization & Decentralization, Decision Making; Fundamentals of Planning; Objectives & MBO; Types of Business Organizations: Private Sector, Public Sector & Joint Sector; Organizational Behaviour: Theories of Motivation, Theories of Leadership
- **FUNCTIONAL MANAGEMENT** **(14 Hours)**
  Marketing Management: Core Concepts of Marketing, Marketing Mix (4p), Segmentation – Targeting – Positioning, Marketing Research, Marketing Information System, Concept of International Marketing, Difference Between Domestic Marketing & International Marketing; Operations Management: Introduction to Operations Management, Types of Operation Systems, Types of Layouts, Material Handling,

Purchasing & Store System, Inventory Management; Personnel Management: Roles & Functions of Personnel Manager, Recruitment, Selection, Training; Financial Management: Goal of Financial Management, Key Activities In Financial Management, Organization of Financial Management, Financial Institutions, Financial Instruments, Sources of Finance

- **MODERN MANAGEMENT ASPECTS** **(02 Hours)**
  Introduction To ERP, e – CRM, SCM, RE – Engineering, WTO, IPR Etc.

Total Hours: 45

Tutorials will be conducted separately for 15 hours

3. Tutorials

1. Case Study Discussion
2. Group Discussion
3. Management games
4. Assignments / Mini projects & presentation on related Topics

4. Books Recommended:

1. Balachandran V. and Chandrasekaran, Corporate Governance, Ethics and Social Responsibility, PHI, 2nd Edition, 2011
2. Prasad L.M., Principles & Practice of Management, Sultan Chand & Sons, 8th Edition,2015
3. Banga T. R. & Sharma S.C., Industrial Organisation & Engineering Economics, Khanna Publishers, 25th Edition, 2015
4. Everett E. Adam, Ronald J. Ebert, Production and Operations Management, Prentice Hall of India, 5th edition, 2012
5. Kotler P., Keller K. L, Koshi A.& Jha M., Marketing Management – A South Asian Perspective, Pearson, 14th Edition, 2014
6. Tripathi P.C., Personnel Management & Industrial Relations, Sultan Chand & sons, 21st Edition, 2013
7. Chandra P., Financial Management, Tata McGraw Hill, 9th Edition, 2015

5. Additional Reference Books / Further Reading:

1. Crane A. & Matten D., Business Ethics: Managing Corporate Citizenship and Sustainability in the Age of Globalisation, Oxford University, 2010
2. Fritzsche D. J., Business Ethics: a Global and Managerial Perspectives, McGraw Hill Irwin, Singapore, 2004
3. Mandal S. K., Ethics in Business and Corporate Governance, Tata McGraw Hill, 2011

B. Tech. II year, Semester IV

SPECIAL ELECTRICAL MACHINES

L	T	P	Credit
3	0	0	03

EE254 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	list different types of special electrical machines
CO2	describe the basic principles of special Electrical machines
CO3	compare the performance of various special electric machines
CO4	analyze the steady state performance of special Electrical machines
CO5	identify the special constructional and operating features of special electrical machines
CO6	select appropriate special electric machine for given application

2. Syllabus

- **SERVO MOTORS** **(05 Hours)**
  Symmetrical components applied to two - phase servo motors - equivalent circuit and performance based on symmetrical components - servo motor torque - speed curves.
- **VARIABLE RELUCTANCE MOTORS** **(08 Hours)**
  Construction of VRM, Concepts of co-energy and expression of torque, inductance, current and torque calculation and waveforms, Drive circuit for VRM.
- **STEPPER MOTORS** **(07 Hours)**
  Construction features, half stepping and the required switching sequence, stepper motor ratings, staticand dynamic characteristics, application and selection of stepper motor.
- **RELUCTANCE MOTORS** **(03 Hours)**
  Construction – poly-phase and split phase reluctance motors - capacitor type reluctance motors.
- **HYSTERISIS MOTORS** **(03 Hours)**
  Construction – poly-phase: capacitor type and shaded pole hysteresis motors.
- **UNIVERSAL MOTORS** **(03 Hours)**
  Essential parts of universal motor, performance characteristics and application.
- **LINEAR MACHINES** **(08 Hours)**
  Basic difference between LEMS and rotating - machine - classification of LEMS, linear motors and levitation machines - linear induction motors - linear synchronous motors - DC linear motors - linearlevitation machines.
- **PMDC MOTORS** **(02 Hours)**
  Construction, principle of operation, performance analysis.
- **BRUSHLESS DC MOTORS** **(06 Hours)**
  Construction, principle of operation, phasor diagram, characteristics, performance analysis.

Total Hours: 45

3. Books Recommended:

1. V. D. Toro, Electric machines and power systems, Prentice Hall of India, 1985.
2. Veinott, Fractional horse power electric motors, McGraw Hill, 4th Edition, 1987.
3. S. A. Nasar, Boldeal, Linear Motion Electric machine, John Wiley,1976.
4. V. V. Athani, Stepper Motors, New Age International Pvt. Ltd., 1997.
5. I. J. Nagrath and D. P. Kothari, Electric Machines, Tata McGraw Hill Publishing Company, New Delhi, 4th Edition, 2010.

B. Tech. II year, Semester IV

DIGITAL SIGNAL PROCESSING

L	T	P	Credit
3	0	0	03

EE255 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	classify the discrete time signals, systems
CO2	design optimum structures for realizing IIR and FIR systems
CO3	apply signal processing techniques to real situation problems
CO4	design and implement different types of FIR/IIR filters
CO5	develop various DSP FFT algorithms through software like MATLAB

2. Syllabus

- **INTRODUCTION** **(04 Hours)**
  Review of continuous-time signals and systems, convolution of continuous-time signals, Laplace transform, the Fourier series and Fourier transform.
- **DISCRETE-TIME SIGNALS AND SYSTEMS** **(08 Hours)**
  Sequences, discrete-time systems, linear time-invariant systems, convolution representation of linear time-invariant discrete-time systems, convolution of discrete-time signals, linear difference equations with constant coefficients, realizations, frequency-domain representation of discrete-time signals and systems.

- **SAMPLING OF CONTINUOUS-TIME SIGNALS** **(08 Hours)**
  Periodic sampling, frequency-domain representation of sampling, reconstruction of a band-limited signal, discrete-time processing of continuous-time signals, continuous-time processing of discrete-time signals, changing the sampling rate using discrete-time processing.

- **THE Z-TRANSFORM** **(07 Hours)**
  The Z-transform, properties of the Z-transform, transfer function representation, Inverse Z-transform, Z-transform applied to difference equations, the complex convolution theorem, stability of discrete-time systems, frequency response of discrete-time systems.

- **THE DISCRETE FOURIER TRANSFORM** **(09 Hours)**
  Discrete-time Fourier transform (DTFT), the discrete Fourier series, the Fourier transform of periodic signals, discrete Fourier transform (DFT), properties of the DFT, system analysis via the DTFT and DFT, circular convolution, linear convolution using the DFT. The Fast Fourier Transform (FFT) Algorithms: Decimation in time FFT, introduction to radix-2 FFTs, some properties of radix-2 decimation in time FFT, decimation in frequency algorithm, computing the inverse DFT by doing a direct DFT.

- **INTRODUCTION TO DIGITAL FILTERS** **(09 Hours)**

  Recursive digital filters-infinite impulse response (IIR) Filters: Analog approximations, impulse invariant method, bilinear transformation method, matched Z-transform method, realizations, non-recursive digital filters – finite impulse response (FIR).

Total Hours: 45

3. Books Recommended:

1. Sanjit K. Mitra, Digital Signal Processing: a computer based approach, McGraw-Hill Education, 2010, ISBN-13: 978-0077366766.
2. A. V. Oppenheim, R W Schafer, J. R. Buck, Discrete-Time Signal Processing, Prentice Hall, New Jersey, 1998.
3. John G Proakis, Dimitris G. Manolikis, Digital Signal Processing, Principles, Algorithms and Applications, Prentice Hall, Inc. New Jersey, 1996

B. Tech. II year, Semester IV

POWER PLANT ENGINEERING

EE256

L	T	P	Credit
3	0	0	03

Scheme

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	understand the economics of power generation
CO2	explain the basics of various components of the power station
CO3	describe the working of steam and hydro power stations
CO4	describe the working of nuclear, diesel and gas power stations.
CO5	explain the working of the power stations based on non-conventional resources.
CO6	design the controllers for various power stations.

2. Syllabus

- **STEAM POWER STATION** **(05 Hours)**
  Main flow circuits of thermal power station, thermodynamic cycles of steam flow, general layout of power stations, power station auxiliaries, cooling system of alternators, flue-gas flow arrangement, circulating water system, cooling tower.
- **HYDROELECTRIC POWER PLANT** **(06 Hours)**
  Selection of site, water power equations, types of dams, arrangement and layouts of hydro-electric station, classification of plants, water turbines, properties of water wheels, specific speed on the basis of discharge, combined steam and hydro-plants, pumped storage hydro station.
- **NUCLEAR POWER STATION** **(08 Hours)**
  Atomic structure, isotopes, energy release by fission, chain reaction, atomic reactor, fuels, moderators and coolants, types of reactors, fast breeder reactor, radio activity and hazards.
- **DIESEL AND GASTURBINE STATION** **(06 Hours)**
  Field of use, general layout and principle of operation.
- **NON-CONVENTIONAL METHOD OF POWER GENERATION** **(06 Hours)**
  MHD generation, wind power, tidal power, solar power, solar cell and fuel cell.
- **COMBINATIONS OF DIFFERENT TYPES OF POWER PLANTS** **(10 Hours)**
  Types of power station, advantages of combined working of different types of power station, need for coordination of different types of power station, run-off river plant in combination with steam plant, hydro- electric plants with ample storage in combination with steam plants, pumped storage plant in combination with ordinary hydro-electric plant, co-ordination of hydro-electric and gas turbine plant, co-ordination of hydro-electric and nuclear power station, co-ordination of different types of power plants in power station.

- **POWER STATION CONTROL** **(04 Hours)**
  Excitation systems, excitation control, field protection, commissioning of alternators, power supply for station auxiliaries, power station control.

Total Hours: 45

3. Books Recommended:

1. Nag, P. K. (2008). Power plant engineering. New Delhi, India: Tata McGraw-Hill.
2. Arogya swamy, Power Station Practice, Oxford & IBM Publication Co., New Delhi, 1976.
3. Baptidanov L., Power Station & Substation, Moscow Peace Publication.
4. Leznov S. & Taits, Power Station & Substation Maintenance, Moscow Mir Publication, 1983.
5. Leznov S. & Taits, Power Station Electrification, Moscow Mir Publication, 1983.
6. Bruce, John, London, Power Station Efficiency Control, Sir Issac Pitman & Sons Ltd., 1926.

B. Tech. II year, Semester IV

ENERGY AUDIT AND MANAGEMENT

L	T	P	Credit
3	0	0	03

EE257 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	recognize the significance of energy management and its role in industries
CO2	analysis of Energy conservation and needs of energy audit and management.
CO3	evaluate the energy economics.
CO4	plan and design energy efficient systems
CO5	estimate the economy and judge the environmental concerns.

2. Syllabus

- **ENERGY MANAGEMENT** **(12 Hours)**
  Energy Scenario – Energy Demand and Ecological Balance –Resource availability and management, Strategies, Tools available, Energy Monitoring and Targeting, Energy Norms, Energy Policy, Demand Side Management–Role of Energy Managers in Industries - maximizing system efficiencies, Optimizing input energy requirements - Principles and Imperatives of Energy Conservation - Energy Consumption pattern, Energy Conservation acts, Energy Conservation Implementation Programme (ECIP), Energy Audit concepts, needs, energy management (audit) approach, energy audit instruments, Energy action planning and Project management.
- **ELECTRICAL ENERGY AUDITING** **(12 Hours)**
  Potential areas of Electrical Energy Conservation in various industries–Energy Management opportunities in Cable selection, Electricity Act, Electric Heating and Lighting systems –Six basic rules of Energy, Efficient Lighting, Energy losses in electric motors and drives, Energy Efficient Motors and Drives, Soft starters with energy saver, Power factor improvement, Energy conservation in domestic gadgets and transport, DG system- factors affecting selection & performance.
- **ENERGY ECONOMICS** **(11 Hours)**
  Economic analysis of investments, Present value criterion, Discount rate, simple payback period, return on investment, net present value(NPV), internal rate of return, life cycle costing, energy performance contracts and role of ESCOs, Energy Management Information Systems.
- **ECONOMICS OF POWER GENERATION** **(10 Hours)**
  Factors affecting the cost of generation – Load factor, Diversity factor, Plant capacity factor, Plant use factor, Load curves, Load duration curves, Reduction of costs by Interconnection of Stations, Choice of size & number of generator units, Tariffs : types and significance.

Total Hours: 45

3. Books Recommended:

1. Albert Thumann, Handbook of Energy Engineering, The Fairmont Press Inc., 6th Edition, 2003.
2. Wayne C. Turner, Energy management Handbook, John Wiley and sons, 9th Edition, 2019.
3. Prasanna Chandra, Financial management, Tata McGraw Hill, 10th Edition, 2019.
4. S. Choudhury, Projects: Planning, Analysis, Selection, Implementation and Review, Tata McGraw Hill Publishing Company, New Delhi, 1995.
5. Cleaner Production, Energy Efficiency Manual for GERIAP, UNEP, prepared by National Productivity Council, Bangkock.

B. Tech. II year, Semester IV

ELECTRICAL CIRCUITS (For Minor Degree)

(For B. Tech. CE, ME, ChE, IndChe, MaC students)

L	T	P	Credit
3	1	0	04

EE281 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	able to apply various techniques like mesh and nodal analysis and network theorems for circuit problems
CO2	explain the principles of magnetic circuits and solve the series and parallel ac circuits
CO3	analyze poly-phase circuits
CO4	calculate various parameters of two port network and inter relationship between them.
CO5	develop a mathematical model (differential equations) of a given electric circuit and solve it

2. Syllabus

- **ELECTRICAL NETWORKS ANALYSIS (10 Hours)**
  Kirchhoff's Voltage Law, Kirchhoff's Current Law, independent and dependent sources, Mesh current and Nodal Voltage analysis, Super position theorem, Thevenin's theorem, Norton's theorem, Reciprocity theorem, Maximum power transfer theorem
- **MAGNETISM AND ANALYSIS OF AC CIRCUITS (12 Hours)**
  Faradays law, Lenz law, self-inductance, mutual inductance, coefficient of mutual inductance, coefficient of coupling, inductance in series, parallel, series-parallel, Analysis of coupled coils, dot rule, conductively coupled equivalent circuit. Complex algebra and its application to circuit analysis, R-L, R-C, R-L-C series and parallel circuits, series and parallel resonance.
- **POLYPHASE CIRCUITS (08 Hours)**
  Balanced three phase systems, star and mesh connections, calculations for balanced and unbalanced three phase networks, poly-phase vector diagram, and measurement of power in three phase circuits.
- **TWO PORT NETWORKS (07 Hours)**
  Introduction two port networks, Impedance Parameters, Admittance Parameters, Hybrid Parameters, inverse hybrid parameters, Transmission Parameters, Relationships Between Parameters, Interconnection of Networks
- **AC AND DC TRANSIENTS (08 Hours)**
  Transient response of R-L, R-C and R-L-C circuits, complete response of RL, RC and RLC circuits to step, sinusoidal, exponential, ramp, impulse and the combinations of these excitations.

Total Hours: 45

Tutorials will be based on the coverage of the topics given in the detailed syllabus separately for 15 hours

3. **Books Recommended:**

1. W. H. Hayt, J. E. Kemmerly, and Durbin S. M., Engineering Circuit Analysis, Tata McGraw Hill, 6th Edition, 2006.
2. M.E. Van Valkenburg, Network Analysis, Prentice Hall, India, 3rd Edition, 2002.
3. A. Chakrabarti, Circuit Theory, Dhanpat Rai & Co., 6th Edition, 2012.
4. A. Edminister Joseph, Electrical circuits, Schaum's outline series, McGraw hill, 2nd Edition, 1983.
5. Charles K. Alaxander and Matthew N.O. Sadiku, Fundamentals of electric circuits, Tata McGraw Hill, 5th Edition, 2013.

B. Tech. II year, Semester IV

ELECTRICAL MACHINES (For Minor Degree)

(For B. Tech. AI,CSE,ECE, ECVLSI, EnggPhy students)

L	T	P	Credit
3	0	2	04

EE282 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	Explain the construction and principle of operation of the DC motors, transformers, induction motors, Synchronous generator and Fractional horse power motors.
CO2	Perform tests on the DC motors, transformers, induction motors and Synchronous generator.
CO3	Compute performance parameters of the DC motors, transformers, induction motors and Synchronous generator.
CO4	Analyze the performance of the DC motors, transformers, induction motors and Synchronous generator.
CO5	Select the machines for different real world applications
CO6	Communicate effectively through laboratory report writing, presentation and perform task as an efficient team member

2. Syllabus

- **DC MOTORS** **(08 Hours)**
  Construction and working principle, EMF equation, Torque equation, Classification of DC motors and their characteristics, Speed control, Braking, Applications.
- **Transformers** **(08 Hours)**
  Construction and working principle, Equivalent circuit, Open circuit and Short Circuit tests, Regulation and efficiency, Autotransformers, Different connections of three phase transformers.
- **THREE-PHASE INDUCTION MOTOR** **(09 Hours)**
  Construction and working principle, Equivalent Circuit, No load and Blocked rotor tests, Torque equation, Torque–slip characteristics, Speed control, Industrial applications.
- **SYNCHRONOUS GENERATOR** **(10 Hours)**
  Construction, Principle of operation and types, Various types of excitation systems, Equivalent circuit, Determination of voltage regulation by synchronous impedance method.
- **FRACTIONAL HORSE POWER MOTORS** **(10 Hours)**
  Single phase induction motors – Construction and principle of operation, Classification based on starting method, Applications in home appliances. Construction and application of Stepper motors, Servomotors and Universal motors.

Total Hours: 45

3. List Of Experiments

1. Determination of efficiency & regulation of single- phase transformer from Open circuit and short circuit test
2. Load test on single phase transformer
3. Determination of the equivalent circuit parameters from No-Load and Blocked rotor tests of three-phase Induction Motor.
4. Load test on three-phase Induction Motor.
5. Speed control of dc shunt motor.
6. Speed torque characteristic of a D. C. Shunt motor.
7. D. C. Series motor, Speed -torque characteristic.
8. Swinburne's test
9. Regulation of an alternator by synchronous impedance method
10. To study the construction and starting method of a single phase induction motor

4. Books Recommended:

1. D.P.Kothari and I.J.Nagrath, 'Electric Machines', McGraw Hill Education Private Limited, latest Edition.
2. A Fitzgerald, Charles Kingsley, Stephen Umans, 'Electric Machinery', McGraw Hill Education, latest edition.
3. Mukherjee and Chakravorty, Electrical Machines, Dhanpat Rai Pub., New Delhi, latest edition
4. M. G. Say, The performance and design of alternating current machines, CBS Publishers and Distributors, Delhi, latest edition
5. A. E. Clayton and N. M. Hancock, The Performance and Design of Direct Current Machines, CBS Publishers

B. Tech. II year, Semester IV

MODELING OF ELECTRICAL MACHINES

(For B. Tech. in Electrical Engineering with honors)

L	T	P	Credit
3	1	0	04

EE291 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	explain the basic principle of electrical machines based on principle of electromagnetic energy conversion
CO2	develop the mathematical model of DC machine
CO3	explain various reference frame theories for modeling electric machines
CO4	deduce the mathematical model of induction, synchronous and permanent magnet synchronous machines based on reference frame theory
CO5	analyze the performance of electric machines based on the derived mathematical machines
CO6	simulate various electric machines based on mathematical models

2. Syllabus

- **BASIC PRINCIPLE OF ELECTRIC MACHINE** **(05 Hours)**
  Review of Magnetic circuit and electromagnetics (Faraday's law, Ampere's law, Bio Savart's law, Kirchhoff law and Maxwell's equation (integral form and point form)), Principle of transformer action, Principle of Electromagnetic Energy Conversion, Elementary electric machine
- **DC MACHINE MODELLING** **(06 Hours)**
  Modeling of D.C. Machine (Separately Excited, shunt and series type), Linearization of machine equations, State-Space Modeling of the machine.
- **INDUCTION MACHINE MODELING** **(12 Hours)**
  Distributed Winding in AC Machinery, winding function, air gap mmf, rotating mmf, Flux linkage and Inductance, Stator and rotor voltage equation and torque equation in stator reference frame, Reference frame theory: Space phasor description, Derivation of induction motor modelling in rotor flux and stator flux reference frame, Derivation of steady state model.
- **PERMANENT MAGNET MACHINE MODELING** **(11 Hours)**
  Voltage and torque equation of surface mount permanent magnet machine in stator reference frame, Voltage and torque equation of surface mount permanent magnet machine in rotor reference frame, Derivation of steady state model.
- **SYNCHRONOUS MACHINE MODELING** **(11 Hours)**
  Voltage and torque equation of salient pole synchronous machine including damper winding in stator reference frame, Voltage and torque equation of salient pole synchronous machine including damper winding in rotor reference frame.

Total Hours: 45

3. Books Recommended:

1. P. C. Krause, Oreg Wasynczuk, Scott D. Sudhoff, “Analysis of Electric Machinery and drive systems”, Wiley Interscience, 2nd Edition, 2010.
2. P. S. Bimbhra, “Generalized theory of Electrical M/C”, Khanna Publication, 2000.
3. S. K. Sen, “Electrical Machinery”, Khanna Pub., Delhi, 2012.
4. Mrittunjay Bhattacharya, “Electrical Machines: Modelling and Analysis”, PHI, 2016.
5. R. Ramanujam, “Modelling and Analysis of Electrical Machines”, Wiley, 2019.

B. Tech. II year, Semester IV

COMPUTER METHODS IN POWER SYSTEM

(For B. Tech. in Electrical Engineering with honors)

L	T	P	Credit
3	1	0	04

EE292 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	illustrate various methods of solving linear system
CO2	apply various methods of solving non- linear system to power system problems.
CO3	apply various methods of solving sparse matrices to power system problems.
CO4	use various methods of numerical integration to solve differential equation pertaining to power system.
CO5	use modal analysis for small signal stability study of power systems.
CO6	Estimate states of the system using optimization techniques

2. Syllabus

- **SOLUTION OF LINEAR SYSTEMS** **(07 Hours)**
  Gaussian elimination, LU factorization with partial and complete pivoting, condition numbers and error propagation, relaxation methods, conjugate gradient methods.

- **SOLUTION OF NONLINEAR SYSTEMS** **(07 Hours)**
  Method to solve nonlinear system: Newton's method, Broyden's method, Finite difference method, Power system applications: Power flow, regulating transformers, Decoupled power flow, Fast Decoupled power flow, PV curves and continuation power flow, Three phase power flow.

- **SPARSE MATRIX SOLUTION TECHNIQUES** **(07 Hours)**
  Storage methods, sparse matrix representation, Ordering schemes: Scheme O, Scheme I, Scheme II, Other scheme, Power system applications.

- **NUMERICAL INTEGRATION** **(07 Hours)**
  explicit methods, implicit methods, One step methods, Multistep methods, fixed step methods, variable step methods, Stability and accuracy-analysis of numerical methods, stiff systems, step size selection, differential algebraic systems, Power system application: Transient stability analysis.

- **EIGENVALUE PROBLEMS** **(08 Hours)**
  Eigen value computations methods: QR algorithm, Power method, Arnoldi methods, Prony method. Power system applications: Modal analysis, participation factors, SSR analysis.

- **OPTIMIZATION** **(09 Hours)**
  Least squares optimization, Weighted Least square optimization, Steepest Descent algorithm, Newton's method. Power system applications: Optimal power flow, Linear and Nonlinear least square state estimation.

Total Hours: 45

3. Books Recommended:

1. Mariesa Crow, Computational Methods for Electric Power Systems, 2nd edition, Electric power engineering series, CRC Press, 2009.
2. S. A. Soman, S. A. Khaparde, and Shubha Pandit, Computational Methods for Large Sparse Power System Analysis, Kluwer Academic Publishers, 2012.
3. Stagg and El-Abiad, Computer Methods in Power System Analysis, McGraw Hill Series, International student Edition, 1968.
4. Reijer Idema and Domenico J. P. Lahaye, Computational Methods in Power System Analysis, Volume 1, Atlantis Press, Atlantis Studies in Scientific Computing in Electromagnetics. 2014.
5. J. Arrillaga and C. P. Arnold, Computer Analysis of Power Systems, John Wiley & Sons Ltd, 1990

B. Tech. II year, Semester IV

Industrial Automation and Control

(For B. Tech. in Electrical Engineering with honors)

L	T	P	Credit
3	1	0	04

EE293 **Scheme**

1. Course Outcomes (COs):

At the end of the course, the students will be able to:

CO1	construct state-space models for the systems from the ubiquitous domains, i.e. electrical, Mechanical Systems and dynamic systems, etc.
CO2	correlate concepts, methodologies of differential equations, transfer function model with the state space techniques.
CO3	recast linear, nonlinear, multi input multi output, continuous and discrete systems in state space form.
CO4	design control systems using the state space techniques and analyze the properties of state space models which are essential for developing controllers and observers.
CO5	apply state space techniques for the models of real world problems.

2. Syllabus

- **MATHEMATICAL BACKGROUND-MATRICES: (03 Hours)**
  Definition of Matrices; Matrix Algebra; Matrix Multiplication and Inversion; Rank of a Matrix; Differentiation and Integration of Matrix.

- **STATE SPACE ANALYSIS METHODS AND TECHNIQUES: (16 Hours)**
  State Variables; State-Space Representation of Electrical and Mechanical and Electromechanical Systems; State Space Representation of Nth Order, Linear Differential Equation; Transformation to Phase Variable Canonical Form; Relationship Between Transfer Functions and State Equations; Characteristic Equation; Eigen Values and Eigen Vectors; Transformation to Diagonal Canonical Form; Jordan Canonical Form.

- **SOLUTION OF THE TIME-INVARIANT SYSTEMS: (07 Hours)**
  Solution of the Time-Invariant State Equation; State Transition Matrix and its Properties; Transfer Matrix; Transfer Matrix of Closed Loop Systems, Methods of calculations of the matrix exponentials using algebraic and algorithmic methods.

- **CONTROLLABILTY AND OBSERVABILITY: (10 Hours)**
  Concept of Controllability and Observability; Kalman's Theorems on Controllability; and Observability, Alternative Tests (Gilbert's Method) of Controllability and Observability; Principle of Duality; Relationship among Controllability, Observability and Transfer Function, Decomposition of Transfer Function-Direct, Cascade and Parallel Decomposition; State Diagram.

- **LYAPUNOV STABILITY ANALYSIS:** **(09 HOURS)**
  Stability of Equilibrium State in the Sense of Lyapunov; Graphical Representation of Stability; Asymptotic Stability and Instability; Sign-Definiteness of Scalar Function; Second Method of Lyapunov; Stability Analysis of Linear Systems; Krasovskii's Theorem; Lyapunov Function Based on Variable Gradient Method.

Total Hours: 45

3. Books Recommended:

1. J. Nagrath & M. Gopal, "Control System Engineering", New Age International Publisher Edition, 2001.
2. K. Ogata, "Modern Control System Engineering", Pearson Education Asia, 4th Edition, 2002
3. B. C. Kuo, "Automatic Control Systems", Prentice Hall of India, 7th Edition, 1995.
4. Nise N. S., "Control System Engineering", John Wiley & sons, 4th Edition, 2004.
5. P. F. Blackman, "Introduction to State Variable Analysis", the McMillan Press, 1st Ed 1977.
6. Williams, R. L. and Lawrence, D. A. Linear State-Space Control Systems, John Wiley: N New Jersey, 2007.

B. Tech. II year, Semester IV Vocational Training/ Professional Experience (optional) (Mandatory for Exit) Energy Audit EEV04/EEP04	Scheme	L	T	P	Credit
		0	0	10	5

Course outcomes:

At the end of this course the students will be able to

CO1	Explain the energy audit process and its importance
CO2	Understand various standards related to energy audit
CO3	Assess the data collected from various sources for energy audit
CO4	Prepare the energy audit report
CO5	Perform case studies for different types of establishments

Sl. No.		Hours
1.	Introduction to Energy Audit: Global standards of Energy Audit, Direct and indirect benefits of energy audit, Energy Audit Process	25
2.	Types of Energy Audit: Preliminary and Detailed Audit, Visible Energy loss identification in walk through audit, Energy Audit criteria, Scope of energy Audit, Selection of Audit team Energy Audit Plan	25
3.	Preparation of Energy Audit: Collecting energy bills and data, Conducting preliminary analysis, Sample Energy flow charts	25
4.	Execution of Energy Audit: Data inventory and management, Graphical representation of data, Analysing Energy use pattern, Bench-marking and comparative analysis, Identifying Energy Saving Potential Cost benefit analysis	25
5.	Reporting of Energy Audit: Preparing Energy Audit Report with Recommendations, Preparing Action Plan, Implementing the action plan, Sample audit report	25
6.	ISO 50001 and Energy Management Case Studies: ISO 50001, Features of ISO 50001	25
7.	Case Studies of various types of buildings or industries etc.	50
	Total (Notional Hours)	200