SYLLABI OF ELECTRICAL ENGINEERING
(Third Semester to Eighth Semester)

THIRD SEMESTER

Sl. No.	Name of Subjects (With Subject Code No)	Periods/ Weeks			Full Marks	Credit Points
		L	T	P/S		
	Theory Papers					
01.	Mathematics – III (BE/M - 301)	3	1	0	100	3
02.	Strength of Materials (BE/ME – 310)	3	1	0	100	3
03.	Thermodynamics & I. C. Engines (BE/ME– 311)	3	1	0	100	3
04.	Electrical Circuits and Systems (BE/EE – 301)	3	1	0	100	3
05.	Electrical Engineering Materials (BE/P(EE) – 302)	3	1	0	100	3
06.	Electronic Devices, Circuits and Techniques (BE/EC – 309)	3	1	0	100	3
	Sessional Papers					
07.	Electrical Engineering Laboratory (BE/EE – 304)	0	0	3	100	3
08.	Electronic Devices and Circuits Laboratory (BE/EC –310)	0	0	3	100	2
09.	Electrical Specifications, Estimation and Design Sessional (BE/EE – 306)	0	0	3	100	2
10	Mechanical Engineering Laboratory – I (BE/ME – 312)	0	0	3	100	3
Total		36			1000	28

(N.B. “L” for “Lecture”, “T” for “Tutorial” and “P/S for “Practical / Sessional”)

FOURTH SEMESTER

Sl. No.	Name of Subjects (With Subject Code No)	Periods/ Weeks			Full Marks	Credit Points
		L	T	P/S		
	Theory Papers					
01.	Electrical Machines – I (BE/EE – 401)	3	1	0	100	3
02.	Power System – I (BE/EE – 402)	3	1	0	100	3
03.	Electrical Measurements and Measuring Instruments. (BE/EE – 403)	3	1	0	100	3
04.	Thermal Power Engineering (BE/ME – 409)	3	1	0	100	3
05.	Hydraulics & Water Turbines (BE/ME – 410)	3	1	0	100	3
06.	Mathematics – IV (BE/M- 401)	3	1	0	100	3
	Sessional Papers					
07.	Electrical Machines Laboratory – I (BE/EE – 405)	0	0	3	100	3
08.	Electrical Measurements Laboratory (BE/EE – 406)	0	0	3	100	3
09.	Electrical Circuits & Systems Lab (BE/EE – 407)	0	0	3	100	2
10	Mechanical Engineering Laboratory – II (ME – 411)	0	0	3	100	2
Total		36			1000	28

FIFTH SEMESTER

Sl. No.	Name of Subjects (With Subject Code No.)	Periods/ Weeks			Full Marks	Credit Points
		L	T	P/S		
	Theory Papers					
01.	Electrical Machines – II (BE/EE – 501)	3	1	0	100	3
02.	Power System – II (BE/EE – 502)	3	1	0	100	3
03.	Electrical Instrumentation (BE/EE – 503)	3	1	0	100	3
04.	Field Theory (BE/EE – 504)	3	1	0	100	3
05.	Microprocessors and their application (BE/EE – 505)	3	1	0	100	3
06.	Control System Engineering – I (BE/EE – 506)	3	1	0	100	3
	Sessional Papers					
07.	Electrical Machines Laboratory – II (BE/EE – 507)	0	0	3	100	2
08.	Electrical Machines Design – I (BE/EE – 508)	0	0	3	100	3
09.	Microprocessors and their application Laboratory (BE/EE – 509)	0	0	3	100	3
10	Instrumentation Laboratory (BE/EE – 510)	0	0	3	100	2
Total		36			1000	28

SIXTH SEMESTER

Sl. No.	Name of Subjects (With Subject Code No.)	Periods/ Weeks			Full Marks	Credit Points
		L	T	P/S		
	Theory Papers					
01.	Electrical Machine - III (BE/EE – 601)	3	1	0	100	3
02.	Power System -III (BE/EE – 602)	3	1	0	100	3
03.	Principle of Communication Engineering & Computer Networks (BE/EC –612)	3	1	0	100	3
04.	Control System Engineering – II (BE/EE – 603)	3	1	0	100	3
05.	Power Electronics (BE/EE – 604)	3	1	0	100	3
06.	Engineering Economics and Costing. (BE/HU-601)	3	0	0	100	2
	Sessional Papers					
07.	Electrical Machines Laboratory – III (BE/EE – 609)	0	0	3	100	3
08.	Electrical Machines Design – II (BE/EE – 606)	0	0	3	100	3
09.	Control System Laboratory (BE/EE – 607)	0	0	3	100	3
10	Electrical Engineering Modelling and Simulation Laboratory (BE/EE-608)	0	0	3	100	2
Total		36			1000	28

SEVENTH SEMESTER

Sl. No.	Name of Subjects (With Subject Code No)	Periods/ Weeks			Full Marks	Credit Points
		L	T	P/S		
	Theory Papers					
01.	Power System Protection and Switch Gear (BE/EE – 701)	3	1	0	100	3
02.	Process Instrumentation and Control (BE/EE – 702)	3	1	0	100	3
03.	High Voltage Engineering (BE/EE – 703)	3	1	0	100	3
04.	Industrial Management (BE/ME-711)	3	1	0	100	3
05.	Elective – I (BE/EE – 704)	3	0	0	100	3
	Sessional Papers					
06.	Power Electronics Laboratory (EE – 705)	0	0	3	100	3
07.	Process Instrumentation and Control Laboratory (EE – 706)	0	0	3	100	2
08.	Power System Laboratory – I (BE/EE – 707)	0	0	3	100	3
09.	Preliminaries of Project & Thesis (BE/EE – 708)	0	0	6	100	3
10	Seminar &VIVA VOCE – I (BE/EE – 709)	0	0	0	50	1
11.	Professional Skill Development – I (BE/GP – 2)	0	0	2	50	1
Total		36			1000	28

EIGHTH SEMESTER

Sl. No.	Name of Subjects (With Subject Code No)	Periods/ Weeks			Full Marks	Credit Points
		L	T	P/S		
	Theory Papers					
01.	Electric Drives and Control (BE/EE – 801)	3	1	0	100	3
02.	Energy System (BE/EE – 802)	3	1	0	100	3
03.	Digital Signal Processing (BE/EC – 807)	3	0	0	100	3
04.	Generalised theory of Electrical Machines (BE/EE – 803)	3	1	0	100	3
05.	Elective – II (BE/EE – 804)	3	1	0	100	3
	Sessional Papers					
06.	Electric Drives and Control Laboratory (BE/EE – 805)	0	0	3	100	3
07.	Power System Laboratory – II (BE/EE – 806)	0	0	3	100	3
08	Project & Thesis (BE/EE-807)	0	0	6	100	3
09	Digital Signal Processing Lab (BE/EC – 810)	0	0	3	50	1
10	VIVA VOCE – II (BE/EE – 809)	0	0	0	100	2
11	Professional Skill Development – II (BE/GP – 3)	0	0	2	50	1
Total		36			1000	28

THIRD SEMESTER

01. MATHEMATICES-III (BE/M – 301)

FIRST HALF:
Classical & Axiomatic construction of the theory of Probability, Conditional probability, and basic formulae, random variables, probability density function and probability distribution function, functions of a random variable. Standard univariate discrete and continuous distributions and their properties. Mathematical expectations, moments, moment generating function. Multivariate distributions; marginal and conditional distributions, conditional expectations.

Fourier series, Half range series, Series solution of ordinary differential equation of second order. Ordinary points and regular singular points. Method of least squares & curve fitting.

SECOND HALF:
Partial Derivatives, Chain Rule, Differentiation of implict functions, exact differentials, Tangent planes and normal. Maxima, minima & saddle points. Simple problems in extrema of functions with constraints. Method of Lagrange multipliers. Multiple- double & triple integrals. Jacobians & transformation of co-ordinates. Applitation to areas, volumes, center of pressure. Improper integrals. Test of convergence. Beta & Gamma functions. Vector differentiation & integration. Gradient, divergence & Curl-applications.

Functions of a complex variable. Limits & Continuity Differentiations. Analytic functions. Cauchy-Riemann equations, Conjugate functions; application to two dimensional problems; Cauchy's Integral theorem; Taylor's & Laurent's expansions; Branch points Zeros, Poles, Residues. Simple problems on contour integration.

02. STRENGTH OF MATERIALS (BE/ME – 310)

1st Half

1. Stress: Normal stress, shear stress, strain, factor of safety, Hoop Stress and Thermal stress.
2. Stress Strain Diagram: Hooks law, Poisson's ratio, Bulk modulus and Elastic limit.

3. Flexural loading: Theory of pure bending, Flexural formula, shear force and bending moment diagram for different types of loading and support conditions of the beam. Sign conversion and point of contra flexure.

2nd Half

1. Torsion: Basic assumption, Torsion formula, Polar Modulus, Hollow and stepped circular shafts, angular deflection, combined bending and Torsional stress. Introduction to shaft coupling.

2. Principal stresses and strain: Normal and shear stress, concept of equivalent twisting moment, Mohr's circle of stress and strain.

3. Column: Euler's formula for different end conditions, concept of equivalent length, eccentric loading, Rankine's formula, Buckling load.

4. Energy methods: Strain energy for uni-axial stress, pure bending, shearing stresses, Use of energy theorems to determine deflection and twisting of shafts.

Reference Books:

1. Strength of Materials By- S. Ramumruthm.
2. Strength of Materials By- Poppov.
3. Strength of Materials By- Timoshenko and Young.
4. Strength of Materials By- A.P.Dongre.

03. THERMODYNAMICS & I. C. ENGINES (BE/ME– 311)

FIRST HALF:

Thermodynamic systems and control volume, equilibrium. Intensive & extensive properties of a system. Pure substance. Pressure, temperature, specific volume, density, power, energy and their units. Thermodynamic processes and cycles. P-V diagrams and work done. Zeroth law and First Law of thermodynamics- statement and explanation, Mechanical equivalent of heat, Energy of a system, specific heats, enthalpy. Second Law of thermodynamics, Carnot cycle. Concept of entropy.

Perfect and real gases – properties, equation of state, gas constants, internal energy and enthalpy of perfect gas, P-V and T-S diagrams. Adiabatic, Isothermal and polytrophic processes. Saturation temperature, saturation pressure, dry, wet and superheated steam, dryness fraction, degree of superheat, sensible heat, latent heat of evaporation, enthalpy of dry saturated, wet, superheated steam.

Basic laws of heat conduction, general heat conduction equation, boundary conditions, one dimensional heat conduction equation solutions.

SECOND HALF:

Classification of I.C.engines.

Functions of cylinder block, cylinder head, piston, piston rings, piston pin, connecting rod, crankshaft, flywheel, carburetor, fuel pump, fuel injectors and nozzles, vibration damper, oil filter etc. used in I.C.engines.

Theories of combustion in S.I and C.I. engine, Otto and Diesel cycles, detonation. Types of combustion chambers in S.I. and C.I. engine.

Desirable characteristics of fuels for I.C. engines. Octane number, Cetane number. Properties of air-petrol mixtures.

Purpose of Cooling and Lubrication systems. Different types of cooling systems, radiator, properties of good lubricants.

Types of pollutants and their sources of emission from S.I & C.I engine.

References:

1. Nag, P.K., *Engineering Thermodynamics, 4th* ed., The McGraw-Hill Companies, 2008
2. Cengel, Y.A and Boles, M.A, *Thermodynamics: An Engineering Approach, 6th* ed., The McGraw-Hill Companies, 2008
3. Ganesan, V., "*Internal Combustion Engines"*, The McGraw-Hill Companies.
4. Sharma, Mathur,. "*Internal Combustion Engines*", Dhanpat Rai & Sons.

04. ELECTRICAL CIRCUITS AND SYSTEMS (BE/EE – 301)

FIRST HALF:

Review of AC Circuits: Applications of Network theorems in AC Circuits, Magnetically Coupled circuits, review of series and parallel resonance circuits, Locus diagram.

Laplace Transform -- Concept of complex frequency, transform of standard periodic and non periodic waveforms. Independent and dependent sources and equivalence of sources. Circuit elements and their transformed equivalents, treatment of mutual couplings. Transient and steady state response of RL, RC, LC and RLC circuits in transient with or without stored energy – solutions in t & s domains. Concept of natural frequency and damping. Sketching transient response, determination of peak values. Practical applications. Loop and node variable analysis of transformed circuits. Modeling of LTI systems, State variable representation of Circuits.

Signals and their mathematical descriptions: Singularity functions. Convolution integral & Dhumel's Integral and their applications.

SECOND HALF:

Fourier series of periodic & aperiodic functions and waveforms and its applications in electrical circuits. Fourier transform of aperiodic functions, Some properties of Fourier transform. Perseval's theorem, Frequency Response: Frequency response of Circuits in Bode plot.

Graph of network: Concept of tree branch, tree link, tie set and cut set. Various incidence matrices and their properties, loop currents and node-pair potentials, formulation of equilibrium equations on the loop and node basis.

Network functions, driving point and transfer functions, two port networks, impedance and admittance parameters, transmission and inverse transmission parameters, hybrid and inverse hybrid parameters. Series, parallel and cascade connections of two port networks. Indefinite admittance matrix and its application in active & Passive circuits. Driving point impedance function for a passive one port and their Positive real functions and their properties. Testing procedures for PR functions. Introduction to Z & inverse Z transformation, theorems of Z transformation.

05. ELECTRICAL ENGINEERING MATERIALS (BE/P(EE) – 302)

FIRST HALF: Introduction :Atomic Structure of materials, energy levels, and Electronic states, bonded structures (Covalent, ionic, metallic), Complex Structures (fiber, plastic elastomers) Binding energy, force and inter-atomic distance. Crystal Geometry, space lattices, unit cells. Crystallographic Axes, solids, Energy Band formation in solid, electronic distinction between conductors, insulators and semiconductor. Insulating Materials: State of insulating materials and their applications. Electronic, ionic, orientation and space charge polarizations. Dielectric constant, frequency and temperature dependence of relative permittivity behavior of dielectric under alternating fields dielectric losses, temperature dependence of insulating resistance, classification of insulating material, high polymer, XLPE, ceramics.

SECOND HALF: Conductors: Electrical conductivity of metals, Lorentz theory, free electron theory, electron scattering, Intrinsic materials and alloys. Resistivities of conductors including alloys. High resistivity conducting materials and their applications, contact materials. Semiconductor: Intrinsic and extrinsic semiconductor, Fermi-Dirac distribution, dependence of carrier concentration on temperature, Zener breakdown phenomena, photo electric effect in semiconductor, Hall effect & tunneling effect. Magnetic Materials: Atomic interpretation of ferromagnetic materials, Atomic exchange force, crystallographic forces, magnetic anisotropy, magnetostriction, Curie-Weiss law, Curie law, Curie temperature of ferromagnetic materials, soft magnetic material, CRGO, Ni-Fe alloy and applications, hard magnetic materials Alnico, Alcomax and application. Ferrite-ferromagnetic materials and their applications, Piezo-electric materials. Super Conductivity: Theory of super conductivities, critical field, critical current density, transition temperature normal and superconductivity steps, types of super conductor, high temperature superconductor and applications.

06. ELECTRONIC DEVICES, CIRCUITS AND TECHNIQUES (BE/EC -309)

FIRST HALF:

Integrated Circuits : LSI, VLSI.

Study of an industry standard multifunction IC like 555 timer and 723 voltage regulator through some of its configurations. The Operational Amplifier : its characteristics. Applications as inverting amplifier, non-inverting amplifier, summing amplifier, differential amplifier, integrator, differentiator, Instrumentation Amplifier. Further use as voltage comparator, Bipolar & Uniform wave forms Generator, Operational amplifier based Oscillator, simple precision rectifiers, simple active filters etc.

SECOND HALF:

Introduction to digital logic gates. Characteristics of TTL, LSTTL, CMOS and HCMOS logic families. Tri-state logic. Implementation of combinational logic functions using basic gates. Implementation of Decoder, Encoder, Multiplexers & demultiplexers and their uses, Minimisation of gates. Sequential logic elements like RS, JK, T & D type flip flops. Uses of flip flops in binary, decimal and divide-by-12 counters. Cascading of counters. Shift registers, serial / parallel input and serial / parallel output. Cascading of shift registers. Counters & Special functions like latch, decoder, display drivers. Digital to Analog and Analog to Digital converters.

07. ELECTRICAL ENGINEERING LABORATORY (EE – 303)

Laboratory classes based on the Basic study on Laboratory Equipments for Electrical Engineering and their applications, Experimentation based on the Basic Electrical Engineering as well as their applications.

08. ELECTRONIC DEVICES AND CIRCUITS LABORATORY (BE/EC –310)

Laboratory experiments based on the Syllabus of "ELECTRONIC DEVICES, CIRCUITS AND TECHNIQUES (BE/EC-309)".

09. Electrical Specifications, Estimation and Design Sessional (BE/EE – 304)

Practice on design, Estimation on Electrical Domestic & Industrial Wiring and Installation, Safety measures and Electricity Acts.

10. MECHANICAL ENGINEERING LABORATORY-I (BE/ME – 312)

Laboratory Experiments based on Syllabus on **BE/ME – 310 & BE/ME – 311**

FOURTH SEMESTER

01. ELECTRICAL MACHINES-I (BE/EE – 401)

FIRST HALF:

General Introduction on Electrical Machines : Faraday's laws of Electromagnetic induction, Fleming's rule and Lenz's law. Space distributions of flux density and time variation of voltage. Magnetic curves and their relevance. Core lose and copper lose. Materials used for rotating electrical machines. DC machines: Detail construction and operating Principle. Function of commutator and brush system. Dc machine as motor and generator.. Shunt ,series and compound excitation. Building up of DC shunt generator. DC motor general torque equation. No-load operation. AC Machines: Three phase balanced excitation system. Development of rotating magnetic field. Frequency of the induced emf and relationship to number of poles. Mechanical and electrical angles. Construction and basic principle of operation of 3-phase induction motor. Slip, slip speed and slip frequency. Basic principle of operation of three phase alternator, synchronous motor, single phase induction motor and alternator.

SECOND HALF:

1-Phase Transformer : Construction and basic principle of operation. Core type and shell type transformers. Materials used for core, winding and insulation. EMF equation. Core loss copper loss and leakage reactances. Harmonics in magnetizing current and magnetizing inrush current. Generalised derivation of electrical equivalent circuit from magnetic structure. Phasor diagram. Dry type and oil cooled type. Natural and forced type of cooling. Tank and radiator construction, operation. Transformer oil, transformer accessories e.g. conservator, breather, Buckholtz relay, bushings etc.

Testing of Transformers : Polarity of windings, OC and SC test. Separation of losses, derivation of equivalent circuit parameters. Regulation, efficiency, all-day efficiency. Parallel operation. Effects of changes of frequency and voltage on transformer performance.

Single phase auto transformers: Principle of operation, phasor diagram. Comparison of weight, copper loss, equivalent reactance with 2-winding transformer.

Reference Books:-

1.Electrical Technology ,Vol-2-B.L.Theraja
2.Electrical Machinery-Fitzerald & Kinsley
3. Electrical Machinery-S.K.Sen

POWER SYSTEM-I – (BE/EE-402)

FIRST HALF:

Introduction to power system. Sources of energy. Conventional and non-conventional electrical energy sources- Recent Trends.

Transmission line structure- Types of conductors, line supports – poles, towers, struts & Guy wires, sag and tension calculations, stringing chart, sag template. Insulators – Materials of

insulators, types of insulators – Pin and Disc type – their applications- String Efficiency-Calculations.

Underground Cables – Construction of cables, single and multicore cables, different types, capacitance of belted cables, . dielectric loss in cables, heating of cables.

SECOND HALF:

Transmission line parameters – Resistance, Inductance, Capacitance and Conductance. Inductance of single phase line, inductance of three phase line with symmetrical and unsymmetrical spacing, concept of GMD and GMR . Inductance of composite conductor systems – stranded conductors, bundle conductor and Double circuit lines . Capacitance of single phase line, capacitance of three phase lines with symmetrical and unsymmetrical spacings, capacitance calculation for double circuit line and bundle conductor. Effect of earth on capacitance calculation. Skin effect and proximity effect.

Variable load on power stations, types of load, load curves, load forecasting, maximum demand, demand factor, load factor, utilization factor, plant capacity factor. Diversity factor important terms and factors, interconnected grid system.

Reference Books:-

1. Power System Engineering,I. J Nagrath and D P Kothari, Tata McGraw Hill
2. Electrical Power System, C. L. Wadhwa
3. Power System Analysis,Stevension
4. A course in Electrical Power-Soni,Gupta,Bhatnagar.Chakraborty

03. ELECTRICAL MEASUREMENT & MEASURING INSTRUMENTS (BE/EE – 403)

FIRST HALF :-

Classification of electrical measuring instruments, general feature of indicating instruments: controlling, damping, balancing. Galvanometer: dynamics, sensitivity, D'Arsonval galvanometer, Ballistic galvanometer, Vibration Galvanometer, PMMC instruments, temperature compensation, rectifier type instrument, Moving iron instruments, errors and compensations, electrodynamometer type instrumenst, power measurement, low power factor wattmeter, wattmeter connections and errors, Induction type energy meter: characteristics, errors and their compensation, extension of instrument range: shunt, multiplier, construction & working principles of current transformer, potential transformer; Maximum demand meter, KVAR meter, tri-vector meter, Testing and calibration of single phase & three phase measuring instruments.

SECOND HALF:-

Kelvin double bridge, series and shunt type ohmmeter, megger, measurement of surface resistivity. Measurement of inductances and capacitances, measurement of incremental inductances, interbridge transformer, residuals, errors in bridges, detectors, dc potentiometer: Weston normal cell,Vernier type, Kelvin-Verley slide, dual range, applications, phantom loading, ac potentiometer: polar type and co-ordinate type, use of Ballistic Galvanometer in magnetic testing, ac magnetic testing: Lloyd-fisher square, Understanding of corecivity, Retentivity, Saturation, Magnetisation saturation, Identification of various magnetic phase, Determination of Hysterises loss. Magnetic Measurement : Gause and Tesla meter,

Measurement of magnetic field by Gauss and tesla meter, Determination of the poles of an Electromagnet with the help of Hall probe and Gauss meter, Measurement of Hall voltage, charge carrier concentration of semiconductor crystal, Hall coefficient of Ge 'P' type crystal, mobility of charge carrier particles, Hall voltage as a function of current at constant magnetic field, dependence of Hall effect coefficient on temperature.

Reference Books:-

1,Electrical Measurements & Measuring Instruments-E.W.Golding& F.C.Widdis
2.Electrical Measuring Instruments-A.K.Sawheny

04. THERMAL POWER ENGINEERING (BE/ME – 409)

FIRST HALF

Introduction- General Layout of modern thermal power plant. Utilities of various components as shown in layout diagram. Site selection.

Steam Generators- Classification, Natural and forced circulation principle. Combustion equipment for burning coal, fuel bed combustion, burners & furnaces. Fluidized bed combustion. Boiler-mounting & accessories, fire tube boilers, water tube boilers, Loeffler boiler, Benson Boiler, steam generator losses & heat balance.

Steam Power Plants- Working cycles– Rankine cycle, Reheat cycle, Regenerative cycle, Reheat-Regenerative cycle. Representation of the cycles on T – S and H – S diagram. Classification of steam turbines, Flow through impulse turbine, velocity diagram, blade efficiency, velocity compounded impulse turbine, reheat factor and internal efficiency. Flow through reaction turbine, velocity diagram, degree of reaction, stage efficiency and optimum velocity ratio. Governing of steam turbine.

SECOND HALF

Compressors- Centrifugal, Reciprocating and Axial flow compressors- principle of operating, working of different components and efficiencies. Root and vane blowers. Introduction to aerofoil theory.

Gas Power Plants- Brayton cycle, efficiency in terms of compression ratio & pressure ratio. Comparison between Brayton cycle & Rankine cycle. Effect of regeneration, intercooling and reheating on Brayton cycle. Ideal regenerative gas turbine cycle with intercooling and reheat. Advantages & disadvantages of gas turbine over steam turbine power plants. Axial flow turbines, velocity diagram, blade loss, static head efficiency, total head efficiency, degree of reaction.

Nuclear Power Plants- General layout of nuclear power plant, nuclear reactor, fuels, moderators, coolants, control rids. Classification of nuclear power plant, precautionary measures adopted in nuclear power plants. Advantages and disadvantages of nuclear power plants as compared with thermal power plant.

Ref Books:

1) Generation of Electrical Energy by B. R. Gupta.
2) Power Plant Engineering by Nagrath & Kothari.
3) Engineering Thermodynamics by P.K. Nag, 4th ed., The McGraw-Hill

05. HYDRAULICS & WATER TURBINES (BE/ME – 410)

FIRST HALF

Properties of fluid- Mass and weight density, specific gravity, specific volume, viscosity, surface tension and capillarity.

Pressure and hydrostatics- Fluid pressure at a point and Pascal's law. Pressure measurement by manometers and mechanical Gauges. Total pressure and centre of pressure for horizontal, vertical, inclined plane surfaces and curved surfaces submerged in liquid.

Dynamics of flow- Euler's equation and Bernoulli's equation, Flow through venturimeter, orifice-meter, and pitot tube.

Orifice and Notches- Flow through orifices, hydraulic coefficients and time of emptying tanks through an orifice at its bottom. Discharge over rectangular, triangular and trapezoidal notches.

SECOND HALF

Flow through Pipes- Major and minor losses in pipes. Flow through pipes in series and parallel, equivalent pipe. Power transmission through pipes, water hammer.

Introduction to water turbines- Its classification and impact of jets.

Water Turbines- Pelton wheel, Francis, Kaplan and Propeller turbines- their principle of operation, function of different components, power, work done & efficiency Characteristic curves. Function of draft tubes.

Hydraulic Pumps- Centrifugal pumps- function of different components, Velocity diagrams, work done & efficiency. Cavitations and its precaution. Performance studies.

References:

1. Bansal, R.K.,"Fluid Mechanics & Hydraulic Machines" Laxmi Publications(Pvt) Ltd.
2. Jain, A.K., "Fluid Mechanics" Khanna Publishers.
3. Rajput, R.K., "Fluid mechanics & Hydraulic machines " S. Chand Publications.

06. MATHEMATICS – IV (BE/M-401)

FIRST HALF

Operation Research:--

n-tuples of real nos., addition and scalar multiplication of vectors, Convex combination, Linearly dependence & independence, basis and dimension, Linear programming, concept of Simplex method, Duality, Two-phase method, Dual-Simplex, Transportation and Assignment models. Concept of Game Theory and solution.

Numerical Analysis:---
Solution of algebraic and transcendental equaton by bisection method, iteration method, Regula-Falsi (False position) method, Newton-Raphson method, complex roots by Lin-Bairstow method. Solution of simultaneous linear equation by Gauss Elmination and Gauss-Seidel method.

SECOND HALF

Partial Differential Equation:--
Solution by separation of variables, Wave equation, Heat equation, One and Two dimensional heat flow.

Interpolation:--
Concept of interpolation, Difference operators, Divided Difference interpolation, Newton's forward, backward interpolation, Lagrange's interpolation, Starling & Bessel's interpolation, Numerical interpolation (1^{st} & 2^{nd} order), numerical integration, (Trapezoidal, Simpson's one-third, three-eight, Weddle's rule).

Numerical Solution of Ordinary Differential Equation:--
Taylor's method, Picard's method, Runge's method, Runge-Kutta method, Euler's method and Euler's modified method, Predictor-corrector method.

Reference Books:--

1) Introduction to Numerical Analysis – Sastry
2) Operation Research – Gupta & Kapoor
3) Linear Programming problem – T.N. Moullick & Chakraborty – Ghosh
4) Advance Engineering Mathematics – B.S. Grewal

07. ELECTRICAL MACHINES LABORATORY – I (EE – 405)

Laboratory Experiments based on the Syllabus of **EE – 401.**

08. ELECTRICAL MEASUREMENTS LABORATORY (EE – 406)

Laboratory Experiments based on the Syllabus of **EE – 403.**

09. ELECTRICAL CIRCUITS AND SYSTEMS LABORATORY (EE – 407)

Laboratory Experiments based on **EE – 301 & EE – 404.**

10. MECHANICAL ENGINEERING LABORATORY – II (ME-410)

Laboratory Experiments based on **BE/ME – 409 and BE/ME – 410**

FIFTH SEMESTER

01. ELECTRICAL MACINES – II (BE/EE – 501)

FIRST HALF

DC machines: Armature windings, equalizers. Armature reaction effects, mmf distribution, compensating windings, improvements. Commutation, sparking, brushes, interface film, inter-poles. Various losses in the DC machine. Core loss , laminated yoke construction.

DC Generators : Characteristics with different excitation systems, voltage regulation, parallel operations.

DC Motors :Characteristics with different excitation, methods of starting, speed control, torque characteristics, equivalent circuits and transfer function. Series parallel operation of motors.

Permanent magnet DC machines. Testing of DC machines : Swinburne's test, Hopkinson's test, Brake test. Tests specified as per standards.

SECOND HALF

Polyphase Transformer : Construction and basic principle of operation. Core type 3-limb and 5-limb construction and shell type. Flux distribution. Star, delta, open delta and Zigzag connections. Tertiary windings. Vector groups. Graded insulation and shielding for HV. Harmonics in 3-phase transformers. Tap Changer principles, types and operation. Parallel operation, unbalanced loading, capacity calculations. Tests specified as per standards.

Special connections : Scott and le Blanc connection, 3-phase to 6-phase and 3-phase to 1-phase transformation. Three phase auto transformers, principle of operation, phasor diagram.

AC Commutator Motors: Transformer and rotation emf's in phase and commutator winding. Expiration for torque and power. Action of commutator as frequency converter. Study of AC plain series motor, its phasor diagram, commutation, brush emf's design features. Use of compensation and com-pole winding to improve power factor and commutation.

Reference Books:-

1.Electrical Technology ,Vol-2-B.L.Theraja
2.Electrical Machinery-Fitzerald & Kinsley
3. Electrical Machinery-S.K.Sen

02. POWER SYSTEM-II– (BE/EE-502)

FIRST HALF

Administrative aspects of electricity supply- Development of power sector in India. Administrative set up and organisations in power sector. Stages involved in power planning-load analysis, load management & load forecasting. Legal aspects of electricity supply-Electricity acts, rules and codes. Standards followed in power supply, environmental and safety measures. Commercial aspects of electricity supply – Expenditure in power Utility. Factors influencing tariffs, types of consumers, different types of tariffs.

Performance of lines: A, B, C, D parameters, short, medium, long lines, transmission efficiency, voltage regulation, Ferrant effect.

SECOND HALF

Substations: Classification of substations, Major equipments in Substation, Busbar layouts. Power factor improvement.
Per unit system: per unit impedence, changing the base of per unit quantities, p.u. impedance of transformer, alternator, advantages of per unit system.

Reference Books:-

1. Power System Engineeriong, J Nagrath and D P Kothari, Tata McGraw Hill
2. Power System Analysis and Design, B R Gupta, Wheelers Publishers
3. Electrical Power Systems, Ashfaq Hussain, CBS publishers and distributor
4. Principles of Power System, V K Mehta.
5. Electrical Power System, C. L. Wadhwa

03. ELECTRICAL INSTRUMENTATION (BE/EE – 503)

FIRST HALF:

Signal conditioning & isolation techniques: low level and high level signals, MUX,PGA; ADC: counter, ramp, dual-slope, successive-approximation, sample & hold circuits; DAC: binary-weighted register, R-2R ladder; ADC & DAC characteristics & specifications, waveform display devices & applications: CRT, LCD, plasma display, alphanumeric display; timing/counting, PLL and its applications, active filters: VCVS, state-variable; filter approximations: Butterworth, Chebyshev; switched capacitor circuits, digital R-L-C meters. Construction & working principles of strain gauge. Measurement of displacement: LVDT, capacitive; Measurement of pressure: diaphragm, bellows, bourdon tube; measurement of flow: electromagnetic, ultrasonic, hot-wire anemometer; measurement of level: resistive, capacitive, ultrasound;

SECOND HALF:

Measurement of humidity: resistive, capacitive; semiconductor temperature sensors/ transducers: RTD, thermistor, thermocouple, laws of thermocouple circuits, cold junction compensation, optical and radiation pyrometers, acoustic sensors and measurement techniques, magnetostrictive transducer, piezoelectric transducers, force-balance transducers, pH sensors. Power quantity transducers. Signal conditioning of transducers for interfacing with the different circuitry and Computer.

Introduction to Programmable logic Controllers (PLC) : Architecture and functional components, I/O Processing Methodologies, Programming Languages. Sequence Function Chart, Relay logic and switching algebra, Ladder diagram representation of sequential systems, & design, PC input/output Diagram. Case Studies.

Reference Books:-

1,Electrical Measurements & Measuring Instruments-E.W.Golding& F.C.Widdis
2.Electrical Measuring Instruments-A.K.Sawheny

04. FIELD THEORY (BE/EE – 504)

FIRST HALF:

Electric vector field and scalar potential field, Relation between electric field intensity and potential, Gauss's integral law for electric displacement field, electric dipole fields, Electric polarization, and its relation to the permittivity of dielectric media, Gauss's law in differential form, Poisson's and Laplace's equations, These equations in cartesian, cylindrical and spherical coordinates, Matching boundary conditions at the interface of different dielectric media, Electric stress and mechanical force in charged conductors, Energy stored in electric field, Solution of Laplace's equation by separation of variables method, Capacitance of coaxial cables and two wire transmission lines and related electric fields, Numerical analysis of electric fields by solving Laplace's equation, Iterative methods, Finite elements. Uniqueness theorem, Method of Images for the solution of electric fields.

SECOND HALF:

Magnetic field intensity, Scalar and Vector magnetic potential, Lorentz force, Motoring and generating principles, Faraday's Law of electromagnetic induction, Ampere's law in both integral and differential forms, Biot-Savart's law, Boundary conditions, Solution of field problem by image method, Self and mutual inductance, Inductance of coaxial cable and two wire transmission lines, Energy in magnetic field, Force due to magnetic field in magnetic medium. Maxwell's field equations, Displacement current density and continuity equation, Electromagnetic wave equation in loss-free and lossy media, Plane and polarized waves and their propagation as solutions of wave equation, Poynting's vector, Power flow through electromagnetic media, Elements of wave guide and radiating systems (antenna), Diffusion equation for eddy currents and skin effect.

05. MICRPROCESSORS AND THEIR APPLICATIONS (BE/EE – 505)

FIRST HALF:

Microprocessor Architecture : Address / Data and Control lines, Timing diagrams, Internal registers, Interrupt mechanism (Hardware/Software), DMA mechanism.

Detailed description of a typical Microprocessor - 8085 & 8086.

Assembly Language Programming of 8 bit and 16 bit Microprocessors : Instruction Cycle, Machine Cycle, T states. Instruction Set, addressing modes, stack subroutine, interrupt service routines. Example programs in assembly languages. Concept and operation of Assembler and Cross Assembler.

SECOND HALF:

Interfacing with support chips : Programmable Peripheral Interface (8255), Programmable time/counter (8253), Programmable USART (8251), Programmable Interrupt Controller (8259), DMA Controller (8257), Programmable Keyboard and Display Controller (8279) - signals and timing details along with hardware/software interfacing techniques. I/O interfaces with switch, multi-segment display, ADC/DAC, Memory interfacing technique. Application of Microprocessors:-Phase sequence,Stepper motor,Power measurement,Speed measurement of motor,Temperature measurement,Voltage & current measurement,Displacement measurement,Transistorized driving of small incremental DC machines in either direction etc.

06. CONTROL SYSTEM ENGINEERING-I (BE/EE – 506)

FIRST HALF:

Introduction to Control Systems: Classification of control systems, Examples of control systems, Block diagram development of Physical systems, block diagram reduction and signal flow graph, Feedback Control Systems, Properties of Control Systems: Stability, steady-state & transient errors, disturbance rejection, insensitivity and robustness. Errors and Error constants, System types. Control system components: Potentiometer, tacho-generator, synchro & resolver, dc & ac servomotors, Amplydyne, Actuator Specification. Time response of system: Transient & steady state response of second order system and ramp response of second order system, system response with additional poles and zeros, concept of dominant poles. Control actions: Proportional, integral, derivative, and their combinations. Case Studies: Performance analysis of remote position control system and voltage regulator. Design and compensation of control systems in frequency domain: Frequency Domain Specifications in open loop and closed loop and their significance. Lag compensator, lead compensator and lag-lead compensator and Actuator design.

SECOND HALF: Stability of linear systems: Routh-Hurwitz criterion, Nyquist criterion. Stability margins. Root locus. Effects of system gain on stability. Nichols chart. State variable analysis: Concept of state, state variable, state model. State variable formulation of control system, diagonalization, Relating transfer function with state model. Time response of state model of linear time-invariant system. Elementary concept of controllability & Observability, Conditions of Complete State Controllability and Observability.

07. ELECTRICAL MACHINES LABORATORY – II (BE/EE – 507)

Laboratory Experiments based on BE/EE – 501.

07. ELECTRICAL MACHINES DESIGN-I (BE/EE – 508)

Load box and rheostat design. Design of single phase transformer, lifting magnets and reactors, Design of integral h.p. DC machine and Three Phase Transformer.

09. MICROPROCESSORS AND THEIR APPLICATIONS LABORATORY (BE/EE – 509)

Hand on experience with different microprocessor and their applications and their interfaces.

10. INSTRUMENTATION LABORATORY (BE/EE – 510)

Laboratory Experiments based on BE/EE – 503.

SIXTH SEMESTER

01 ELECTRICAL MACHINES –III (BE/EE - 601)

FIRST HALF:

Three Phase Induction Motor : Per Phase equivalent Circuit. Phasor Diagram. Types of windings. Deep bar and double cage rotor. Pole changing motor. Equations of torque. Torque-speed characteristics. Effect of change of rotor resistance in slip-ring machine and slip power recovery. Circle diagram. Methods of starting and speed control. Tests as per standards. Separation of losses. Operation of induction machines as generator. Single Phase induction motor : Split phase capacitor-start-induction-run with centrifugal switch. Operating principles. Operating characteristics. Double revolving field theory, cross field theory. Equivalent circuit, phasor diagram. Shaded pole type motor: Construction and operating principle, operating characteristics.

SECOND HALF:

Synchronous generator : Armature reaction, its effect on load power factor. Alternator regulation, synchronous reactance. Prediction of regulation by various methods. Cylindrical rotor and salient rotor construction. Two reaction theory. Damper windings. Short circuit transient and subtransient reactances. Determination of Xs, Xd, Xq, X1, X2 , X0, Xd', Xq', Xd'', Xq''. Methods of voltage control, static excitation system. Synchronisation of alternators, power flow, power angle characteristics, operating chart, synchronizing power, stability. Excitation characteristics, V-curves, parallel operation.

Synchronous Motors : Power developed, circle diagrams for constant power developed and constant excitation. V-curves and O-curves. Starting methods. Operation as synchronous condenser.

Reference Books:-

1.Electrical Technology ,Vol-2-B.L.Theraja
2.Electrical Machinery-Fitzerald & Kinsley
3. Electrical Machinery-S.K.Sen

02.POWER SYSTEM-III– (BE/EE-602)

FIRST HALF:

Voltage control: Methods of voltage control, tap changing transformer, location of series capacitor, TCR, TSC, FC-TCR, TSC-TCR, advantages of SVS, application of SVS.

Generation and absorption of reactive power, line compensation, Ferranti effect. Load flow study of interconnected system, Guess seidel method, Newton Raphson method.

Power System transient Stability: Stability limit, infinite bus, M & H constants Synchronous generator connected to an infinite bus, power angle curve, steady state, transient, swing equation, Equal area, criteria of stability, stability improvement, system fault and subsequent circuit.

SECOND HALF:

Symmetrical fault and Unsymmetrical Faults: Single (L-G) fault, L-L fault, L-L-G faults on power systems

Power station control, excitation system, speed governing system, ALFC, AVR, AGC.

Economic operation of power system: Introduction- Incremental fuel rate curves, Incremental fuel cost curve, constraints in economic operation of power system, cost function control for economic operation of a two area power system.

Reference Books:-

1. Power System Engineeriong, J Nagrath and D P Kothari, Tata McGraw Hill
2. Power System Analysis and Design, B R Gupta, Wheelers Publishers
3. Electrical Power Systems, Ashfaq Hussain, CBS publishers and distributor
4. Principles of Power System, V K Mehta.
5. Electrical Power System, C. L. Wadhwa

03 PRINCIPLE OF COMMUNICATION ENGINEERING AND COMPUTER NETWORKS (BE/EC – 612)

FIRST HALF:

Communication Engineering :- Signals and Spectra: Properties of Signals and Noise, Fourier Transform, Power Spectral Density and Autocorrelation, Random signals, Random Process Analog modulation and demodulation techniques: AM, FM, PM. Digital modulation: PAM, PWM, PPM, PCM, Delta. Analog Transmission of Digital Signal: ASK, FSK, PSK, MSK, and Performance of Communication Systems corrupted by noise, Signal-to-Noise Ratio, C /I Ratio. Multiple Access methods: TDMA, FDMA, Spread spectrum analysis, FH, DS, CDMA, CSMA, WDMA. Wire and Wireless Communication Systems: Telephone systems, Cellular System (Concepts, AMPS, GSM, 3G, 4G), Satellite Communication system :Earth Transmitting Station, Transponder, Earth Receiving Station, Frequency Bands. Link Budget Analysis, Optical communication.

SECOND HALF:

Computer Networks :- Introduction to Computer Networks: Analog vs. Digital Transmission, Nyquist and Shannon Limits, ISO-OSI layer architecture, OSI Reference Model: A Layered Approach, Introduction to TCP/IP. Basics of Digital Data Transmission and Media: UTP, STP, Coax, fiber, Wireless, Analog or Digital Data to Analog Signals, Modems, RS-232C, Error Detection and CRC Polynomial Codes, encoding schemes: NZ, NRZ, Manchester encoding. Local Area Networks (LAN), Topologies, Media, Medium Access Control, MAC Layer, LLC, IEEE 802.3, 802.5 Standards, Token Ring, Token bus, CSMA/CD, Ethernet, Hub Switches & Bridges. Wireless LAN, IEEE802. 11X standard. Circuit Switching and Packet Switching, Digital Switching Concepts, Virtual Circuits, X.25. Network & Transport layer, Routing and Traffic Control, Flow and Congestion Control, Internetworking, Routers and Gateways, Internet IP, Transport Protocols, TCP/IP, Frame and Cell Relay, ATM and ISDN. Network Security system.

04.CONTROL SYSTEM ENGINEERING-II (BE/EE – 603)

FIRST HALF:

Robust control system and sensitivity, stability of system with uncertain parameters, Kharithnov's methodology, structured and unstructured robustness of control systems.

Nonlinear systems: Describing functions of common nonlinearity, stability analysis by describing function method, phase plane method, construction of phase Trajectories. System analysis on phase plane. Bang-bang control system. Lyapunov stability analysis, Popov's circle diagram. Case studies in non-linear control performance analysis of system with dead-time.

Modelling & specifications, actuators, electric, hydraulic & pneumatic internal sensors, Gyroscopes & Accelerometers:- Modelling & specification. Case studies of an Aerospace control system.

SECOND HALF:

Discrete Data System-Introduction to Digital Control system, Pulse transfer function. Transfer function from difference equation. Z-Transform, Transient response, characteristics of z-plane pole-locations. Damping ratio and natural frequency. Discretization and Bilinear transformation. Stability on z-plane, Jury's stability criterion, Routh-Hurwitz stability criterion. Choice of sampling rate. Frequency response of discrete functions. Sampling Spectra and Aliasing. Sampling theorem, Systems with time-delay. Specifications and Design of Discrete data of Control System. Digital compensator design in frequency domain. Lead, lag and lag-lead compensation, Single loop digital controllers. Two term (PI, PD) and three term (PID) Control algorithm design. Implementation of digital controllers. Controllability and Observability of discrete-data control system. Solution of state difference equations. Similarity transformation. Discrete-time state-space design - state variable feedback control by pole-placement method.

05. POWER ELECTRONICS (BE/EE – 604)

FIRST HALF:

Major Power semiconductor devices like Diode, SCR, Triac, Bipolar Power Transistor, Power MOSFET, IGBT, GTO, MCT - their type variations, important parameters, Safe Operating Area, Drive techniques, turn-off methods, protection, snubbers, cooling and Heat-sinks. Principles of Step-down and step-up Choppers. Half-bridge, push-pull and bridge inverters. Methods of voltage control : dc bus variation and PWM. SCR forced commutation techniques and their application to choppers and inverters. Principles of isolated dc/dc converters and SMPS.

SECOND HALF:

Input and output characteristics of common rectifier topologies : Single-phase half-wave and full-wave Diode rectifiers with R, RL and RC load. Study of same with highly inductive load. Effect of Free-wheel diode. Three-phase half-wave and full-wave Diode rectifiers with highly inductive load. Use of Inter-Phase Reactor and introduction to higher pulse rectifier systems. Single-phase half-wave and full-wave SCR rectifiers with R and RL load. Study of same with highly inductive load. Effect of Free-wheel diode. Three-phase half-wave and full-wave SCR rectifiers with highly inductive load. Effect of free-wheel diode. Half-controlled rectifiers with highly inductive load. Commutation effects, overlap angle and voltage loss. Input current harmonics and power factor, output harmonics. Principle of generation of control pulses for SCR converters : cosine, ramp and equidistant pulse methods. Principle of UJT control. Line Commutated SCR inverters, reverse power flow. Principle of the Cyclo-converter.

06.ENGINEERING ECONOMICS AND COSTING(BE/HU – 601)

FIRST HALF:

Introduction – Engineering economy and its important, Want activity satisfaction of wants. Resources planning and distribution in economic system – Laissez Faire and socialism. Factors of production and concept of optimum. Laws of return. Demand - Elasticity of demand, demand – estimation, market research, supply and industrial costs. Money – Value of money, quantity theory; inflation and deflection. Neural network and its applications.

Banking - role in commercial banks credit and its importance in industrial financing, sources of finance Reserve bank of India and its functions. Business management and organization, Proprietorship, Partnership and joint stock company – their formation, finance and management. Elements of taxation, insurance, Business combinations. Basic Principals of management.

SECOND HALF:

Industrial record keeping : Double entry system – Journal, lager, trail balance, cash book, preparation of final accounts, trading and profit and lose account and balance sheet. Industrial costs and their classifications – Material cost control, labor cost control and overhead cost control. Depreciation and replacement studies; Financial control ratio analysis and their interpretation for industrial control. Budgetary control.

08. ELECTRICAL MACHINES LABORATORY – III (BE/EE – 609)

Laboratory Experiments Based on the Syllabus of BE/EE – 601.

09. ELECTRICAL MACHINES DESIGN – II (BE/EE – 606)

Design of three phase induction motor and single phase induction motor. (Computerized performance calculation)

10. CONTROL SYSTEM LABORATORY (BE/EE – 607)

Laboratory Experiments based on the Syllabus of EE – 604 using different Trainers.

a. Study of Torque – speed characteristics of A.C & D.C. Servo Motors.
b. Study of Synchro Transmitter – Receiver Characteristic.
c. Study of A. C. Servo Mechanisms.
d. Study of DC Position Control System and its performance analysis, Stability analysis using Computer (P, PI, PD, PID with velocity feedback).
e. Study of Control system performances using Industrial Plant Emulator, Inverted Pendulum and Rectilinear Plant.
f. Control System Performances analysis and Design & Simulation using MATLAB Software.

11. ELECTRICAL ENGINEERING MODELLING AND SIMULATION LABORATORY (BE/EE-608)

Introduction to SPICE, MATLAB, SIMULINK, ETAP and PSCAD Software: Basic matrix operation, file operations, plotting, MATLB program development in command window. Simulation of problems on SPICE/MATLAB/ SIMULINK/ ETAP/ PSCAD related to:

– Modeling of 1st and 2nd order systems. Study on time domain and frequency domain behavior.
– D.C. circuit transients in time domain.
– A.C. circuit response in time and frequency domain.
– Simulation of D.C. shunt motor and open loop response.
- Closed-loop speed control of D.C. shunt motor: Stability analysis by root-locus method.
- Full State feed back LQR Control, Digital controller design etc.
– Simulation of circuit of long transmission line and study of wave propagation.
– Simulation of series and shunt faults in transmission lines.
– Simulation of load frequency control for single-area and two-area power system.
– Simulation of sampling and aliasing phenomenon.
Virtual Instrumentation system using Lab view Software and its familiarizations.

SEVENTH SEMESTER

01. POWER SYSTEM PROTECTION AND SWITCH GEAR (BE/EE –701)

FIRST HALF:

Analysis of asymmetrical faults in power system. General requirements of circuit breakers. Auto re-closing feature – three pole & single pole auto re-closing. Formation of electric arc. Arc build-up and quenching theory, recovery voltage and RRRV, Arc re-striking phenomena. Problems of capacitive and low inductive current interruptions. Rating of circuit breakers and effect of transient current on it. Different types of arc quenching media and special devices for arc quenching. Different types of circuit breakers - their relative merits and demerits. Specific field of usage. Testing of circuit breakers. D.C circuit breaking.

SECOND HALF:

Fundamental principles of protective relays, their properties and block diagrams. Single input relays, over current, earth fault and over voltage relays. Principle and application of directional over current and earth fault relays. Principle of 2-input comparison, two and multi input comparators. Distance relays & their settings, errors and remedies to errors. Differential relays current and voltage comparison. Motor protection, Different types of pilot protection wire, carrier and wireless pilot. Carrier aided distance protection. Carrier phase comparison schemes.

02. PROCESS INSTRUMENTATION AND CONTROL (BE/EE – 702)

FIRST HALF:

Concept of Processes and Units: Process statics, mass and enthalpy balance. Modeling of process dynamics. Process Control terminology. Process Instrumentation diagrams. Modeling of Chemical processes. Single loop control of standard first order process plants. Controller Implementation : Electronic Analog, Digital, Pneumatic Controllers. P, P-I, P-D, P-I-D control, Controller tuning, Ziegler-Nichlol's method, Frequency domain design. Feed-forward control, Ratio Control, Multi-loop and Cascade control, Interaction and decoupling Non-linear effects in plants and controllers. Simulation of process control systems. Boiler Drum Level Control. Discrete Controllers: Selection of sampling intervals, stability analysis.

SECOND HALF:

Concepts of Modulating and Sequential Control. Structure of Modulating Control loops.
Self-tuning and Multifunction Controllers, Control Valves. Process Actuators: Electrical, Pneumatic, Hydraulic, Valve positioners. Industrial Instrumentation Systems: Components, structure, specification. Self tuning and Adaptive controllers.
Supervisory control : Objectives and Implementation.

03. HIGH VOLTAGE ENGINEERING (BE/EE – 703)

FIRST HALF:

Types of Insulators and their applications, Voltage distribution and string efficiency of disc insulators Evolution of high voltage cables, XLPE cables, Gas-filled cables, Inter-sheath grading, Thermal characteristics of cables Non-condenser and condenser bushings, Field distribution in and around bushings Gas Insulated Substation – Layout and Components, Gas mixtures and their properties, Technical and economic considerations Corona discharge, Corona Loss and radio interference, Suppression of corona and its ill effects Traveling wave equations, Reflection and refraction of traveling waves, Line terminations, Ladder diagram, Traveling waves in multi-conductor systems Causes of lightning over voltage, Interaction between lightning and power system, Causes of switching surges and power-frequency over voltages, Estimation of switching surges in power system Basic idea about protection against over voltage, Lightning arresters and surge suppressors, Ground wires, Grounding practices, Insulation coordination scheme of open-air substation, Basic Impulse Level,

SECOND HALF:

Statistical Methods Generation of High AC Voltage – Testing transformer and its cascade connection, single-phase series resonance circuit, Generation of High DC Voltage – Single-stage and multi-stage symmetric as well as asymmetric voltage multiplier circuits, Generation of Impulse Voltage – Single-stage and multi-stage impulse generators circuits, Triggering and synchronization with CRO Measurement of Peak value of high AC Voltage – Frequency dependent method: Chubb & Fortescue Method, Frequency independent methods: Davis-Bowdler Method, Rabus Method, Sphere-Gap Method Measurement of RMS value of high AC Voltage – Capacitive Voltage Transformer, Potential Dividers, Electrostatic Voltmeter Measurement of High DC Voltage – Ammeter in series with high resistance Measurement of Dielectric Loss-factor – High Voltage Schering Bridge High Voltage type tests of insulators, Impulse test of transformers as per relevant Indian standards

04. INDUSTRIAL MANAGEMENT(BE/ME – 711)

Growth of Industries, Management thoughts and scientific management, Taylorism; Factory system of production, Introduction to management problems, Types of manufacture, Planning analysis and control aspects in industries.

Types of business ownership, means of finance and business combinations, organization structures, committee organization, authority and responsibility, duty and span of control.

Plant location, factory buildings and physical facilities, plant layout, tools and techniques of plant layout, materials - handling arrangements. Product development, standardization, simplification and diversification.

Functions of production, planning and control, production forecasting, production scheduling and network techniques, Gantt chart, CPM, PERT etc.

Work study, job evaluation and merit rating; purchase system and inventory control. Inspection and quality control of systems, statistical quality control, maintenance and replacement policies for machine and equipments; decision making theories, breakeven analysis cost benefit analysis, evaluation of financial and managerial efficiencies.

Introduction to operational research techniques. Application of fuzzy logic in modern management concepts. Human relations in industry and labour compensation. Personnel management, provision of industrial legislations in India. Wage and salary administrations. Welfare and safety provisions, trade union acts. Study of environmental impacts and environmental laws.

05. ELECTIVE – I (BE/EE – 704)

Student of 7th Semester Electrical Engineering Department has to select any one of following subjects as **ELECTIVE – I.**

1. ELECTRICAL UTILISATION & ILLUMINATION ENGINEERING (BE/EE – 704/1)

Harmonic current generation due to non-linear loads. Effect of Harmonic currents on power supply system and its components. Power factor degradation due to harmonics. Displacement Factor, Distortion Factor and Harmonic Factor. Power line filters. Concepts of static Var compensators. Introduction to near-unity power factor rectifiers and Active Power Filters. Electric heating : Basic advantages, classification of furnaces and ovens. Industrial application areas. Resistance Furnaces : basic principles of direct and indirect heating types. Control of heating : on-off control, graded resistance, tapped inductor. Solid state control - SCR on-off control, ac phase control, integral cycle control. Arc Furnaces : basic principles of direct and indirect heating types. 1-phase and 3-phase AC and DC arc types. Their power supply regulator system. Electrode position control system.

Induction Furnaces : basic principles of coreless and core types. Their power supply systems. SCR resonant inverters for induction heating.

Dielectric Heating : basic principle. Storage Batteries : common types and their characteristics. Principles of charging, modes of charging, eg., float, boost, constant current, constant voltage, etc. Temperature compensation of charging voltage. Uninterruptible Power Supplies : Basic concepts, schemes, back-up, redundancy, transfer switch. AC Voltage Stabilisers : Basic principles like tap-changing, servo-controlled buck-boost transformer, Constant Voltage Transformer.

Light and electromagnetic radiation; sources of light- thermal radiator-blackbody radiator, laws of thermal radiation; daylight and artificial light, spectral power distribution (SPD) of light sources. Radiometric and photometric quantities, visual response curve of standard observer, relation between lumen and watt, photometric standards. Laws of illumination, perfect diffuser, Lambert's law.

Photometry - visual & physical photometry, Bench photometer, Luxmeter, Integrating sphere, Distribution photometer. Computation of lumen output from luminaire from luminous intensity distribution- zone factor, zonal lumen. Lamps-general classification, incandescent, tungsten halogen, fluorescent, compact fluorescent – construction, principle of operation, features etc. Ballast- its function, electromagnetic and electronic type - principle of operation. Luminaire- its function and classification. Elementary lighting design- design parameters, BIS recommendation, general indoor lighting design by Lumen method. Concepts of energy efficient lighting design and payback calculation.

2. ADVANCED POWER SYSTEMS ANALYSIS (BE/EE – 704/2)

Load flow analysis : Formulation of the load flow problem. Solution of load flow problem by Newton Raphson methods. Incorporating tape changing transformers and phase shifters in load flow problem, area interchange control. Short circuit study: Formulation of bus impedance matrix, digital computer solution of symmetrical and unsymmetrical faults. Economic operation: Characteristics of generating units, generation scheduling neglecting transmission loss, scheduling problems considering transmission loss and its solution by B-

coefficient method, derivation of B-coefficients, unit commitment problem and its solution by dynamic programming, hydro-thermal scheduling and its solution for short range problem. Load frequency control : Multi area load frequency control problem and concept of tie line control. Transient stability: Multi-machine transient stability, its mathematical formulation and solution, representation of excitation system and its inclusion in stability studies, methods of improving transient stability. Introduction to dynamic stability: Small perturbation model of single machine connected to infinite bus, analysis of voltage regulator action, cause of negative damping, preliminary concept of dynamic stability and power system stabilizer.

3. DYNAMICS OF ELECTRICAL MACHINES (BE/EE – 704/3)

Basic concept-Energy balance principle, Analogy between mechanical and electrical systems, Active and Passive Load torque. Review of torque-speed characteristics of different types of motor, factors affecting the study of machine's dynamics. General drive equation, single excitation and double excitation system & their comparison.

DC m/c dynamics: current and speed expression during starting, role of starter in dynamics of starting, expression for current & speed, expression during dynamic and braking & computation of braking time, dynamics of counter current braking & speed expression. Dynamics of series motor starting. Dynamics of DC Drives controlled by Thyristors.

Induction machine dynamics: Dynamics of starting of Induction Motor, Dynamics of braking of Induction Motor, computation of braking time, energy loss during dynamic operating condition, procedure for reducing energy loss during transient process. Reactive power consideration in Induction Motor operation & stability.

Synchronous motor:- review of power equation & p-s relationship, dynamic condition in alternator following load change, oscillation under dynamic disturbances(Generator mode), pulling in phenomenon.

4. OPTIMAL AND ADAPTIVE CONTROL (BE/EE – 704/4)

Introduction to optimal control
Performance measure for optimal control problems, the principle of optimality, Concept of dynamic programming, The Hamilton-Jacobi-Bellman Equation
The calculus of variation
Fundamental of a single function, Functionals involving several independent functions, Constrained minimization of functionals.
The variational approach to Optimal Control problems
Linear regulator problems, Potryagin's minimum principle and state inequality constraints, minimum time and minimum control-effort problems.
Estimation techniques, least mean square, Maximum likelihood.
Different types of Adaptive control systems, classifications, Design technique of different types of Adaptive Control, Identification Procedure.
Neural Networks for control : Neuron Models, Artificial Neuron, Activation function, Mathematical Model, Network Architecture, Learning in Neural Networks, System Identification with Neural Networks, Adaptive Control with Neural Networks, Fuzzy Controller, Design and analysis of controller using MATLAB and SIMULINK.

5. ADVANCED COMPUTING TECHNIQUES (BE/EE – 704/5)

Numerical solutions of Boundary Value problems: Finite Difference Method – derivation of FDM equations from Tailor series in two dimensional composite media systems. Finite Element Method – derivation of nodal equations from minimum energy constraint in two dimensional and composite media systems. Formation of coefficient matrix, solution of sparse coefficient matrix. Generalized function estimation techniques: Artificial Neural Networks – Perception, supervised and unsupervised learning , multi layer feed-forward network, error back propagation. Fuzzy Systems – Properties of fuzzy sets, fuzzy membership function, knowledge base, inference engine, defuzzyfication. Fuzzy interfacing systems, introduction to neuro-fuzzy systems. Classical optimization techniques: Non linear programming: Unconstrained minimization, necessary and sufficient conditions for optimality, convexity, direction vector, Steepest descent method, Newton's method, Quasi Newton's methods. Introduction to constrained minimization problem, KKT optimality condition, Penalty function method. Linear Programming: LP problem, Simplex Algorithm, two phase method, Duality in LP. Integer Programming: Branch and bound algorithm. Combinatorial optimization techniques: Genetic Algorithms – Concept of chromosome, reproduction, Crossover & mutation, fitness function. Real coded Genetic Algorithms. Simulated Annealing technique – Annealing in metal crystallization, Boltzman distribution, Initial temperature, cooling rate, metropolis algorithm.

06. POWER ELECTRONICS LABORATORY (EE –705)

Laboratory Experiments based on the syllabus of BE/EE – 604.

07. PROCESS INSTRUMENTATION & CONTROL LABORATORY (EE-706)

Laboratory Experiments based on the Syllabus of EE – 702.

08. POWER SYSTEM LABORATORY-I (BE/EE – 707)

Laboratory Experiments based on the syllabus of BE/EE – 402 & BE/EE 502.

09. PRELIMINARIES OF PROJECT & THESIS (BE/EE – 708)

Each candidate or a group will assign a problem in Electrical Engineering on which the candidate(s) will carry out detail review/ study and/or analysis. They will submit a detail report and present his/ her/ their work in an open defend at the end of the Semester.

10. VIVA VOCE – I (BE/EE – 709)

Viva Voce test will be based on theoretical and practical knowledge of students in their branch of Engineering.

11. PROFESSIONAL SKILL DEVELOPMENT – I (BE/GP – 2)

- Filling up of Curricula Vitae.
- Response to a Job advertisement.
- Joining Report in a Profession.
- Report writing on issues related to your profession such as – Improvement of work culture, Improvement of Relationship with your Collogues, submission of a sum-up of annual Report, Maintaining of Environment Friendly atmosphere in the office, Basic amenities requirement to run a good Organization / Office.
- Basic requirements of Management / Managerial Jobs.
- Notice Inviting Tenders, Issuance of Supply Orders, Memo, Complaint Letter, Invitation, Notifications etc.
- Oral Communicative Skill Practice.
- Mock Interview.

EIGHTH SEMESTER

01. ELECTRIC DRIVES AND CONTROL (BE/EE – 801)

Electric Drives in Industry, Drives Specifications, four quadrant representation, dynamics of loading of motors, selection of motors.

DC Drives :- DC motors speed control by converter circuits, Armature, field & voltage control, three phase & single phase half wave converter, full wave converter & Dual converter Drives, regenerative and rheostatic brake control, two/ four quadrant chopper drives, closed loop control of DC drives: Drive schemes with armature voltage feedback and IR-compensations together with speed feedback for both constant flux and field weakening., PLL control, Microprocessor/ Micro-controller/ DSP & PLC based DC Drives.

Voltage Source inverters (VSI), Current Source Inverter (CSI). Current controlled VSI and cyclo-converters. Basic operating principle and characteristics of the schemes. Regeneration in Drives, Dynamic braking, regenerative braking, DC injection, plugging. Protection schemes for overall drive systems.

Solid state control of AC motors : Basic principles. Drive schemes with stator voltage control, Static control of rotor resistance, slip power control, dynamic DC injection & plugging of Induction motor, V/f control with constant flux and field weakening with and without speed feed-back, slip compensation, Introduction to Vector Control in Induction motor Drive system. Modeling of different AC converter system. Solid state control of Synchronous motor.

Electric Traction : General introduction and requirements, speed-time curve mechanics in train movement. DC and AC traction supplies. Current collectors. Traction motors. Linear motors and magnetic levitation. Boosters in traction supplies.

02. ENERGY SYSTEM (BE/EE – 802)

Energy Resources: Terminology, Major Energy Resources in use: Resource, Reserve and Availability of Oil, Gas and Coal in global and national context. Hydro-electricity and Nuclear-electricity: Availability and developmental Constraints. Energy Consumption Demand: Consumption Sectors; Growth rate in Industrial, Commercial & Residential, Agriculture and Transportation Sector of total energy and electricity National and International trends. Renewable Energy: Need for accelerated growth: availability and environmental constraints of traditional non-renewable sources. Demerits of Solar sources. Technologies for electricity generation (I) wind, (ii) PV and (iii) Biomass; Tidal and Geothermal power plants. Ocean Thermal and Wave electricity generation. Fuel cells. Energy Storage: Role of Storage in electricity supply: Types and operation of Storage systems: (I) Chemical, (ii) Mechanical, (iii) Thermal, (iv) Magnetic Storage. Hydrogen energy.

Energy Management and Audit: Demand Side and Supply Side of Management (DSM & SSM): Conservation of electrical energy, Technology & Potential Energy. Conservation Act, 2001. Energy Audit: Preliminary Detailed Audit.

03. DIGITAL SIGNAL PROCESSING (BE/EC – 807)

Description of Signals and Systems: Types of signals and their characteristics, types of systems and their behavior.
Discrete-time Fourier transform: Definition of Fourier transform (FT), important properties of FT, properties of FT for real-valued sequences, use of FT in signal processing, FT of special sequences, the inverse FT, FT of the product two discrete-time sequences, program to evaluate the FT by computer.
Discrete Fourier Transform: The definition of the Discrete Fourier Transform (DFT), computation of the DFT from the discrete-time sequence, properties of the DFT, circular convolution, performing a linear convolution with the DFT, computations for evaluating the DFT, programming the DFT, increasing the computational speed of the DFT, intuitive explanation for the decimation-in-time FFT algorithm, analytic derivation of the decimation-in-time FFT algorithm, some general observations about the FFT.
Digital filter: Definition and anatomy of a digital filter, frequency domain description of signals and systems, typical applications of digital filters, replacing analog filters with digital filters, filter categories: IIR and FIR, recursive and non-recursive.
Digital Filter Structures: The direct form I and II structures, Cascade combination of second-order sections, parallel combination of second-order sections, Linear-phase FIR filter structures, Frequency-sampling structure for the FIR filter.
Typical DSP Hardware: Texas instruments family of DSP devices, TMS320F2407 Board, Architecture, Supporting chips, Raxix-2 DIT FFT Program using TMS 320CXXX Multirate DSP: Decimation by a factor D, interpolation by a factor I, sampling rate conversion, filter design and implementation, digital filter banks. Applications of DSP : DTMF signal detection, Musical sound processing, Digital FM stereo generation, oversampling A/D and D/A converters.

04. GENERALISED THEORY OF ELECTRICAL MACHINES (BE/EE – 803)

Introduction to generalized theory :- Elementary energy converter of Gibbs and Adkins – assumption of transformation from 3-phase to 2-phase flux linkage, inductance matrix, Voltage-current relationship.

d-q transformation of park, geometrical interpretation, d-q transformation of Voltage-current relationship, torque equation, motional impedance matrix, application to synchronous machines Voltage-current relationship.

Application to Induction Machine :- voltage-current relationship, dynamic equation, stability of load, general stability of Induction Machine.

Application to DC Machine:- Voltage-current relationship, short circuit study of DC generator (Separately excited), short circuit study of shunt generator, stability of DC Machines.

05. ELECTIVE – II (BE/EE – 804)

Student of 8th Semester Electrical Engineering Department has to select any one of following subjects as **ELECTIVE – II.**

1. REAL TIME COMPUTER CONTROL SYSTEM (BE/EE – 804/1)

A survey of computer control system, Architecture of computer control structure, Distributed computer control system, Supervisory control system, Direct digital control system. Comparison between Distributed and centralized computer control system, Functional requirements of distributed computer control system & System Architecture.
Construction of Software for Real-time computer control systems :- Characteristics, Classifications, Single and Multi task system, Implementation of Virtual Machine, Structured development of REAL – TIME Systems, Languages for Real-Time system, creation & Management of tasks, communication between software components, Mutual exclusion,
Expert system in Real time Control, Task scheduling and dispatch, Knowledge based process management. Real Time Operating system.
Application of distributed Computer control system in Sequential control, Ratio control, Cascade control, Feed-forward control and Multivariable control.

Introduction to Microprocessor/ Micro-controller based Data-acquisition system:- Interfacing consideration for Digital I/O, Analog I/O of Industrial Processes. Stand-alone Honeywell Universal Controller :- Its features, function, algorithms, diagnostic features of auto-manual system.
Common features of Microprocessor/ Micro-controller based dedicated controller:- Its display system, auto-manual system, anti-windup method, local-remote control, Direct digital actuator control schemes, Manual reset control, time proportional control, Hardware and Software of process dedicated Microprocessor/ Micro-controller based controller.
Digital Implementation of PID Controller:- Velocity Algorithm, Position Algorithm, Dahlin,s and Kalman's Algorithms, Dead-beat control Algorithm and its implementation.
Application of Programmable Logic Controller (PLC), CPLDs and FPGAs in Real time control system.

2. ADVANCED INSTRUMENTATION (BE/EE – 804/2)

Waveform-synthesizer. vector voltmeter. lock-in amplifier. Instrumentation networking techniques: GPIB, field bus etc. Smart sensor systems. Error of measurements and statistical analysis of data. Correlation methods of measurement, time-averaging techniques, signal averaging, median filtering. System identification techniques: de-convolution, least square and recursive least square, regression models, AR, MA and ARMA models, applications.

Advanced sensors: corriollis mass flow meter, opto-electronic sensors. Sensor fusion. Tomographic measurement techniques. Sensor linearization techniques. Inductive voltage divider – construction, testing and uses. Current comparators – A.C. and D.C., their uses in transformer. Calibrations and resistance comparisons. Absolute measurement of voltage by oscillating electrode voltmeter. Josephson junction voltage standard. Quantum Hall resistance standard. Non-destructive testing: ultrasonic, eddy current, electromagnetic etc.

3. ADVANCED TOPICS IN POWER SYSTEMS (BE/EE – 804/3)

Static & Digital Relaying: Generalized approach for two input and multi input comparators, derivation of inputs for different types of static distance protection, hard- ware for static relays, concept of digital relaying, derivation of fundamental component of voltage and current for digital protection. HVDC Operation and control : CIA. CC and CEA control. Determination of stable operating point. Introduction to FACTS – Brief description of various FACTS devices and their principle of operation, role of FACTS in active and reactive power control. Harmonics in Power Systems – Different sources of harmonics, effects of harmonics on Power System performance and power quality. Computer aided operation and control of Power Systems--- Concept of Energy Control Center, introduction to SCADA and Security monitoring.

4. RELIABILITY ENGINEERING (BE/EE –804/4)

Reliability Mathematics : – Probability concepts – Rules of probability – Probability distributions – Discrete distributions – Continuous distributions – Statistical confidence – Statistical hypothesis testing Analysis of Reliability Data : - Probability plotting – Ranking of data – Probability plotting techniques – Hazard plotting. Reliability Prediction & Modeling : - Prediction Accuracy – System Reliability models – Availability – Standard approaches to Reliability prediction.

Component Reliability : - Reliability of components like resistors, capacitors, diodes etc. – Reliability prediction worksheet.

Software Reliability : - Software failure modes – Structured programs – Program checking & testing – Software reliability Statistics. Basic Reliability Concepts : - Reliability Function – Repairable and Non-repairable Systems – Markov modeling – Two state models – Series , parallel and composite systems – MTTF, MTTR, MTBF etc. Static Generating Capacity Reliability Evaluation : - Construction of Capacity Outage Probability Tables – Rounding off capacity outage probability tables – Deterministic risk criteria – Percentage reserve – Loss of largest unit – Recursion algorithm – Calculation of loss of load indices – Frequency and duration technique – State space diagram – Load model. Reliability of Substation : - Substation failure events – Stuck condition of breaker Order of load point failures. Reliability of Distribution systems : - Load and energy oriented indices – Residual systems – Effect of lateral distribution protection – Effects of isolators – Disconnectors etc. - Method of network reduction. Temporary and Transient outages– inclusion of weather effects– Stotacastic approach etc.

05. ELECTRIC DRIVES AND CONTROL LABORATORY (BE/EE – 805)

Laboratory Experiments based on the Syllabus of EE – 801.

06. POWER SYSTEM LABORATORY-II (BE/EE – 806)

Laboratory Experiments based on the syllabus of BE/EE – 602.

07. PROJECT & THESIS (EE – 808)

Each candidate or a group assigned problem (Preliminaries of Project & Thesis) in Electrical Engineering in 7th Semester on which the candidate(s) will carry out detail review/ study and/or analysis. They will submit a detail Project report and present his/ her/ their work in an open defend at the end of the Semester.

08. Digital Signal Processing Lab (BE/EC – 810)

Laboratory Experiments based on the syllabus of BE/EC – 810.

09. VIVA VOCE – II (EE – 809)

Viva Voce test will be based on theoretical and practical knowledge of students in their branch of Engineering.

10. PROFESSIONAL SKILL DEVELOPMENT – II (BE/GP – 3)

- Group Discussion
- SEMINERS (Power Point Presentation)
- Extempore Speech Practice
- Details of Future Profession of the Student Concerned – to be prepared / presented in the practice shop.
- General aptitude Test.