

Dr. Babasaheb Ambedkar Technological University, Lonere.

B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

Curriculum of Second Year

Semester III

Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				Credit
			L	T	P	CA	MSE	ESE	Total	
BSC	BTBS301	Engineering Mathematics-III	3	1	-	20	20	60	100	4
PCC1	BTEEC302	Electrical Machines-I	3	1	-	20	20	60	100	4
PCC2	BTEEC303	Electrical and Electronics Measurement	3	1	-	20	20	60	100	4
HSSMC	BTHM304	Basic Human Rights	2	-	-					Audit
ESC	BTES305	Engineering Material Science	3	-	-	20	20	60	100	3
LC	BTEEL306	Electrical Machines-I Lab			2	60		40	100	1
LC	BTEEL307	Electrical and Electronics Measurement Lab			2	60		40	100	1
Project	BTEEP308	Mini Project-I			4	60		40	100	2
Internship	BTES211P	Internship-I Evaluation						50	50	1
			14	3	8	260	80	410	750	20

Semester IV

Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				Credit
			L	T	P	CA	MSE	ESE	Total	
PCC3	BTEEC401	Network Theory	3	1	-	20	20	60	100	4
PCC4	BTEEC402	Power System	3	1	-	20	20	60	100	4
PCC5	BTEEC403	Electrical Machine-II	3	1	-	20	20	60	100	4
BSC	BTBS404	Analog and Digital Electronics	3	-	-	20	20	60	100	3
PEC1	BTEEPE405	Group A	3	-	--	20	20	60	100	3
LC	BTEEL406	Network Theory Lab	-	-	2	30		20	50	1
LC	BTEEL407	Power System Lab	-	-	2	30		20	50	1
LC	BTEEL408	Electrical Machine-II Lab	-	-	2	30		20	50	1
LC	BTEEL409	Analog and Digital Electronics lab	-	-	2	30		20	50	1
Internship	BTEEP410	Internship-II (minimum of 4 weeks which can be completed partially in third or fourth semester or in at one time)	-	-	-	-	-	-	-	-
						220	100	380	700	22

Group-A

- (A) Electromagnetic Field Theory
- (B) **Signals and System**
- (C) Advance Renewable Energy Sources
- (D) **Electronic Devices and Circuits**

Second Year B. Tech Classes (Common to all Branches)

Subject with code : **Engineering Mathematics III (BTBS 301)**

Semester: **III**

Teaching Scheme

Theory : 03 Hrs/Week

Tutorial : 01 Hr/Week

Credits: 04

Examination Scheme

Mid-term Test : 20 Marks

Internal Assessment: 20 Marks

End Semester Exam: 60 Marks

Duration: 03 Hrs.

Course Contents:

Unit 1: Laplace Transform

Definition – conditions for existence ; Transforms of elementary functions ; Properties of Laplace transforms - Linearity property, first shifting property, second shifting property, transforms of functions multiplied by t^n , scale change property, transforms of functions divided by t , transforms of integral of functions, transforms of derivatives ; Evaluation of integrals by using Laplace transform ; Transforms of some special functions- periodic function, Heaviside-unit step function, Dirac delta function.

[09 Hours]

Unit 2: Inverse Laplace Transform

Introductory remarks ; Inverse transforms of some elementary functions ; General methods of finding inverse transforms ; Partial fraction method and Convolution Theorem for finding inverse Laplace transforms ; Applications to find the solutions of linear differential equations and simultaneous linear differential equations with constant coefficients.

[09 Hours]

Unit 3: Fourier Transform

Definitions – integral transforms ; Fourier integral theorem (without proof) ; Fourier sine and cosine integrals ; Complex form of Fourier integrals ; Fourier sine and cosine transforms ; Properties of Fourier transforms ; Parseval's identity for Fourier Transforms.

[09 Hours]

Unit 4: Partial Differential Equations and Their Applications

Formation of Partial differential equations by eliminating arbitrary constants and functions; Equations solvable by direct integration; Linear equations of first order (Lagrange's linear equations); Method of separation of variables – applications to find solutions of one dimensional heat flow equation (i.e. $\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$), and one dimensional wave equation (i.e. $\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2}$).

[09 Hours]

Unit 5: Functions of Complex Variables

Analytic functions; Cauchy- Riemann equations in Cartesian and polar forms; Harmonic functions in Cartesian form; Cauchy's integral theorem; Cauchy's integral formula; Residues; Cauchy's residue theorem (All theorems without proofs). **[09 Hours]**

Text Books

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by H. K. Das and Er. Rajnish Verma, S. Chand & CO. Pvt. Ltd., New Delhi.
3. A course in Engineering Mathematics (Vol III) by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.

Reference Books

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, New York.
2. A Text Book of Engineering Mathematics by Peter O' Neil, Thomson Asia Pte Ltd. , Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
4. Integral Transforms and their Engineering Applications by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
5. Integral Transforms by I. N. Sneddon, Tata McGraw-Hill , New York.

Unit 1: Single Phase Transformer**7 Hours**

Transformer construction, Ideal and practical transformer, exact and approximate equivalent circuits, no load and on load operation, phasor diagrams, power and energy efficiency, voltage regulation, parallel operation, effect of load on power factor, Per Unit system, excitation phenomenon in transformers, switching transients, Auto transformers, Variable frequency transformer, voltage and current transformers, welding transformers, Pulse transformer and applications

Unit 2: Three Phase Transformers**8 Hours**

Constructional features of three phase transformers, Cooling methodology, Standard and special transformer connections, Phase conversion, Parallel operation of three phase transformers, three winding transformers and its equivalent circuit, On load tap changing of transformers, Modern trends in transformers, Type and routine tests, Standards.

Unit 3: Electromechanical Energy Conversion Principles**6 Hours**

Energy in a magnetic systems, field energy and mechanical force, energy in singly and multiply excited magnetic systems, determination of magnetic force and torque from energy and coenergy, Forces and torques in magnetic field systems, dynamic equations of electromechanical systems and analytical techniques.

Unit 4: DC Generators**9 Hours**

Construction of armature and field systems, Working, types, emf equation, Armature windings, Characteristics and applications, Building of emf, Armature reaction - Demagnetizing and Cross magnetizing mmfs and their estimation; Remedies to overcome the armature reaction; Commutation process, Causes of bad commutation and remedies: Construction of armature and field systems, Working, types, emf equation, Armature windings, Characteristics and applications, Building of emf, Armature reaction - Demagnetizing and Cross magnetizing mmfs and their estimation; Remedies to overcome the armature reaction; Commutation process, Causes of bad commutation and remedies,

Unit 5: D.C. Motors**9 Hours**

Principles of working, Significance of back emf, Torque Equation, Types, Characteristics and Selection of DC Motors, Starting of DC Motors, Speed Control, Losses and Efficiency, Condition for Maximum Efficiency, Braking of DC Motors, Effect of saturation and armature reaction on losses; Applications, Permanent Magnet DC Motors, Type and Routine test

Unit 6: Special Machines**6 Hours**

Constructional details of reluctance machine, variable-reluctance machines, basic VRM analysis, practical VRM analysis, stepper motors and their analysis, Brushless DC motors.

Text Books :

1. J. B. Gupta, "Theory and Performance of Electrical Machines," S. K. Kataria & Sons, New Delhi
2. P. S. Bimbra, "Electrical Machinery", Khanna Publishers
3. B. L. Theraja, A. K. Theraja, "A text book of Electrical Technology," S. Chand Publishers
4. Asfaq Hussein, "Electric Machines," Danpat Rai Publisher

Reference Books :

1. Bhattacharya S. K, "Electrical Machines", (Tata McGraw Hill Publications)
2. Kothari Nagrath, "Electrical Machines", (Tata McGraw Hill Publications)
3. M. N. Bandopadhyay, "Electrical Machines", (Tata McGraw Hill Publications)
4. Fitzaralda, "Electrical Machines", (Tata McGraw Hill Publications)

Unit 1: Philosophy of Measurement**4 Hours**

Introduction to Measurement, Methods of Measurements, Measurement System, Instruments, Classification of Instruments, Characteristics of Instruments & Measurement System, Errors in Measurement, Types of Errors, Calibration, Standards and their classifications.

Unit 2: Analog Measurement of Electrical Quantities**8 Hours**

Classification of Analog Instruments, Principle of Operation, Operating Torques, Different types of Damping and Control Systems, Types of Instrument: PMMC, Extension of Range of PMMC Instruments, Moving Iron, Electro-dynamometer, Hot wire, Thermocouple, Induction, Electrostatic, Rectifier.

Power Measurement: Power measurement in AC and DC circuits, Power and Power Factor, Electrodynamometer-type Wattmeter, Induction-type Wattmeter, Power measurement in Poly-phase systems, Power measurement in Three-Phase systems, Reactive Power measurements, Power measurement with Instrument Transformers - Potentiometer and Current Transformer.

Measurement of Energy: Induction-type Energy Meter, Errors in Induction-type Energy Meters and their compensation, Testing of Energy Meters.

Unit 3: A.C. and D.C. Bridges**8 Hours**

Measurement Resistance: Wheatstone Bridge, Kelvin Bridge Method, Kelvin Double Bridge Method, Ammeter-Voltmeter Method, Direct deflection method, Loss of charge method, Megohm Bridge, Megger.

Measurement of Inductance and Capacitance: Maxwell Bridge, Hays Bridge, Anderson Bridge, De-Sauty Bridge, Schering Bridge, Wien Bridge.

Localisation of Cable Faults: Murray Loop Test, Varley Loop Test.

Magnetic Measurements: Ballistic Galvanometer, Flux Meter, Maxwell's Bridge Method, AC Potentiometer Method.

Unit 4: Digital Measurement of Electrical Quantities**7 Hours**

Concept of Digital Measurement, Block diagram of Digital Instrumentation System, Digital versus Analog Instrument, Digital Voltmeter, Types of Digital Voltmeter, Digital Multi-meter Digital Counter, Digital Frequency Meter, **Power Analyzer &** Harmonic Analyzer, Spectrum & Wave analyzer, Oscilloscopes, Cathode Ray Oscilloscope (CRO), Digital Storage Oscilloscopes (DSO), Signal Generator, Q-Meter.

Unit 5: Transducers**8 Hours**

Definition, Classification & selection of transducers, Characteristics, Transducers for measurement of Displacement (RVDT & LVDT), Speed, Angular Rotation, Altitude, Force, Torque, Humidity and Moisture, Pressure, Strain and Temperature (Thermocouple and RTD method), Position, Hall Effect transducer and applications. Instrumentation amplifiers, Signal Conditioning, Data Transmission and Telemetry, Data Acquisition Systems.

Displays and Recorders: Different types of Display – Different types of Recorder: Graphic Recorder, Strip Chart Recorder, **Galvanometric and** Potentiometer type **Recorders**, X-Y Recorder, Circular Chart Recorder, Magnetic Tape Recorder, **Digital Recorders**, Printer and Plotter **(Block Diagram, theory and applications only)**

Reference Books/ Text Books:

1. E.W. Golding & F.C. Widdis, "Electrical Measurement & Measuring Instrument", A.H. Wheeler & Co. India.
2. A.K. Sawhney, "Electrical & Electronic Measurement & Instrument", Dhanpat Rai & Sons.
3. Forest K. Harries, "Electrical Measurement", Willey Eastern Pvt. Ltd. India.
4. M.B. Stout, "Basic Electrical Measurement" Prentice hall of India.
5. W.D. Cooper, "Electronic Instrument & Measurement Technique", Prentice Hall International.
6. J.B. Gupta, "Electrical Measurements and Measuring Instruments", S.K. Kataria & Sons.
7. Prithwiraj Purkait, Budhaditya Biswas, Santanu Das and Chiranjib Koley, "Electrical and Electronics Measurements and Instrumentation", McGraw Hill.

Unit 1: The Basic Concepts**6Hrs**

Individual, Group, Civil Society, State, Equality, Justice, Human Values: - Humanity, Virtues, Compassion.

Unit 2: Human Rights and Human Duties:**6 Hrs**

Origin, Civil and Political Rights, Contribution of American Bill of Rights, French Revolution, Declaration of Independence, Rights of Citizen, Rights of working and Exploited people, Fundamental Rights and Economic program, India's Charter of freedom

Unit 3: Society, Religion, Culture, and their Inter-Relationship**6 Hrs**

Impact of Social Structure on Human behaviour, Roll of Socialization in Human Values, Science and Technology, Modernization, Globalization, and Dehumanization.

Unit 4: Social Structure and Social Problems**6 Hrs**

Social and Communal Conflicts and Social Harmony, Rural Poverty, Unemployment, Bonded Labour, Migrant workers and Human Rights Violations, Human Rights of mentally and physically challenged.

Unit 5: State, Individual Liberty, Freedom and Democracy**6 Hrs**

The changing of state with special reference to developing countries, Concept of development under development and Social action, need for Collective action in developing societies and methods of Social action, NGOs and Human Rights in India: - Land, Water, Forest issues.

Unit 6: Human Rights in Indian Constitution and Law**6 Hrs**

The constitution of India:

- (i) Preamble
- (ii) Fundamental Rights
- (iii) Directive principles of state policy
- (iv) Fundamental Duties
- (v) Some other provisions

Universal declaration of Human Rights and Provisions of India, Constitution and Law, National Human Rights Commission and State Human Rights Commission

Reference Books:

1. Shastri, T. S. N., India and Human rights: Reflections, Concept Publishing Company India (P Ltd.), 2005.
2. Nirmal, C.J., Human Rights in India: Historical, Social and Political Perspectives (Law in India), Oxford India.

Unit: 1 Electrical Conducting Materials**7 Hours**

Introduction, Crystal structure, atomic bonding, Electronic and Ionic Conduction, Conductivity in Metals, Ohm's Law, Relaxation Time, Collision Time, Mean Free Path of an Electron, Electron Scattering, Resistivity of Metals, Effect of Temperature and Impurity on Conductivity, Joule's Law, High Conductivity And Resistivity Materials, Superconductivity and Applications Conducting materials: quantum free electron theory- Fermi-Dirac distribution - Materials for electric resistances.

Unit 2: Dielectric Materials**7 Hours**

Crystalline structure-perfection/imperfection, Dielectric as Electric Field Medium, Dielectric constant and polarizability, types of polarization, leakage currents, dielectric loss, dielectric strength, breakdown voltage, temperature and frequency dependences of Dielectric parameter, internal fields in solids, Clausius-Mosotti equation, ferroelectric, pyroelectric and piezoelectric materials, applications of dielectric materials

Unit 3: Semiconductor Materials**7 Hours**

Semiconductors: Mechanism of conduction in semiconductors. Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale integration techniques (VLSI). Properties of Semiconductors: Electron-hole concentration, Fermi level, Generation and recombination, carrier lifetime, diffusion length. Scattering and mobility of carriers. Einstein relation. LASER Plain carbon steels and their applications. Alloy steels: High speed steels, stainless steels, HSLA; Non Ferrous alloys: Al alloys, Cu alloys, applications of these alloys

Unit 4: Magnetic Materials**7 Hours**

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, 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, Ferromagnetic materials, properties of ferromagnetic materials in static fields, curie point, anti-ferromagnetic materials, piezoelectric materials, pyro electric materials Magnetic Properties of Materials: Atomic Interpretation of Diamagnetic, Paramagnetic, Anti-Ferromagnetic and Ferromagnetic Materials. Ferromagnetic Domain, Magnetic Materials for Ferromagnetic Tape And Memory Devices, Magnetic materials: magnetic materials used in electrical machines instruments.

Unit 5: Special Purpose Materials**05 Hours**

Refractory Materials, Structural Material's, Radioactive Materials, Galvanization and Impregnation of materials, Non Destructive Testing: Ultrasonic Radiography, X-ray diffraction- Bragg's law.

Text Books:

1. Material Science and Engineering – V. Raghavan

Reference Books

1. Electrical Engineering Materials – A.J. Dekker
2. Science of Engineering Materials and Carbon Nanotubes - C.M. Srivastava and C. Srinivasan
3. Solid State Physics – A.J. Dekker.

Perform Any eight experiment from given list as a part of practical submission

List of Experiments

1. To perform the polarity test on single phase transformer
2. To perform the transformation ratio test on single phase transformer
3. To perform the following three phase transformer connections:
 - 1) Star-star
 - 2) Star-Delta
 - 3) Delta – Delta
 - 4) Delta –Star
 - 5)Open Delta
 - 6) Scott Connection
4. To perform the direct loading test on three phase transformer to calculate efficiency and regulation
5. To perform the indirect loading test on three phase transformer to calculate efficiency
6. To perform the parallel operation of two single phase transformers.
7. To study D. C. Machine
8. To draw the speed characteristics of DC shunt motor by- (1) Armature Control method (2) Field Control method
9. To perform the load test on DC Shunt motor.
10. To study the load characteristics of DC generator
 - I) Cumulative compound generator.
 - II) Differential compound Generator
11. To study the magnetization ,internal and External characteristics of a D. C. generator
12. To Study Starters for DC Shunt Motor.

List of Experiments: (Perform minimum 8-10 experiments from following list)

- 1) Measurement of Low resistance by Kelvin Double bridge.
- 2) Measurement of High resistance and Insulation resistance using Megger.
- 3) Measurement of Inductance by Maxwell bridge, Hays bridge, Anderson bridge.
- 4) Measurement of Capacitance by De Sauty bridge, Schering bridge.
- 5) Measurement of Earth resistance using Earth Tester.
- 6) Study the extension of Voltmeter, Ammeter and Wattmeter.
- 7) Measurement of three phase power by Two Wattmeter and One Wattmeter method.
- 8) Study of types of instrument: PMMC, Moving Iron, Electro-dynamometer, Hot wire, Thermocouple, Induction, Electrostatic, Rectifier.
- 9) Study of Energy Meter.
- 10) Study of Instrument T/F and its types.
- 11) Characterize the temperature sensor (RTD):
 - a) Static Characteristics of RTD: Study the change in resistance of RTD probe depending on the process temperature.
 - b) Dynamic characteristics: Study the dynamic response of RTD probe
- 12) Characterize the Thermocouple:
 - a) Static Characteristics of Thermocouple: Study the change in EMF of a thermocouple in response to the process temperature.
 - b) Dynamic characteristics of Thermocouple: Study the dynamic response of Thermocouple.
- 13) Characterize of LVDT: To find the effect of various parameters like change in supply voltage, change in supply frequency on output of given LVDT
- 14) Characterize the strain gauge sensor:
 - a) Study of Strain Gauge: To study the working principle of strain gauge.
 - b) Study of effect of change in position of weight applied on Strain Gauge performance.
 - c) Study of effect of change in temperature on the performance of Strain Gauge.
- 15) Measurement of phase difference and frequency of a sinusoidal ac voltage using C.R.O.
- 16) Study of storage oscilloscope and determination of transient response of RLC circuit.

Guidelines:

Stages	Work to be carried	Time
I	<ul style="list-style-type: none">• Selection of a mini viable project idea (Hardware or Software Based) on recent trends in Electrical Engineering.	4 hours
II	<ul style="list-style-type: none">• Study various resources and components in electrical engineering projects• Application of those components in Selected Project	6 hours
III	<ul style="list-style-type: none">• Study of Circuit Diagram• Study datasheet of basic circuit components of a project• Study various software in building of project like SCILAB, MATLAB or other circuit Simulator	6 hours
IV	<ul style="list-style-type: none">• Designing of PCB for selected Project once tested on breadboard	4 hours
V	<ul style="list-style-type: none">• Verification of the results obtained of the working model or the simulation results.• Compare with desired results and take corrective action	4 hours
VI	<ul style="list-style-type: none">• Completion of project by developing the Project Report and submitting the report to the concerned to receive the final credits.	6 hours

Unit 1: Active & Passive Circuit Element**7 Hours**

Independent & dependent voltage & current sources, R, L, C, self and mutual inductance circuit parameters, Their mathematical models, Voltage- current- power relations, Independent voltage and current sources, dependent sources, Source transformation, star-delta conversion. Classification of element: Lumped and distributed, Linear and non-linear, Unilateral and Bilateral, Time invariant and variant.

Unit 2: Network theorems**12Hours**

Kirchhoff's laws (KCL and KVL), Mesh analysis, nodal analysis, Solution of D.C. resistive network, writing loop equations, Node equations directly in matrices form, super node and super mesh analysis, Superposition theorem, Thevenin's theorem, Norton's theorem, Reciprocity theorem, Maximum power transfer theorem, Substitution theorem, Millman's Theorem, Tellegen's theorem for D.C and A.C. circuits.

Graph Theory: Network topology, graph, Tree, Branches, Chords, incidence, cut set and tie set matrix using network topology, Concept of duality & dual networks.

Unit 3: Transient Response Analysis in circuit**7 Hours**

Initial and final condition of circuit, procedure for evaluating initial conditions, solution of first and Second order differential equations of series & parallel R-L, R-C, R-L-C circuits, Time constant, General & particular solutions, Particular integral & complimentary functions, Numerical

Unit 4: Application of Laplace's Transform**7 Hours**

Standard test input signal- Unit step, Impulse & ramp functions and their Laplace transform, Solution of differential equation using Laplace transform, solve of R-L, R-C, R-L-C circuits using Laplace transform, Transient and steady state response of RL and RC circuit to various functions using Laplace transform.

Two port network: Terminals & terminal pairs, Driving points & transfer admittance, Transfer functions, Concept of poles & zeroes, Two port networks, Z, Y & the transmission parameters relationship between parameter sets.

Unit 5: Sinusoidal Steady State A. C. Circuit**7 Hours**

R-L-C series circuits, Series resonance Variation of Z with frequency, maximum value of VC & VL, Magnification, Bandwidth, Q factor. Parallel Resonance: Resonance frequency for tank circuit frequency, Locus diagram of series R-L, R-C with variable R & X.

Filter: Introduction classification, Low pass, High pass, Band pass & band reject filter, active & passive filters. Application of Fourier series, Expansion for periodic & non-sinusoidal waveforms.

Text/Reference Books:

1. N Balabanian and T.A. Bickart, "Linear Network Theory: Analysis, Properties, Design and Synthesis", Matrix Publishers, Inc. 1981.
2. L.O. Chua, C.A. Desoer, E.S. Kuh, "Linear and Nonlinear Circuits", McGraw – Hill International Edition 1987.

3. Van Valkenburg, "Network Analysis", Third Edition, 2009, Prentice Hall of India.
4. Sudhakar, A. Shyammohan, "Circuits and Network", Third Edition, 2006, Tata McGrawHill
5. D. Roy Choudhury, "Networks and systems".New Age International Publishers
6. Kelkar and Pandit, "Linear Network Theory", Pratibha Publication.
7. Mahmood Nahvi, Joseph AEdminister, "Schaum's Outline of Electric Circuits", 6th edition,Tata McGraw-Hill.

Unit 1: Electrical Power Generation**9 Hours**

Evolution of Power Systems, Typical Layout of an Electrical Power System–Introduction to different sources of energy. Construction and working of thermal power plants, Hydro power station, Nuclear Power Plant with neat block diagram of main parts. Descriptive treatment of alternator exciter & excitation systems, major electrical equipments in generating stations.

Unit 2: Electrical Design of Overhead Transmission Lines**9 Hours**

Line conductors, inductance and capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing, concept of GMD and GMR, Composite conductors-transposition, bundled conductors, and effect of earth on capacitance. skin effect, proximity effect, Ferranti Effect.

Corona: Introduction, Factors affecting corona loss and methods of reducing corona loss, Disadvantages of corona.

Unit 3: Mechanical Design of Transmission Lines**8 Hours**

Types of conductors, Choice of conductor materials, Stranded copper & ACSR conductor, Insulation consideration, Different types of insulator, supports, distribution of voltage across the insulator string, String efficiency, Effect of wind & ice coating on transmission line, sag due to equal & unequal supports, with their derivation, Numericals.

Unit 4: Performance of Transmission Lines**8 Hours**

Classification of overhead transmission lines, important terms, performance of single phase short transmission lines, three phase short transmission lines, effect of load power factor on regulation and efficiency, different types of medium transmission line, Analysis of long transmission lines, generalized constant of transmission line, determination of generalized constant of transmission lines, percentage regulation, Transmission efficiency, numerical based on above.

Unit 5: AC & DC Distribution**8 Hours**

Classification of Distribution system, Requirement of distribution system, design consideration in distribution system. AC Distribution: Calculations, method of Solving AC Distribution problem, three phase unbalanced load, four wire unbalanced star connected load, ground detector, DC Distribution: types, DC distribution calculation, three wire DC system.

Text/References :**REFERENCES:**

1. V.K Mehta & Rohit Mehta. “ Principles of Power System” S Chand Publications
2. Gupta B. R. ” Power Plant Engineering”.(Eurasia publications)
3. Nag P. K. “ Power Plant Engineering”,(Tata McGraw Hill Publications)
4. Kothari Nagrath, “Electric Power System”, (Tata McGraw Hill Publications)
5. Wadhva S. L.,“Electric Power System”,(Tata McGraw Hill Publications)
6. Stevenson W. B., “Power System”, (English Language Book Society publications)

Unit 1: Basic Concepts in A.C. Machines**5 Hours**

Classification of A.C. Machines, principle of operation and constructional features of synchronous and induction machines, rotating mmf waves in A.C. Machines

Unit 2: Constructional Armature windings**5 Hours**

Introduction, ac machine windings, winding factors, the emf equation, harmonics in generated emf, causes of harmonics and their suppressions

Unit 3: Synchronous Machines**9 Hours**

Synchronous Machines : Construction, types, armature reaction, circuit model of synchronous machine, determination of synchronous reactance, phasor diagram, power angle characteristics, parallel operation of synchronous generators, synchronizing to infinite bus bars, two axis theory, synchronous motor operation, characteristic curves, synchronous condenser, dynamics.

Unit 4: Three phase Induction (Asynchronous) Motor**9 Hours**

Types of induction motor, flux and mmf waves, development of circuit model, power across air gap, torque and power output, oc and sc tests, circle diagram, starting methods, cogging and crawling, speed control, deep bar/ double cage rotor, induction generator, induction machine dynamics, high efficiency induction motors

Unit 5: Fractional Kilowatt Motors**6 Hours**

Introduction, single phase induction motors, double revolving field theory, circuit model of single phase induction motor, determination of circuit parameters

Unit 6: Special Machines**6 Hours**

Single phase synchronous motors, permanent magnet ac motors, ac servomotors, linear induction motor

Text Books :

1. J. B. Gupta, "Theory and Performance of Electrical Machines," S. K. Kataria & Sons, New Delhi
2. P. S. Bimbra, "Electrical Machinery", Khanna Publishers
3. B. L. Theraja, A. K. Theraja, "A text book of Electrical Technology," S. Chand Publishers
4. Asfaq Hussein, "Electric Machines," Danpat Rai Publisher

Reference Books :

1. I. Say M. G., "Design & performance of A.C. Machines", (Book Publications, 3rd edition)
2. B. S. Bhimra P. S., "Electric Machines", (South Ex Publications, New Delhi)
3. D. P. Kothari, I. J. Nagrath, "Electric Machines", Tata McGraw Hill Publication, Fourth edition, reprint 2012.
4. A. F. Puchstein, T.C. Lloyd, A.G. Conrad, "Alternating current machines", John Wiley and Sons, New York 1954.
5. S.A.E. Fitzgerald, Charles Kingsley Jr., Stephen D. Umans, "Electric Machinery", Tata McGraw Hill Publication, sixth edition 2002. 4. Fitzaralda, "Electrical Machines", (Tata McGraw Hill Publications)

Unit 1: Transistor as an Amplifier**5 Hours**

Load line, Small signal low frequency analysis of single stage amplifier in different configuration, High frequency equivalent circuit of transistor (hybrid pi), Cascade amplifier, High input resistance circuits- C coupled amplifier Frequency response, Definition of 3 dB bandwidth, Effect of cascading on gain & BW, Classification of amplifiers

Unit 2: operational amplifier**6 Hours**

Block diagram of operational amplifier, Properties of ideal operational amplifier, Explanation of different terms appearing in OP-Amp application (offset, bias, quantities, PSRR, CMRR, Ad, AC, Slew rate etc.), Operation of circuit diagram of OP-Amp using discrete components & I.C. diagram, Different types of current of current sources in I.C. technology, frequency response of OP-Amp, OP-Amp parameters & minimization technique of temperature effect, Inverting & Non-inverting operation of Op-Amp & analysis for AG, RI, RO, Linear & non-linear circuit application of OP-Amp

Unit 3: Number Systems**6 Hours**

Basic Logic Gates & Boolean Algebra: Binary Arithmetic & Radix representation of different numbers. Sign & magnitude representation, fixed point representation, complement notation, various codes & arithmetic in different codes & their inter conversion. Features of logic algebra, postulates of Boolean algebra. Theorems of Boolean algebra. Boolean function. Derived logic gates: Exclusive-OR, NAND, NOR gates, their block diagrams and truth tables. Logic diagrams from Boolean expressions and Vica-versa. Converting logic diagrams to universal logic. Positive, negative and mixed logic. Logic gate conversion.

Unit 4: Digital Logic Gate Characteristics**6 Hours**

TTL logic gate characteristics: Theory & operation of TTL NAND gate circuitry. Open collector TTL. Three state output logic. TTL subfamilies. MOS & CMOS logic families. Realization of logic gates in RTL, DTL, ECL, and C-MOS & MOSFET. Interfacing logic families to one another. Sequential Systems: Latches, flip-flops, R-S, D, J-K, Master Slave flip flops. Conversions of flip-flops Counters: Synchronous & asynchronous ripple and decade counters, Modulus counter, skipping state counter, counter design, state diagrams and state reduction techniques. Ring counter. Counter applications. Registers: buffer register, shift register

Unit 5: Minimization Techniques**7 Hours**

Minterm, Maxterm, Karnaugh Map, K map upto 4 variables. Simplification of logic Conversion of truth tables in POS and SOP form Incomplete specified functions. Variable mapping Quinn-McKlusky minimization techniques c functions with K-map

Unit 6: Combinational Systems**6Hours**

Combinational logic circuit design, half and full adder, subtractor. Binary serial and parallel adders BCD adder Binary multiplier Decoder: Binary to Gray decoder, BCD to decimal, BCD to 7- segment decoder' Multiplexer, DE multiplexer, encoder. Octal to binary, BCD to excess-3 encoder. Diode Switching matrix. Design of logic circuits by multiplexers, encoders, decoders and DE multiplexers.

Text/Reference Books:

1. Mandal, Digital Electronics: Principles and Applications, TMH 2009

2. Leach, Digital Principles and Applications, ed. 7, TMH 2008
3. M. Morris Mano, Digital Logic and Computer Design, Pearson Edu. 2014

Unit 1: vector calculus**7 Hours**

Scalars and vectors, Vector algebra, Vector components and unit vectors, Vector field Vector field Dot, cross products circular, cylindrical and spherical coordinate systems Coulomb's Law and electric field intensity Electric field due to a continuous Volume Charge Distribution field of a line charge field of a Sheet of a charge streamlines and sketches of fields

Unit 2: Electromagnetic field 1**8 Hours**

Constructional Gauss's Law and its Applications: to some symmetrical charge distribution and differential volume element divergence Maxwell's first equation (electrostatics), the vector operator and the Divergence theorem Energy and Potential Energy expended in moving a point charge in an electric field line integral, potential difference potential, potential gradient, potential field of a point charge and system of charges dipole, energy density in electrostatic field

Unit 3: Electromagnetic field 2**6 Hours**

Current and current density, continuity of current, metallic conductors conductor properties and boundary conditions method of images, semiconductors, nature of dielectric, boundary conditions for perfect dielectric capacitance, and capacitance of two-wire line. Poisson's and Laplace Equations Uniqueness theorem examples in rectangular, spherical and cylindrical coordinates, product solutions of Laplace equations, and solutions of Poisson's equations

Unit 4: Magneto statics 1**8 Hours**

Biot-Savart's law Amperes circuital law curls strokes theorem magnetic flux and magnetic flux density scalar and vector magnetic potentials

Unit 5: Magneto statics 2**7 Hours**

Force on moving charge, differential current element force between differential current element and torque on a closed circuit nature of magnetic materials, magnetization permeability, magnetic boundary conditions, magnetic circuit, potential energy and forces on magnetic materials, self and mutual inductance

Unit 6: Maxwell's equations**4 Hours**

Faradays law, Maxwell's equations in point form, Maxwell's equations in integral form, Retarded potentials.

Text Books :

- 1) "William H. Hayt & John. A. Buck, "Engineering Electromagnetics" Mc. Graw-Hill Companies, 7th Editon.2006.
- 2) "Sadiku- "Electromagnetic Fields" , Oxford Publications.

Reference:

- 3) D. J. Griffiths, _Introduction to Electrodynamics^, Addison Wesley, 1999.
- 4) D. K. Cheng, _Field and Wave Electromagnetics^, Addison Wesley, 1999.
- 5) N. N. Rao, _Elements of Engineering Electromagnetics^, Pearson Education, Inc, 2004.
- 6) Mathew N.O. Sadiku,Elements of Electromagnetics,Oxford Univ Press
- 7) N.N. Rao, Basic electromagnetic and applications, McGraw Hill

Unit 1: Elements of Signal Space Theory**7 Hours**

Objective and overview, signal and system types and classifications, Different types of signals; Linearity, time invariance and causality; Impulse sequence, impulse functions and other singularity functions

Unit 2: Classification of System**9 Hours**

CT and DT system, basic properties of system – linear time invariant system and properties, LTI system: Causality, stability, step response, impulse response.

Unit 3: Convolution**7 Hours**

Convolution sum, convolution integral and their evaluation; Time-domain representation and analysis of LTI systems based on convolution and differential equations. Convolution for CT & DT signals and systems; Necessity of representations of Signals & Systems in Time- and Transformed-domains

Unit 4: Transform domain considerations**7 Hours**

Laplace transforms, inverse Laplace transforms and Z-transforms; Applications of transforms to discrete and continuous systems-analysis; Transfer function, block diagram representation.

Unit 5: Fourier series and Fourier Transform**7 Hours**

Sampling theorem, Discrete Fourier transform (DFT), estimating Fourier transform using DFT Analysis of discrete time signal: sampling of CT signals and aliasing, DTFT and properties.

Reference Books:

1. Signals and Linear Systems, Gabel R.A. and Robert R.A, John Wiley and Sons, New York
2. Signals and Systems , Oppenheim, Wilsky and Nawab, Prentice Hall, New Delhi
3. Systems and Signal Analysis, C.T.Chen, Oxford University Press, New Delhi
4. Probabilistic Methods of Signals and System Analysis, Cooper G.R and McGillem C.D, Oxford University Press, Cambridge.
5. Signals and Systems, Ziemer R.E., Tranter W.H., and Fannin D.R., Pearson Education Asia, Singapore

Unit 1: Introduction**7 Hours**

Renewable Sources of Energy- Introduction to renewable energy, various aspects of energy conversion, principle of renewable energy systems, Grid-Supplied Electricity-Distributed Generation-Renewable Energy Economics-Calculation of Electricity Generation Costs –Demand side Management Options –Supply side Management Options-Modern Electronic Controls of Power Systems.

Fuel Cells: The Fuel Cell-Low and High Temperature Fuel Cells-Commercial and Manufacturing Issues-Constructional Features of Proton Exchange-Membrane Fuel Cells –Reformers-Electrolyzer Systems and Related Precautions-Advantages and Disadvantages of Fuel Cells-Fuel Cell Equivalent Circuit-Practical Determination of the Equivalent Model Parameters -Aspects of Hydrogen as Fuel.

Unit 2: Wind Power Plants**7 Hours**

Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, windspeed monitoring, Appropriate Location -Evaluation of Wind Intensity -Topography -Purpose of the Energy Generated -General Classification of Wind Turbines-Rotor Turbines-Multiple-Blade Turbines -Drag Turbines -Lifting Turbines-Generators and Speed Control used in Wind Power Energy -Analysis of Small Generating Systems. Aerodynamics of wind turbine rotor, site selection, wind resource assessment, wind energy conversion devices: classification, characteristics, and applications. Hybrid systems, safety and environmental aspects.

Unit 3: Photovoltaic Power Plants**7 Hours**

Solar Energy-Generation of Electricity by Photovoltaic Effect -Dependence of a PV Cell Characteristic on Temperature-Solar cell Output Characteristics-Equivalent Models and Parameters for Photovoltaic Panels-Photovoltaic Systems-Applications of Photovoltaic Solar Energy Economical.

Analysis of Solar Energy. environment and social implications Solar Energy: Solar radiation its measurements and prediction, solar thermal flat plate collectors, concentrating collectors, applications, heating, cooling, desalination, power generation, drying, cooking etc.principle of photovoltaic conversion of solar energy, types of solar cells and fabrication.

Photovoltaic applications: battery charger, domestic lighting, street lighting, and water pumping, power generation schemes.

Unit 4: Bio-Energy**8 Hours**

Biomass resources and their classification, chemical constituents and physicochemical characteristics of biomass, biomass conversion processes, thermo chemical conversion: direct combustion, gasification, pyrolysis and liquefaction. Biochemical conversion: anaerobic digestion, alcohol production from biomass. Chemical conversion process: hydrolysis and hydrogenation.

Biogas: generation, types of Biogas Plants, applications

Induction Generators: Principles of Operation-Representation of Steady-State Operation-Power and Losses Generated-Self-Excited Induction Generator-Magnetizing Curves and Self-Excitation Mathematical Description of the Self-Excitation Process-Interconnected and Stand-alone operation Speed and Voltage Control-Economical Aspects.

Unit 5: Storage Systems**8 Hours**

Energy Storage Parameters-Lead-Acid Batteries-Ultra Capacitors-Flywheels - Superconducting Magnetic Storage System-Pumped Hydroelectric Energy Storage - Compressed Air Energy Storage-Storage Heat -Energy Storage as an Economic Resource.Integration of Alternative Sources of Energy: Principles of Power Injection-Instantaneous Active and Reactive Power Control Approach-Integration of Multiple Renewable Energy Sources Islanding and Interconnection Control-DG Control and Power Injection.

Interconnection of Alternative Energy Sources with the Grid: Interconnection Technologies Standards and Codes for Interconnection-Interconnection Considerations -Interconnection Examples for Alternative Energy Sources.

Text/Reference Books :

1. Rao and Parulekar, Energy Technology, Khanna Publishers, New Delhi, Second reprint 2002
2. G.D Rai, Non-conventional Energy Sources, Khanna Publishers, New Delhi, tenth reprint 2002
3. C. S. Solanki, —Solar Photovoltaics Fundamentals, Technologies and Applications, PHI, 2011
4. B. H. Khan, —Non-conventional Energy Resources, Tata McGrawhill Publishing Co.Ltd., 2006
5. S.P. Sukhatme, J.K. Nayak, —Solar Energy-Principals of Thermal Collection and Storage, Tata Mc Graw hill Publishing Co. Ltd., New Delhi 2008
6. J. Twidell and T. Weir, —Renewable Energy Resources, E & F N Spon Ltd, London, 1999
7. Thomas Ackermann, —Wind Power in Power Systems, John Willey & Sons.

Any Eight Experiments from the following list

Expt. No.	Title of Experiment
1	Verification of Kirchhoff's Laws
2	Verification of Superposition Theorem
3	Verification of Thevenin's Theorem
4	Verification of Norton's Theorem
5	Verification of Maximum Power Transfer Theorem
6	Verification of Reciprocity Theorem
7	Determination of transient response of RL & RC series circuits
8	To study Resonance in RLC series Circuit.
9	To study Resonance in parallel RLC Circuit.
10	Determination of driving point and transfer functions of a two port ladder network and verify with theoretical values
11	To calculate and verify 'Z' Parameters of a Two-Port Network.
12	To calculate and verify 'Y' parameters of Two-Port Network.

Sr. No	Experiment Title
1	To study the layout of a Thermal Power Plant with its components.
2	To study the layout, classification and components of a Hydro Power Plant.
3	To study the alternator excitation system
4	To study the types and properties of various Overhead insulators
5	To study the types and properties of various Overhead Conductors.
6	To study the Power cable and its various components and types.
7	To study the layout of a substation along with its components
8	To determine the ABCD parameters of a medium and long transmission line.
9	To Visit a Thermal Power plant and write a technical report on the observations

Perform Any Eight experiment from given list as a part of practical submission

List of Experiment

1. Determination of sequence impedances of salient pole synchronous machine To perform
2. Determination of X_d and X_q of a salient pole synchronous machine from slip test.
3. V and inverted V curves of a 3-phase synchronous motor
4. Regulation of alternator by Direct loading method (R,L,C load)
5. Regulation of alternator by synchronous impedance method
6. Regulation of alternator by MMF method
7. Parallel operation of Synchronous generator
8. To study different types of starters for three phase Squirrel cage induction motor
9. Rotor resistance starter for slip ring induction motor.
10. To conduct no load and blocked rotor test and to determine performance characteristics of three phase induction motor from circle diagram
11. Load and block rotor tests on squirrel cage induction motor
12. Brake test on slip ring induction motor
13. To control speed of wound rotor induction motor by rotor resistance control method
14. To control speed of induction motor by V/F
15. To control speed of induction motor by i) star-delta ii) autotransformer

Perform Any Eight experiment from given list as a part of practical submission

List of Experiment

1. To plot input characteristics and Output characteristics of common emitter configuration.
2. To plot frequency response of RC coupled and Transformed coupled amplifier
3. To measurement of OP-AMP parameter
4. To verify the operation of op amp in Inverting & Non-inverting mode on AC input
5. Verify truth table of following basic and derived gates
 - a. AND, OR, AND
 - b. Ex-OR, NAND, NOR
6. Verification of truth table of flipflop
7. Design and implementation of 3-bit synchronous up/down counter
8. Design and implementation of half and full adder using logic gates
9. Design and implementation of Multiplexer and De-multiplexer and study of IC74150 and IC 74154
10. Design and implementation of code converters
 - a. Binary to gray code converter
 - b. BCD to Excess 3