# Syllabus

## B.Tech. (Electrical and Electronics Engineering)

### II Year III Semester

| 3EX4-01:Electrical Circuit Analysis-I | |
|---|---|
| **Credit:3** | **Max Marks:100(IA: 30,ETE: 70)** |
| **3L+0T+ 0P** | **EndTermExams:3hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Construct a circuit to suit the need and apply Nodal and Mesh methods to analyze the circuit.

**CO-2:** Learn the importance of circuit and networks and its applications in Electrical Engineering using theorems.

**CO-3:** Apply linearity/superposition concepts to analyze RL, RC and RLC circuits in time and frequency domains.

**CO-4:** Understand the concept of Laplace Transform and its application for the transient analysis of the circuits.

| S.No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:**Objective, scope and outcome of the course. | **1** |
| 2. | **Basic Concepts**: Active and passive elements, Concept of ideal and practical sources, Ohm's law, Source transformation, Kirchoff's laws, Analysis of networks by Mesh and Node voltage methods with independent and dependent sources. **Graph Theory:**Graph of network, Tree, Incidence matrix, Cut-sets, f-circuits analysis and f-cut set analysis, Duality, Methods of obtaining dual network. | **9** |
| 3. | **Network Theorems:** Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem and Tellegen's theorem. Analysis of networks with and without dependent AC and DC sources. | **9** |
| 4. | **1-phase and 3-phase AC Circuits:** 1-phase series and parallel AC circuits, Analysis of series and parallel resonant circuits. Bandwidth and Quality factor at resonance.<br>3-phase Star and Delta connection, Balanced and unbalanced 3-phase voltages, currents and impedances. Powers in 3-phase AC system, Power triangle, Complex Power. Analysis of three phase AC circuits. | **8** |
| 5. | **Transient Analysis:** Transient analysis of RL and RC circuits under DC excitations, Behavior of circuit elements under switching action, Response of networks under step, ramp, impulse, pulse and sinusoidal inputs. Time domain | **8** |

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| | and frequency domain analysis of circuits. | |
| 6. | **Transient Analysis using Laplace Transformation:** Laplace transformation, Laplace transformation of impulse, step, ramp, sinusoidal signals and shifted functions. Initial and Final value theorems. Special signal waveforms with Laplace transform and applications to circuit operations. | **7** |
| | **Total** | **42** |

**Suggested Books:**


1. Engineering Circuit Analysis, William H. Hayt et al, Mc Graw Hill Publications.
2. Network Analysis, M.E.Vanvalkenburg, Pearson Publications.
3. Fundamentals of Electric Circuits, Charles K.et al, Mc Graw Hill Publications.
4. A. Chakarvorty, Circuit Theory, Publisher Dhanpat Rai & Co. (Pvt.) Ltd.
5. Engineering Circuit Analysis, J David Irwin et al, Wiley India.
6. Electric Circuits, Mahmood Nahvi, Mc Graw Hill.
7. Introduction to Electric Circuits, Richard C Dorf and James A Svoboda Wiley.
8. Circuit Analysis: Theory and Practice, Allan H Robbins et al, Cengage.
9. Basic Electrical Engineering, V. K. Mehta, Rohit Mehta, S. Chand Publications.
10. D. Roy Choudhury: Network & Systems, Wiley Eastern Ltd.

**II Year III Semester**

| 3EX4-02: Electrical Machines-I | |
|---|---|
| **Credit:3** | **Max Marks:100(IA: 30,ETE: 70)** |
| **3L+0T+ 0P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Understand the magnetic circuits and basic principle of energy conversion.
**CO-2:** Learn the basic principles of DC machine and transformers.
**CO-3:** Evaluate performance characteristics of the DC machine and transformer.
**CO-4:** Know the basic working of single phase as well as poly phase Transformer.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **Magnetic Circuits:** MMF, flux, reluctance, inductance, Ampere'slaw and Biot-Savart'slaw, Visualization of magnetic fields produced by a bar magnet and a current-carrying coil through air and magnetic medium, Influence of permeable materials on the magnetic flux lines.<br>B-H curve of magnetic materials, Characteristic of magnetic circuits; Linear and nonlinear magnetic circuits; Energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to the position of a moving element. | **7** |
| 3. | **D.C. Generators:** Construction of DC machines, Types of DC machines, Working principle and EMF equation of DC generators, Lap and Wave windings, Armature reaction in DC Generators, Commutation and methods of improving commutation, Characteristics of DC Generators, Voltage Build-up in self-excited generator, Critical field resistance and critical speed, Characteristics of DC Shunt, Series and Compound generators, Power Flow in DC Generator, Losses and Efficiency in DC Generator,Condition for maximum efficiency. | **9** |
| 4. | **DC Motors:** Basic principles of electromagnetic energy conversion, Principal, Back-EMF and torque of DC motor, Types, V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control of DC motors through field and armature voltage. Basic idea of solid-state devices in controlling of DC motors.<br>Starting of DC motors, three point and four-point starters, losses and efficiency, testing of DC motors: Brake test and Swinburne's test, Electric braking of DC motors, Applications. | **8** |
| 5. | **Transformers:** Construction, principle of working, equivalent circuit of single-phase transformers, EMF equation, No-load and Full-load operation of transformer, Voltage regulation, Losses and Efficiency, Parallel operation of transformer, Open circuit and short circuit test, back-to-back (Sumpner's test), | **8** |

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| | Condition for Maximum Efficiency, All Day Efficiency, Applications of Transformer. | |
| 6. | **Three-phase Transformers:** Constructional features of 3-phase transformers. Transformer connection for 3-phase operation–star/star, delta/delta, star/delta, zigzag/star and V/V, comparative features. Phase conversion-Scott connection for 3-phase to 2-phase conversion.<br>**Auto-transformers:** Single phase Auto-transformer, Volt-ampere relations, Step-up Auto-transformers, Efficiency, Saving in Copper material, Conversion of two winding transformer to an Auto-transformer, Advantages, Disadvantages and applications of Auto-transformer. | **8** |
| | **Total** | **41** |

**Suggested Books:**


1. Electrical Technology Part - II by B. L. Theraja, S. Chand Publications.
2. Electrical Machines by M. V. Deshpande, PHI Learning.
3. Electrical Machines by Ashfaq Hussain, Dhanpat Rai and Co.
4. Electrical Technology by S. L. Uppal, Khanna Publication
5. Electric Machinery by E. Fitzgerald and C. Kingsley, McGraw Hill Education
6. Electric Machines by I. J. Nagrath and D. P. Kothari, McGraw Hill Education
7. Theory and Performance of Electrical Machines by J. B. Gupta, Katson Publication
8. Electrical Machinery by P. S. Bhimbhra, Khanna Publishers

## II Year III Semester

| 3EX4-03: Electrical Measurements | |
|---|---|
| **Credit:3** | **Max Marks:100(IA: 30,ETE: 70)** |
| **3L+0T+ 0P** | **End Term Exams: 3 hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Understand the common electrical measuring instruments and their use in field.

**CO-2:** Learn about the instrument transformers for the measurement of high voltage and current along with the testing of CTs and PTs.

**CO-3:** Know the categories of various resistances and their measurement techniques along with the potentiometer.

**CO-4:** Understand the concept AC bridges for the measurement of electrical circuit parameters.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:**Objective,scopeandoutcomeofthecourse. | **1** |
| 2. | **Electrical Measuring Instruments:** Deflecting, control and damping torques in instruments, moving coil, moving iron, electrodynamic and induction type instruments-construction, operation, torque equation and errors. Applications ofinstruments for measurement of current, voltage, 1-phase power and energy. Induction type of energy meter:driving and braking torques, Errors in wattmeter and energy meter and their compensation.Testing and calibration of energy meter by phantom loading. | **7** |
| 3. | **3-phase Metering:** Blondel's Theorem for n-phase, p-wire system. Measurement of power and reactive kVA in 3-phase balanced and unbalanced systems: One-wattmeter, two- wattmeter and three-watt meter methods. 3-phase induction type energy meter. **Instrument Transformers:** Construction and operation of current and potential transformers. Errors and their minimization in CT and PT. Testing of CT sand PTs. Applications of CTs and PTs for the measurement of current, voltage, power and energy. | **9** |
| 4. | **Resistance Measurement:** Method of measuring low, medium and high resistances. Measurement of medium resistances: ammeter and voltmeter method, substitution method, Wheatstone bridge method. Measurement of low resistances: Potentiometer method and Kelvin'sdouble bridge method. Measurement of high resistance: Loss of charge method, Price's Guardwiremethod. Measurement of earth resistance. | **8** |
| 5. | **Potentiometers:** Construction, operation and standardization of DCpotentiometers: Slide wire and Crompton potentiometers. Use of potentiometer formeasurement of resistance and calibration of voltmeter and ammeter.**AC potentiometer**: Volt ratio boxes. Construction, operation and standardization of AC potentiometer: in-phase and quadrature potentiometers. | **8** |

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| | Applications of AC potentiometers. | |
| 6. | **AC Bridges:** Four-arm AC bridges. Sources and detectors in bridges. Maxwell's bridge, Hay's bridge and Anderson bridge for self-inductance measurement. Heaviside's bridge for mutual inductance measurement. De-Sauty Bridge for capacitance measurement. Wien's bridge for capacitance and frequency measurements. Errors in measurements through AC bridge and precautions. Screening of bridge components. Wagner earth device. | **8** |
| | **Total** | **41** |

**Suggested Books:**

1. Electrical Measurements and measuring Instruments, E.W. Golding and F.C. Widdis, Wheeler Publishing.
2. Electrical and Electronic Measurement and Instruments, A.K.Sawhney, Dhanpat Rai and Co.
3. Electrical Measurements, Buckingham and Price, Prentice – Hall.
4. Electrical Measurements: Fundamentals, Concepts, Applications, Reissland, M.U, New Age International (P) Limited Publishers.

## II Year III Semester

| 3EX4-04:Analog Electronics | |
|---|---|
| **Credit:3** | **Max Marks:100(IA: 30,ETE: 70)** |
| **3L+0T+ 0P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:
**CO-1:** To analyze PN junctions in semiconductor devices under various conditions.
**CO-2:** To Design and analyze various diodes and its applications.
**CO-3:** To understand BJT and FET configurations.
**CO-4:** To design and analyze BJT and FET amplifiers.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **Fundamental of Semiconductor Physics:** General Material Properties & Crystal Structures, Classifications of Semiconductors, Fermi-Dirac Distribution Function, Density of State, Equilibrium Carrier Concentration of Holes/Electrons in Intrinsic/Extrinsic Semiconductors, Drift/Diffusion Equations, Generation/ Recombination, Carrier Lifetime, Continuity Equation, Elements of Quantum Mechanics, | **7** |
| 3. | **PN Junction Diode and its Applications:** Junction Terminologies, Qualitative and Quantitative Analysis of Diode (Poisson Equation, space charge, built-in potential, depletion width), ideal diode volt-ampere equation, Avalanche and Zener breakdown, diode capacitances, reverse recovery transients, Diode based circuits, clippers, clampers, voltage multipliers, half/full wave rectifiers, diode as gate, Zener diode voltage regulators, Small Signal Model of Diode. | **9** |
| 4. | **Bipolar junction Transistors:** Terminology, Simplified Structure, Electrostatics, General Operation Considerations, Performance Parameters, I-V characteristics of CE/CB/CC configuration, Ebers-Moll Model, base width modulation, Load Line Analysis, DC Operating Points, Need of Biasing, Fixed Bias Circuits, Self-Bias Circuits, Voltage Divider Bias Circuits, Stability Factor, Thermal Runaway, Thermal Stability. | **8** |
| 5. | **Field Effect Transistors:** Introduction to FET, Bias stability in FET, Different FET Configuration, Analysis of CS, CG and CD Configuration, Voltage Biasing Techniques, MOS capacitor, Depletion Mode and Inversion, MOSFET Operation and Enhancement Mode of MOSFET, derivation of I-V Characteristics of MOSFETs. | **8** |
| 6. | **Low Frequency Small Signal Amplifiers:** BJT as an amplifier, small signal models of BJT, CE/CC/CB amplifiers, emitter degeneration, multistage amplifiers, low frequency analysis of amplifiers, Miller Theorem, | **8** |

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|---|---|---|
| | JFET/MOSFET as an amplifier, small signal models of JFET/MOSFET, CS/CD/CG amplifiers, source degeneration. | |
| | **Total** | **41** |

**Suggested Books:**


1. J. Millman and C. Halkias, Integrated Electronics, TMH
2. R. L. Boylestad & L. Nashelsky, Electronic Devices and Circuit Theory, Pearson Education
3. A. Sedra and K. Smith, Microelectronic Circuits, Oxford University Press
4. B. Razavi, Fundamentals of Microelectronics, Wiley
5. B. G. Streetman and S. K. Banarjee, Solid State Electronic Devices, Pearson/PHI
6. Donald Neamen, Semiconductor Physics & Devices, TMH
7. D. A Neaman, Microelectronics: Circuit Analysis & Design, TMH


**Other Resources**

NPTEL Course on Electronics for Analog Signal Processing (I & II) by K. R. Rao, IIT Madras
NPTEL Course on Analog Circuits by A. N. Chandorkar, IIT Bombay
NPTEL Course on Analog Circuits by Sauribrata Chatterjee, IIT Delhi
NPTEL Course on Introduction to Solid State Devices by S. Karmalkar, IIT Madras

## II Year III Semester

| 3EX4-05: Power System Instrumentation | |
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| **Credit:2** | **Max Marks:100(IA: 30,ETE: 70)** |
| **2L+0T+ 0P** | **EndTermExams:2 hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Understand the various types of errors in instruments.

**CO-2:** Learn about the sensors and transducers for the measurement of temperature, pressure, displacement, acceleration and noise level.

**CO-3:** Know the amplifiers, multipliers, dividers, function generators, timers, sample-hold, isolators, shielding and grounding.

**CO-4:** Understand the instrumentation in the power plants and computer based modern schemes for operation, maintenance and protection of power systems.

| S. No. | Contents | Hours |
| --- | --- | --- |
| 1. | **Introduction:**Objective,scopeandoutcomeofthecourse. | **1** |
| 2. | **Errors:**Types of errors, Accuracy and precision, systematic and random errors, limits oferror, probable error and standard deviation. Gaussian error curves, combination oferrors. | **7** |
| 3. | **Sensors and Transducers:** Construction and operating characteristics of active and digitaltransducers, Measurement of temperature, pressure, displacement, acceleration, noiselevel.Instrumentation for strain, displacement, velocity, acceleration, force and torque. | **8** |
| 4. | **Signal Conditioning:** Instrumentation amplifiers, isolation amplifiers, analogmultipliers, analog dividers, function generators, timers, sample and hold,optical and magnetic isolators. Frequency to voltage converters, temperature to current converters. Shielding and grounding. | **8** |
| 5. | **Instrumentation in Power System:** Measurement of voltage, current, phase angle, frequency, active power and reactive power in power plants. Capacitive voltage transformers and their transient behaviour, Energy meters and multi part tariff meters, Basic idea of LT & HT panels. | **7** |
| 6. | **Power System Monitoring and Control:** Computer based data acquisition system for power plant operation, maintenance and protection, Use of SCADA in power systems, IoT based metering, Smart meters. | **7** |
| | **Total** | **38** |

**Suggested Books:**

1. Electronic Measurements and Instrumentation, Oliver and Cage, TMH.
2. Electrical and Electronic Measurement and Instruments, A.K. Sawhney, Dhanpat Rai and Co.
3. Instrumentation Fundamentals and Applications, R. Morrison, John Wiley and Sons.
4. Instrumentation for Engineering Measurements, R. H. Cerni and L. E. Foster, John Wiley and Sons.
5. Principles of Measurement & Instrumentation, A. S. Moris, Prentice Hall.

## II Year III Semester

| 3EX3-06: Advanced Engineering Mathematics-I | |
|---|---|
| **Credit:3** | **Max Marks:100(IA: 30,ETE: 70)** |
| **3L+0T+ 0P** | **EndTermExams:3 hrs.** |

**Course Objectives:**

This course aims to impart knowledge of fundamental concepts of numerical analysis, probability & statistics and an introduction to partial differential equations and Fourier series.

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** To study the numerical interpolations for equal and unequal intervals, numerical differentiation, integration and solving ordinary differential equations by numerical methods.

**CO-2:** To study the solution of polynomials, algebraic and transcendental by numerical methods including linear equations.

**CO-3:** Compute the discrete and continuous random variables, probability distributions, expectations, moments, MGF, mean and variances.

**CO-4:** Define and explain the different statistical distributions like Binomial, Poisson, Normal, Uniform, and Exponential distributions and compute the method of least squares, correlation and regression.

**CO-5:** To study the theory of partial differential equations by using the separation of variables.

**CO-6:** To study and understand the Fourier series, half range Fourier sine and cosine series.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Numerical Analysis**–1: Finite differences and operators, interpolation by using Newton's forward and backward difference formula. Gauss's forward and backward interpolation formula. Stirling's formula. Newton's divided difference and Lagrange's interpolation for unequal intervals. Numerical differentiation. Numerical integration by Trapezoidal rule and Simpson's 1/3 and 3/8 rules. Numerical solution of ordinary differential equations by Euler's method modified Euler's methods, Runge- Kutta method and Milne's PC methods. | **10** |
| 2. | **Numerical Analysis–2**: Solution of polynomials, algebraic and transcendental equations by using the Bisection method, Newton-Raphson method and Regula-Falsi method. Solution of systems of linear equations by using LU decomposition and Gauss elimination method. | **7** |
| 3. | **Probability and Statistics-1:** Discrete and continuous random variables, probability distribution function, mathematical expectations, moments, moment generating functions, mean and variance, cumulant generating function. | **6** |

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| 4. | **Probability and Statistics-2:** Binomial distribution, Poisson distribution, Normal distribution, curve fitting, correlation and regression. | **9** |
| 5. | **Fourier Series**: Periodic functions, Fourier series, change of intervals, half range Fourier sine and cosine series, Parseval's theorem.<br>**Partial Differential Equations:** Classification of second order partial differential equations, separation of variables: One dimensional Heat and Wave equations, Two dimensional Laplace equations. | **8** |
| | **Total** | **40** |

**Suggested Books:**


1. JR.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Fifth Edition, Narosa Publishing House, (2016).
2. H.K. Dass, Advanced Engineering Mathematics, 22nd Edition, S. Chand, (2018).
3. Erwin O. Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Pvt. Ltd, (2015)
4. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Academic Press, (2009).
5. K. E. Atkinson, An Introduction to Numerical Analysis (2nd edition), Wiley-India, (1989).

## II Year III Semester

| 3EX4-20:Electrical Machines Lab-I | |
|---|---|
| **Credit:1.5** | **Max Marks:100(IA:60,ETE: 40)** |
| **0L+0T+3P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Obtain the characteristics of the separately-excited DC shunt generator.

**CO-2:** Perform the speed control of DC shunt motor.

**CO-3:** Determine the efficiency of DC shunt machine by performing Swinburne's test in practice.

**CO-4:** Know the Sumpner's test on two identical 1-phase transformers for finding the efficiency.

| S. No. | List of Experiments | Hours |
|---|---|---|
| 1. | To obtain the armature voltage vs armature current load curve of the separately-excited DC shunt generator. | **3** |
| 2. | Speed control of DC shunt motor by field current control method and plot thecurve for speed verses field current. | **3** |
| 3. | Speed control of DC shunt motor by armature voltage control method and plot the curve for speed verses armature voltage. | **3** |
| 4. | Determine the efficiency at full load of a D.C shunt machine consideringit as a motor by performing Swinburne's test. | **3** |
| 5. | Perform Open Circuit and Short Circuit test on a 1-phase transformer and determine the parameters of its equivalent circuit, its voltage regulation and efficiency. | **3** |
| 6. | Determine the efficiency and voltage regulation of a 1-phasetransformer by direct loading method. | **3** |
| 7. | Perform Sumpner's test on two identical 1-phase transformers and find efficiency and parameters of the equivalent circuit. | **3** |
| 8. | To study conversion of three-phase supply to two-phase supply using Scott-Connection. | **3** |
| | **Total** | **24** |

## II Year III Semester

| 3EX4-21:Electrical Measurement and Instrumentation Lab | |
|---|---|
| **Credit:1.5** | **Max Marks:100(IA:60,ETE: 40)** |
| **0L+0T+3P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Operate and take the measurements from CRO, DSO and various other meters.

**CO-2:** Measure the active power, reactive power and power factor of three-phase load using two-wattmeter and one-wattmeter method.

**CO-3:** Operate the Crompton's Potentiometer and DC slide wire potentiometer for the measurement of low resistance, unknown EMF and calibration of voltmeter and ammeter.

**CO-4:** Perform the experiments on Kelvin's double bridge and Anderson's bridge.

**CO-5:** Know about the real time use of LVDT and Strain Gauge.

| S. No. | List of Experiments | Hours |
|---|---|---|
| 1. | Study the working and applications of CRO, Digital Storage Oscilloscope (DSO), Meggar and Tong-tester. | **3** |
| 2. | Measure power and power factor in 3-phase load by (i) Two-watt meter method and (ii) One-wattmeter method. | **3** |
| 3. | Measure low resistance by DC slide wire potentiometer. | **3** |
| 4. | Calibrate a voltmeter using Crompton potentiometer. | **3** |
| 5. | Calibrate a single-phase energy meter by phantom loading at different power factors. | **3** |
| 6. | Measure Low resistance by Kelvin's double bridge. | **3** |
| 7. | Measure self-inductance using Anderson's bridge. | **3** |
| 8. | Measure the displacement using LVDT. | **3** |
| 9. | Measurement of load using strain gauge-based load cell. | **3** |
| | **Total** | **27** |

## II Year III Semester

| 3EX4-22: Analog Electronics Lab | |
|---|---|
| **Credit:1.5** | **Max Marks:100(IA:60,ETE: 40)** |
| **0L+0T+3P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Understand the working of diodes, special purpose diodes, their characteristics and circuits.

**CO-2:** Analyze the transistor circuits and their characteristics.

**CO-3:** Application of diodes and transistors, working on mini projects.

| S. No. | List of Experiments | Hours |
|---|---|---|
| 1. | Study the following devices: (a) Analog CRO (b) Analog and digital Multimeters (c) Function/ Signal generators (d) Regulated DC power supplies. | **6** |
| 2. | Plot V-I characteristic of PN junction diode and find the cut-in voltage, reverse saturation current. | **3** |
| 3. | Plot V-I characteristic of Zener diode and study of Zener diode as voltage regulator. | **3** |
| 4. | Plot the various characteristics of field effect transistor (FET). | **3** |
| 5. | Plot input and output characteristics of BJT in CB, CC and CE configurations. | **3** |
| 6. | Study and perform an experiment on half wave rectifier and effect of filters on wave. Also obtain the ripple factor. | **3** |
| 7. | Study bridge rectifier and measure the effect of filter network on DC voltage output and ripple factor. | **3** |
| | **Total** | **24** |

## II Year III Semester

| 3EX4-23: Electrical Circuit Lab | |
|---|---|
| **Credit:1.5** | **Max Marks:100(IA:60,ETE: 40)** |
| **0L+0T+3P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Use the tools of Soldering - Desoldering process.

**CO-2:** Simulate a circuit to verify the superposition theorem and observe the voltages and currents at the various nodes and branches of the circuit respectively.

**CO-3:** See the characteristic of BJT and SCR through simulation and hands on bread board or PCB.

**CO-4:** Simulate the speed control of DC motor, Battery Voltage Level Indicator Circuit, RC and RL circuits.

| S. No. | List of Experiments | Hours |
|---|---|---|
| 1. | Introduction to Soldering - Desoldering process and tools. | **3** |
| 2. | Simulate a circuit to verify the superposition theorem. | **3** |
| 3. | Simulate a resistor network and determine node voltages, components voltages, and component currents. | **3** |
| 4. | Simulate characteristic of BJT and SCR. Validate on Bread Board orPCB. | **3** |
| 5. | Simulate rectifier circuit of Half-bridge and Full-bridge and validate on Bread Board or PCB. | **3** |
| 6. | Simulate the speed control of DC motor using field flux and armature voltage control method. | **3** |
| 7. | Simulate Battery Voltage Level Indicator Circuit and validate on Bread Board or PCB. | **3** |
| 8. | Simulate RC and RL circuits to produce tables of component voltage and current levels for a given set of time instants and produce graphs of voltages and currents versus time. | **3** |
| | **Total** | **24** |

# Syllabus

## B.Tech. (Electrical and Electronics Engineering)

### II Year IV Semester

| **4EX4-01: Electrical Machines-II** | |
|---|---|
| **Credit:3** | **Max Marks:100(IA: 30,ETE: 70)** |
| **3L+0T+ 0P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Understand the fundamental of the AC machines.

**CO-2:** Understand the working and characteristics of poly phase induction machine.

**CO-3:** Learn about the working and characteristics of single-phase induction motor and special machines.

**CO-4:** Understand the working and characteristics of alternator and synchronous motor.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **Introduction of AC Machines:** EMF equation, MMF of three phase AC winding, production of rotating magnetic field, types of AC windings, Concentric, distributed and chorded windings, pitch factor, distribution factor,effect of these factors on induced EMF, effect of harmonics. | **7** |
| 3. | **Induction Machines:** Construction, Types (squirrel cage and slip-ring),working principle, equivalent circuit, torque-slip curves, Phasor Diagram, Losses and Efficiency, starting, braking and speed control of three-phase induction motors. Cogging and Crawling. Induction generator. | **9** |
| 4. | **Single-phase Machines:** 1-phase induction motor: Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications. 1- phase synchronous motor, series motor, universal motor. | **8** |
| 5. | **Synchronous Machines:** Constructional features, cylindrical rotor synchronous machine: generated EMF, equivalent circuit and phasor diagram, armaturere action, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine – two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators -synchronization and load division. | **9** |
| 6. | **Special Machines:** Construction, principal of working and characteristics of Brush-less DC (BLDC)machine, Switched Reluctance Motor (SRM), Stepper motors, Doubly Fed Induction Generator (DFIG), Permanent Magnet | **7** |

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|---|---|---|
| | Synchronous Generator (PMSG). | |
| | **Total** | **41** |

**Suggested Books:**

1. Electric Machinery and Transformers, Irving L. Kosow, Prentice Hall India Publication.
2. Electrical Machines, A.E. Fitzgerald, Charles Kingsley, Mc-Graw Hill.
3. Theory of Alternating Current Machinery, A.S. Langsdorf, Tata Mc-Graw Hill.
4. Electrical Machines, I. J. Nagrath, D.P. Kothari, Tata McGraw Hill.
5. The Performance and Design of Alternating Current Machines, M. G. Say, CBS Publishers.
6. Electrical Machinery by P. S. Bhimbhra, Khanna Publishers.

**II Year IV Semester**

| 4EX4-02: Generation of Electrical Power | |
|---|---|
| **Credit:3** | **Max Marks:100(IA: 30,ETE: 70)** |
| **3L+0T+ 0P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Know the basic operation of conventional power plants, especially, Thermal, Hydro, Gas and Nuclear Power Plants.

**CO-2:** Understand the working of wind, tidal and solar PV systems.

**CO-3:** Learn about the various factors associated with the power plants & loads and tariffs.

**CO-4:** Understand the economics of power plants and power factor improvement.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **Conventional Power Plants-I:** Thermal Power Plants: Scheme and operating principles. Hydro Power Plants: Classification of hydroelectric plants, Basic schemes of hydroelectric and pumped storage plants. Selection and location of power plants. | **7** |
| 3. | **Conventional Power Plants-II:** Gas Power Plants: open cycle and closed cycle gas turbine plants. Nuclear Power Plants: Nuclear fission and nuclear fusion. Fissile and fertile materials. Basic plant schemes with boiling water reactor, heavy water reactor and fast breeder reactor. Impact of thermal, gas, hydro and nuclear power stations on environment. Concept of co-generation. | **8** |
| 4. | **Non-conventional Energy Sources:** Green House Effect, Global warming, Renewable energy scenario in India and world, Introduction to electric energy generation by wind, solar and tidal. Conservation of natural resources and sustainable energy systems, Introduction to Micro-grid. | **8** |
| 5. | **Loads and Their Characteristics:** Various types of loads, chronological load curve, load duration curve, energy load curve and mass curve. Maximum demand, demand factor, load factor, diversity factor, capacity factor and utilization.<br>**Tariff:** Objectives of tariffs. General tariff form. Flat demand rate,straight meter rate, block meter rate. Two-part tariff, powerfactor dependent tariffs, three-part tariff. Spot pricing. | **8** |
| 6. | **Economics of Power Plants:** Capital cost of plants, annual fixed and operating costs of plants, generation cost and depreciation. Effect of load factor on unit energy cost. Role of load diversity in power system economics. Calculation of most economic power factor when (i) kW demand is constant and (ii) kVA demand is constant. Energy cost reduction: off peak energy utilization, energy | **8** |

| | | |
|---|---|---|
| | conservation.<br>**Power Factor Improvement:** Causes and effects of low power factor and advantages of power factor improvement. Power factor improvement using shunt capacitors and synchronous condensers. | |
| | **Total** | **40** |

**Suggested Books:**


1. Generation of Electrical Energy, Gupta B. R., S. Chand and Company Ltd.
2. Principles of Power system, V. K. Mehta, S. Chand Publication.
3. Generation, Distribution and Utilization of Electrical Energy, Wadhwa C. L., Wiley Eastern Ltd.
4. Elements of Electrical Power station Design, M. V. Deshpande, PHI India
5. Nagrath & Kothari, Power System Engineering, PHI India
6. Generation of Electrical Power, Soni, Gupta and Bhatnagar, Dhanpat Rai and Sons.

## II Year IV Semester

| 4EX4-03: Electrical Circuit Analysis-II | |
|---|---|
| **Credit:3** | **Max Marks:100(IA: 30,ETE: 70)** |
| **3L+0T+ 0P** | **EndTermExams:3hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Understand the concept of Fourier Series for sinusoidal and non-sinusoidal waveforms and its application for the circuits.

**CO-2:** Analyze the transfer impedance and admittance and learn the physical significance of poles and zeros for the circuits.

**CO-3:** Know about the two-port models and parameters to simplify large circuits.

**CO-4:** Synthesize the immittance networks and construct filters to eliminate the unwanted signals from the circuits.

| S.No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **Non-Sinusoidal Waves:** Complex periodic waves and their analysis by Fourier series. Different kinds of symmetry, Determination of Co-efficient, Average and effective values of a non-sinusoidal wave, Power in a circuit of non-sinusoidal waves of current and voltage, Responseof linear network to non-sinusoidal periodic waves. | **8** |
| 3. | **Network Functions:** Impedance and admittance functions, concept of complex frequency, transform impedance and admittance, series and parallel combinations.<br>Terminals and terminal pairs, driving point impedance transfer function, poles and zeros, Restrictions on pole and zero location in s-plane, Routh-Hurwitz criterion, Time domain behavior from pole and zero plot. Procedure for finding network functions for general two terminal pair networks. | **8** |
| 4. | **Two Port networks:** Definition, Open circuit impedance, Short circuit admittance, Hybrid and Transmission parameters and their evaluation for simple circuits, Relationships between parameter sets. Image impedance, Image transfer function. | **8** |
| 5. | **Network Synthesis:** Hurwitz polynomial, Positive real functions, reactive networks. Separation property for reactive networks. The four-reactance function forms, Specification for reactance function. Foster form of reactance networks. Cauer form of reactance networks. Synthesis of R-L and R-C networks in Foster and Cauer forms. | **8** |
| 6. | **Two Port Reactive Network (Filters):** Constant K filters. The m-derived filter. composite filters, Bands pass and band elimination filters, lattice filters. Barlett’s bisection theorem. Introduction to active filters. | **7** |

| | |
|---|---|
| **Total** | **40** |

**Suggested Books:**

1. Engineering Circuit Analysis, William H. Hayt et al, Mc Graw Hill Publications.
2. Network Analysis, M. E. Vanvalkenburg, Pearson Publications.
3. Fundamentals of Electric Circuits, Charles K. et al, Mc Graw Hill Publications.
4. A. Chakarvorty, Circuit Theory, Publisher Dhanpat Rai & Co. (Pvt.) Ltd.
5. Engineering Circuit Analysis, J David Irwin et al, Wiley India.
6. D. Roy Choudhury: Network & Systems, Wiley Eastern Ltd.
7. Electric Circuits, Mahmood Nahvi, Mc Graw Hill.
8. Introduction to Electric Circuits, Richard C Dorf and James A Svoboda Wiley.
9. Circuit Analysis: Theory and Practice, Allan H Robbins et al, Cengage.
10. Basic Electrical Engineering, V. K. Mehta, Rohit Mehta, S. Chand Publications.

**II Year IV Semester**

| 4EX4-04: Electrical Machine Design | |
|---|---|
| **Credit:3** | **Max Marks:100(IA: 30,ETE: 70)** |
| **3L+0T+ 0P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Understand the fundamentals of the various design parameters along with the electrical engineering material.

**CO-2:** Design the heating and cooling arrangement for the electrical machines.

**CO-3:** Design the core and winding of the power and distribution transformers as per the given requirements.

**CO-4:** Design synchronous and induction machines as per the given requirements.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **Fundamentals of Electrical Machine Design:** Specifications, Factors affecting the design, Limitations, main dimension, loadings, output equation, factor affecting the size and rating.<br>**Electrical Engineering Materials:** conducting, magnetic and insulating materials, Magnetic Circuit Calculation: Ohm's law for magnetic circuit. | **8** |
| 3. | **Heating and Cooling of Electrical Machines:** Heat dissipation and heat flow equations, Newton's law of cooling, equations for temperature rise, mean temperature rise, hydrogen cooling of turbo alternators, quantity of cooling medium, Methods of ventilation | **8** |
| 4. | **Design of Transformers:** Power and Distribution Transformers, core and yoke cross sections, square and stepped core, output equations, main dimensions, types and design of windings, optimization concepts. | **8** |
| 5. | **Design of Synchronous Machines:** Turbo and Hydro alternators, choice of specific magnetic and electric loading, short circuit ratio and its effects, air gap length, output equation, main dimensions, flow charts for design of synchronous machine, design of stator core and winding. | **8** |
| 6. | **Design of Induction Machines:** Output equation, main dimensions, design criteria, flow charts for design of induction motor, air gap length, design of stator core and winding, rotor design. | **7** |
| | **Total** | **40** |

**Suggested Books:**

1. A Course in Electrical Machine Design, A.K. Sawhney, Dhanpat Rai and Co.
2. Principles of Electrical Machine Design, R.K. Agarwal, S.K. Kataria and Sons.
3. Design and Performance of A.C. Machines, M. G. Say, CPS Publishers.
4. Generalized Theory of Electrical Machines, B. Edikins.

**II Year IV Semester**

| 4EX4-05: Computer Programming | |
|---|---|
| **Credit:3** | **Max Marks:100(IA: 30,ETE: 70)** |
| **3L+0T+ 0P** | **EndTermExams:3 hrs.** |

**Course Objectives:**

1. To understand the basic concepts of data structures and algorithms.
2. To understand the basic concepts of object-oriented programming.
3. To differentiate linear and non-linear data structures and the operations upon them.
4. Ability to perform sorting and searching in a given set of data items.
5. To comprehend the necessity of time complexity in algorithms.
6. Ability to apply concept of abstraction, inheritance, polymorphism and operator overloading.

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Understanding the fundamental analysis and time complexity for a given problem.
**CO-2:** Articulate linear & non data structures and legal operations permitted on them.
**CO-3:** Applying a suitable algorithm for searching and sorting.
**CO-4:** Understanding of the basic concept of object-oriented programming.
**CO-5:** Application of abstraction, Inheritance, Polymorphism and function and operator overloading.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction to Algorithms and Analysis:** Fundamentals of algorithm analysis, Space and time complexity of an algorithm, Types of asymptotic notations and orders of growth, Algorithm efficiency – best case, worst case, average case, Analysis of non-recursive and recursive algorithms. | **8** |
| 2. | **Linear Data Structures:** Array- 1D and 2D array, Stack - Applications of stack: Expression Evaluation - Conversion of Infix to postfix and prefix expression.<br>**Sorting and Search Techniques:** Sorting Algorithms: Basic concepts, Bubble Sort, Insertion Sort, Selection Sort, Quick Sort, Shell Sort, Heap Sort, Merge Sort, Counting Sort, External Sorting, Internal Sorting, Stable & Unstable Sorting. Searching: Linear Search, Binary Search. | **10** |
| 3. | **Introduction:** Introduction OOP, Procedural Vs. Object Oriented Programming, Principles of OOP, Benefits and applications of OOP. Overview, Program structure, namespace, identifiers, variables, constants, enum, operators, typecasting, control structures, Operators, array and pointer. | **8** |
| 4. | **Basics of Abstraction and Inheritance:** Classes, private, public, constructors, destructors, member data, member functions, inline function, friend functions, | **7** |

| | | |
|---|---|---|
| | static members, and references. Inheritance: Class hierarchy, derived classes, single inheritance, multiple, multilevel, hybrid inheritance. | |
| 5. | **Basics of Polymorphism and Overloading:** Polymorphism: Binding, Static polymorphism and Dynamic polymorphism Overloading (Operator and Function):This pointer, applications of this pointer, Operator function, member and nonmember operator function, Function overloading, operator overloading | **7** |
| | **Total** | **40** |

**Suggested Books:**


1. Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms, Third edition, MIT Press, 2009.
2. Ellis Horowitz, S. Sahni, Freed, "Fundamentals of Data Structures in C",2nd edition,2015.
3. C++ How to Program, Paul Deitel, Harvey Deitel, Pearson Education ;10th edition
4. Object Oriented Programming in Turbo C++, Robert Lafore, Galgotia publication
5. The Compete Reference C++, Herbert Schlitz, TMH
6. Object Oriented Programming with C++, E Balagurusamy, TMH
7. Y. Langsam, M. J. Augenstein and A. M. Tanenbaum, ―Data Structures using C, Pearson Education Asia, 2004.
8. Seymour Lipschutz, Data Structures, Schaum's Outlines Series, Tata McGraw-Hill.

## II Year IV Semester

| 4EX3-06: Advanced Engineering Mathematics-II | |
|---|---|
| **Credit:3** | **Max Marks:100(IA: 30,ETE: 70)** |
| **3L+0T+ 0P** | **EndTermExams:3 hrs.** |

**Course Objectives:**

This course aims to impart knowledge of fundamental concepts of Laplace transform, Fourier transform, Z-transform and introduction to the theory of functions of complex variables.

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** To understand the concepts and to solve the problems of Laplace transform along with their properties and applications to ODE and PDE.

**CO-2:** To understand the concepts and to solve the problems of Fourier transform along with their properties.

**CO-3:** To study and understand the concepts of Z- transform along with their properties.

**CO-4:** To study the techniques of complex variables together with other concepts and properties of an analytic function, complex integration, classification of singularities, calculus of residues and evaluation of integrals.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Laplace Transform**: Definition of Laplace transform, properties of Laplace transform and examples, Laplace transform of Unit step, Dirac delta and periodic functions, inverse Laplace transforms, properties of inverse Laplace transform, inverse Laplace transform by partial fraction method, convolution theorem, solving ODEs and PDEs by Laplace transforms method. | **12** |
| 2. | **Fourier Transform**: Fourier transform, Fourier sine and cosine transform, properties and formulae, inverse Fourier transform, convolution theorem, application of Fourier transforms to one-dimensional heat and wave equations only. | **8** |
| 3. | **Z-Transform:** Introduction, definition of the Z-transform and examples, basic operational properties of Z-Transform, inverse Z-transform and examples | **8** |
| 4. | **Complex Analysis-I**: Analytic functions, Cauchy-Riemann equations, harmonic functions, construction of analytic function, complex line integral, Cauchy theorem, Cauchy integral formula. | **6** |
| 5. | **Complex Analysis-II**: Taylor and Laurent's theorem, zeros and singularities, residues at poles and infinity, Cauchy residue theorem, evaluation of definite integrals | **6** |
| | **Total** | **40** |

**Suggested Books:**


1. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Fifth Edition, Narosa Publishing House, (2016).
2. H.K. Dass, Advanced Engineering Mathematics, 22nd Edition, S. Chand, (2018).
3. Erwin O. Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Pvt. Ltd, (2015)
4. Lokenath Debnath and Dambaru Bhatta, Integral Transforms and Their Applications, Third Edition, CRC Press, Taylor and Francis Group, A Chapman and Hall Book, (2015).
5. M.R. Spiegel et.al., Complex Variables-Schaum's Outline series 2ed., The Mc-Graw Hill, (2009).
6. E.T. Copson, An introduction to the theory of a complex variables, Oxford University Press, (1935).

**II Year IV Semester**

| 4EX4-20: Electrical Machines Lab-II | |
|---|---|
| **Credit:1.5** | **Max Marks: 100 (IA: 60, ETE: 40)** |
| **0L+0T+ 3P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Operate and test the 3-phase induction motor to find its characteristics and efficiency at the different load settings.

**CO-2:** Connect two 3-phase induction motor in cascade and study their speed control.

**CO-3:** Run an alternator to find its OCC & SCC characteristics and voltage regulation.

**CO-4:** Perform an experiment on synchronous motor to obtain its V-curve.

**CO-5:** Synchronize an alternator across the infinite bus and control load sharing.

| S. No. | List of Experiments | Hours |
|---|---|---|
| 1. | Perform load test on 3-phase induction motor and calculate torque, output power, input power, efficiency, input power factor and slip for various load settings. | **3** |
| 2. | Perform no load and blocked rotor test on a 3-phase induction motor and determine the parameters of its equivalent circuits. | **3** |
| 3. | Connect two 3-phase induction motor in cascade and study theirs peed control. | **3** |
| 4. | Perform the speed control of 3- phase Induction Motor. | **3** |
| 5. | Perform an experiment on alternator to plot its Open Circuit Characteristics (OCC) and Short Circuit Characteristics (SCC). | **3** |
| 6. | Determine the voltage regulation of a 3-phase alternator by directloading. | **3** |
| 7. | Study the effect of variation of field current upon the stator current andpower factor of synchronous motor and plot the V-Curve and inverted V-Curve of synchronous motor for different loads. | **3** |
| 8. | To synchronize an alternator across the infinite bus and control load sharing. | **3** |
| | **Total** | **24** |

## II Year IV Semester

| 4EX4-21: Power System Design Lab | |
|---|---|
| **Credit:1.5** | **Max Marks: 100 (IA: 60, ETE: 40)** |
| **0L+0T+ 3P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Design the basic schemes of hydro, thermal, nuclear and gas power plants.
**CO-2:** Design feeders, distributors and auxiliary power supply schemes.
**CO-3:** Forecasting the load in short term, medium term and long-term.
**CO-4:** Design CT and PT for measurement of voltage and current at sub stations.

| S. No. | List of Experiments | Hours |
|---|---|---|
| 1. | Power Plant Design: Design considerations and basic schemes of hydro, thermal, nuclear and gas power plants. | **3** |
| 2. | Study about the auxiliary power supply scheme for thermal power plant. | **3** |
| 3. | Design criterions the feeders and distributors. Calculation of voltage drops in distributors. | **3** |
| 4. | Calculation of conductor size using Kelvin's law. | **3** |
| 5. | Study the methods of short term, medium term and long-term load forecasting. | **3** |
| 6. | Design a transmission line with sending end and receiving end power circle diagrams. | **3** |
| 7. | Design considerations of Current Transformer (CT) and Potential Transformer (PT) for measurement and protection. | **3** |
| 8. | Study and design of various types of substations, various bus–bar arrangements and electrical equipment for substations. | **3** |
| | **Total** | **24** |

## II Year IV Semester

| 4EX4-22: Computer Programming Lab | |
|---|---|
| **Credit:1.5** | **Max Marks:100(IA:60,ETE: 40)** |
| **0L+0T+ 3P** | **EndTermExams:3 hrs.** |

**Course Objectives:**

1. To implement an algorithm for a problem and analyze its time and space complexity.
2. To understand the basic concepts of object-oriented programming.
3. To implement the algorithm for Searching (Linear and Binary).
4. To implement the algorithms for the different types of sorting.
5. To implement algorithms for different type of sorting and compare their performance in terms of the space and time complexity

**Prerequisites:** Computer Programming knowledge.

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Be able to design and analyze the time and space efficiency of the data structure.

**CO-2:** Understand the concept of static & Dynamic memory management

**CO-3**: Be capable to identity the appropriate data structure for given problem.

**CO-4:** Have practical knowledge on the applications of data structures.

**CO-5:** Understanding of the basic concept of object-oriented programming.

**CO-6:** Application of abstraction, Inheritance, Polymorphism and function and operator overloading.

**List of Experiments**

1. Write a program to find the mean and the median of the numbers stored in an array.
2. Write a program to insert one element in an array and delete an element from an- array.
3. Write a program to Linear & Binary search for a number in an array.
4. Write a program to store the marks obtained by 10 students in 5 courses in a two-dimensional array.
5. Write a Program for Matrix Multiplications.
6. Write a program to implement single linked list, including insertion, deletion and searching in the linked list.
7. Write a program to print the elements of a linked list in reverse order without disturbing the linked list.
8. Write a program to reverse a linked list.
9. Write a program to implement a doubly linked list including insertion, deletion and searching in the linked list.
10. Write a program to prepare students marksheet using linked list.
11. Write a program to implement a stack using an array and linked list.
12. Write a program to implement a queue using an array and linked list.
13. Write a program to implement a circular queue using an array.

14. Write a program to implement a priority queue using a linked list.
15. Write a program to implement a double-ended queue using a linked list.
16. Write a program to implement different types of sorting (Bubble, Insertion, Quick, Selection, Merge, Heap).
17. Write a program to develop hierarchy of inheritance for the properties of shapes and their relevant functions. e.g. Shapes→2D/3D, 2D→ellipse→circle rectangle→square and expand it for 3D accordingly.
18. Write a simple function template for predicate function is Equal To that compares its two arguments with the equality operator (==) and returns true if they are equal and false if they are not equal. Use this function template in a program that calls is EqualTo only with a variety of built-in types. Now write a separate version of the program that calls is Equal to with a user defined class type, but does not overload the equality operator.

**II Year IV Semester**

| **4EX4-22: Electrical Machine Design Lab** | |
|---|---|
| **Credit:1.5** | **Max Marks: 100 (IA: 60, ETE: 40)** |
| **0L+0T+ 3P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

Upon successful completion of the course, the students will be able to:

**CO-1:** Design the core and windings of a transformer considering minimum cost and minimum losses.

**CO-2:** Design DC machines and SC machines considering specified parameters.

**CO-3:**Design of 3-phase induction motor and 1-phase capacitor start induction motor.

**CO-4:**Design a 3-phase turbo alternator and synchronous generator.

| **S. No.** | **List of Experiments** | **Hours** |
|---|---|---|
| 19. | Design of transformers: output of transformer, output equation- volt per turn, core area and weight of iron and copper, optimum design–(i) minimum cost and (ii) minimum losses. Design the core and windings of a transformer. | **3** |
| 20. | Design of rotating machines: General concepts. specific loading, output equations –dc machines and ac machines, factor affecting size of rotating machines, choice of specific magnetic and electric loadings. | **6** |
| 21. | Design of 3-phase induction motors: output equation, choice of air gap flux density and ampere, conductor's parameter, main dimensions. Design of a 3-phase squirrel cage induction motor. | **3** |
| 22. | Design of 1-phase induction motors: output equation, main dimensions, relative size of 1-phase and3-phase induction motors. Design of a 1-phase capacitor start induction motor. | **6** |
| 23. | Design of synchronous machines**:** output equation, choice of specific magnetic and electric loadings, main dimensions, short circuit ratio. Design a 3-phase turbo alternator. | **6** |
| | **Total** | **24** |