BACHELOR OF ELECTRICAL ENGINEERING

I. First Year - First Semester

(Hum/T/A) HUMANITIES-A

ENGLISH

2 classes per week x 14 weeks = 28 classes.

Internal Assessment 2 weeks.

Teaching: 24 classes.

1. Basic writing skills: based on Sections 1 and 2 of *English for All* = 8 classes (4 weeks).

2. Communication skills.
   a. Report writing = (4 classes) 2 weeks
   b. Précis writing = (4 classes) 2 weeks
   c. CVs and resumes = (4 classes) 2 weeks
   d. Reading scientific papers: Scholarly conventions = (4 classes) 2 weeks

3. Two prose extracts from *English for All* (may be changed from time to time: proposal for this year, JBS Haldane, "Scientific Research for Amateurs" and Rabindranath Tagore "The Religion of the Forest") = (4 classes) 2 weeks.

4. One short story from *English for All* (may be changed from time to time: proposal for this year, James Thurber, "The Secret Life of Walter Mitty") = (4 classes) 2 weeks.

Group presentations in class to be encouraged.

SOCIOLOGY

.Sociology: Nature and scope of Sociology - Sociology and other Social Sciences - Sociological Perspectives and explanation of Social issues 2. Society and Technology: Impact of Technology on the Society - A case study 3. Social Stratification: Systems of Social Stratification - determinants of Social Stratification - Functionalist, Conflict and Elitist perspectives on Social Stratification 4.Work: Meaning and experience of work:

Postindustrial society- Post-Fordism and the Flexible Firm 5.Development - Conceptions of and approaches to development - The Roles of State and the Market in the Development 6. Globalization: The concept of globalization - globalization and the nation state - Development and globalization in post colonial times. 7. Industrial Policy and Technological change in India - The nature and Role of the State in India 8. Technology Transfer: The Concept and Types of Technology Transfer-Dynamics of Technology Transfer 9. Technology Assessment: The Concept - Steps involved in Technology Assessment 10. Environment: Sociological Perspectives on Environment - Environmental Tradition and values in ancient India 11.The Development of Management: Scientific Management - Organic Organization - Net Work organization - Post modern Organization - Debureaucratization - Transformation of Management 12. Technological Problems and the Modern Society: Selected Case Studies - Electric Power Crisis, Industrial and/or Environmental Disaster, or Nuclear Accident

(EE/T/111) PRINCIPLES OF ELECTRICAL ENGINEERING-I

Units and Dimensions in Electrical Engineering – History of the development of Electrical unit system. Unit conversions. Dimensional analysis. Related problems.

A.C. Fundamentals - Periodic waves and Sinusoids. Average and RMS values. Phasor concepts of sinusoids.

Impedance and Admittance. Power, VA, VAR and Power Factor.

Series, parallel and series-parallel RLC circuit analysis. Series and parallel resonance.

Power factor correction.

Network Theorems – Kirchoff's laws, Loop-current method, Superposition theorem, Thevenin's and Norton's theorems, Maximum power transfer theorem, Star-Delta conversion, Nodal Analysis. Related problems on A.C. and D.C. circuits.

Electromagnetism- Ampere's law, Magnetic field intensity, Magnetic flux and flux density, MMF, Magnetic circuit, Permeability, Reluctance and Permeance, Leakage and fringing.

Concept of inductance, Stored energy, Lifting power.

Ferromagnetic materials, Magnetisation curve, Hysteresis loop and hysteresis loss, Eddy current loss, Derivation of expressions for hysteresis and eddy-current losses. Properties of permanent magnets.

Electrostatics – Coulomb's law, Electric charge, Gauss theorem, Electric flux and flux density, Electric field intensity, potential and potential gradient.

Concept of capacitance, Different types of capacitors – parallel plate, cylindrical, spherical capacitors with homogeneous and composite dielectric.

Stored energy in capacitors, Series-parallel combination of capacitors, Capacitor banks and rating of capacitors.

Reference Books:

1. Advanced Electrical Technology – H. Cotton
2. Electrical Technology – Hughes
3. Alternating Current Circuits – Kerchner and Corcoran
4. Fundamentals of Electrical Engineering – Ashfaq Husain
5. Applied Electricity for Engineers – Bessonov
6. Electrical Engineering Fundamentals – V. Del Toro
7. Electrical Science- Choudhury, Chakraborty and Chatterjee

(EE/Math/T/112) MATHEMATICS-IF

(Feedback from Mathematics Dept is awaited)

Functions of a single variable: Rolle's Theorem; Mean value theorem; Taylor's Theorem; MacLaurin's series- indeterminate forms; Maxima and minima.
Functions of several variables: limit and continuity; Partial derivatives; differentials; partial derivatives of a composite function; implicit functions; Taylor's Theorem; Maxima and minima- Lagrange method.
Riemann Integration- definition and properties. Fundamental theory of integral calculus; improper integrals; gamma and beta functions. Multiple integrals- definition of double and triple integrals; properties and applications.
Fourier series: Periodic functions, Trigonometric series of sine and cosines. Euler formulae, Dirichlets' conditions, even and odd functions, half range sine and cosine series, Fourier series in intervals, multiple Fourier series, Discrete-time Fourier series.

Sequence; Infinite series- Comparison test, D'Alembert's test, Cauchy's root test.

Reference Books:

(EE/Math/T/113) MATHEMATICS-IIF

(Feedback from Mathematics Dept is awaited)

Solid Geometry: Cartesian coordinates in three dimensions, direction cosines.

Vector Algebra: Addition and subtraction, products of vectors, Different types of of vectors.

Vector calculus: Scalar and vector fields, Concepts of gradient, divergence and curl, Laplace operator and their expression in Cartesian, Cylindrical and Spherical coordinate systems. Gauss, Stokes' and Green's theorem.

Marices: Addition and multiplication of matrices, Determinant of a square matrix and its properties, Transpose and inverse, Solutions of system of linear equations. Symmetric, Skew-symmetric and Hermitian matrices. Ranks of a matrix, Eigenvalues and eigenvectors. Characteristic polynomial. Caley-Hamilton theorem and applications.

Ordinary Differential equation: 1st order exact equations, first order linear equations. Second order linear equation with constant co-efficients. Euler Cauchy equation, method of variation of parameters.

Reference Books:

(AM/ME/T/1A) ENGINEERING MECHANICS

Statics: Introduction, Idealizations of Mechanics, Fundamentals of Vector Algebra, Application of Vectors in Mechanics, Equiv System, Equilibrium, FBD Concept, Fundamentals of Friction, Properties of surface, Centroid, Moment of Inertia Dynamics: Intro to vector calculus, Definition of vectors in Dynamics, Rectilinear Motion, Curvilinear motion of particle and description of different coordinate systems, Kinetics, Newton's Law and D' Alembert's principle and application to rectilinear and curvilinear motion, constrained motion, Energy and Momentum methods.

(Feedback from Mechanical Engg Dept is awaited)

(Ph/T/1A) PHYSICS-1A

42 Lecture hours in semester + help room

1. Scalar and vector fields, Gradient of a scalar field, Physical interpretation of gradient, Divergence and curl of a vector field, Conservative vector fields and their potential functions – gravitational and electrostatic examples. (4)
2. Simple harmonic motion, free vibration, damped and forced vibration, resonance. Wave motion, Superposition principle, phase velocity and group velocity. (4)
3. Motion of fluid, Bernoulli's theorem, Poiseuille's equation for the flow of liquid through a narrow tube, Motion of a body through a viscous medium: Stokes' law. (4)
4. Overview of Coulomb's law, Gauss's law, dielectric polarization, Displacement vector, Overview of Biot Savart law and Ampere's Circuital law. (4)
5. Time-varying field, Faraday's law of electromagnetic induction, Transient phenomena in electric circuits (series L-R, series C-R), Electrical oscillations in L-C circuit. Alternating voltage applied to series L-C-R circuit and the idea of electrical resonance . (5)
6. Macroscopic and microscopic description, Thermal equilibrium, Zeroth law of thermodynamics, Heat and Work, First law of thermodynamics and some applications, Reversible and irreversible processes, Carnot cycle, Second law of Thermodynamics, Concept of entropy. (6)

7. Interference of light waves, Young's experiment, Spatial and temporal coherence, Interference in thin film, Newton's rings, Diffraction of light waves, Fraunhoffer diffraction due to single slit and plane diffraction grating, Polarisation of light waves, Polarisation by reflection, Brewster's law. (9)

8. Wave particle duality, de Broglie waves and uncertainty principle, Concept of wave function and its physical interpretation. Normalisation, 1-D Schrödinger equation – 1-dimensional (infinite) potential well. (6)

(Ph/S/1) PHYSICS LABORATORY-I

Students have to perform experiments from the following list.

1. Determination of Young's modulus by Flexure method.
2. Determination of moment of inertia of a cylindrical body.
3. To determine co-efficient of viscosity by Capillary flow method.
4. Determination of co-efficient of linear expansion by optical lever method.
5. Determination of focal length of a concave lens by combination method.
6. Determination of refractive index of the material of the glass prism by prism spectrometer.
7. To find the wavelength of a monochromatic light by single slit.
8. To find the wavelength of a monochromatic light by Newton rings.
9. Determination of Galvanometer resistance by half - deflection method.
10. Determination of Galvanometer resistance by Thomson's method.
11. To find high resistance by Galvanometer deflection method.
12. To measure mechanical equivalent of heat, J by electrical method (Joule's) using copper calorimeter (radiation correction to be done).
13. To compare two low resistances by drop of potential method.
14. To determine resistance per unit length of a wire by using Carey Foster bridge.
15. To estimate strength of current by using copper voltmeter.
    a) To compare the EMF's of two cells by using a potentiometer
    b) To measure current by using a potentiometer
16. To measure the horizontal component of earth's magnetic field using deflection and vibrating magnetometers.

(BED/ME/S/1) BASIC ENGINEERING DRAWING

Drawing primitives: instruments, letters, lines, title block, geometric curves & shapes, scale and dimension. Projection: orthographic and isometric, sectional views.

(Feedback from Mechanical Engg Dept is awaited)

(WS/ME/S/6A) WORKSHOP PRACTICE-VI (Carpentry and Fitter Shop)

Introduction to types of Indian woods used for engineering purposes and carpenter’s tools; use of wood working machines; making of selected joinery. Introduction to fitter’s tools, gauges, measuring instruments etc.; marking of jobs; fitter’s job involving chipping, filing, sawing, drilling; use of taps and dies; pipe fittings and plumbing.

(Feedback from Mechanical Engg Dept is awaited)

(WS/ME/S/10) WORKSHOP PRACTICE-X

(Forging and Welding)

Forging: Introduction to forging tools, furnaces and forging machines; to practice basic forging operations- drawing out, upsetting, necking etc.; introduction to forge welding. Introduction to and practice of different welding processes- gas, SMAW, TIG, MIG, SAW, resistance welding etc.; introduction to gas cutting and its application; soldering, brazing etc.; making welded joints using different welding processes.

(Feedback from Mechanical Engg Dept is awaited)

Theory – 19 pds. Sessional- 12 pds. TOTAL- 31 pds.

II. First Year - Second Semester

(EE/T/121) PRINCIPLES OF ELECTRICAL ENGINEERING-II

Network Theorems – Reciprocity theorem, Compensation theorem, Substitution theorem, Tellegen's theorem and Millman's theorem for voltage and current sources. Problems.

Locus diagram – series circuits of variable impedance: constant reactance, variable resistance; constant resistance, variable reactance; series resonance by varying frequency; Admittance locus diagram, parallel circuit with variable impedance, parallel resonance circuit by varying inductance, parallel resonance by varying capacitance, resonance at all frequency (a singular case of parallel resonance).

Analysis of coupled circuit – Conductively coupled circuits, Magnetically coupled circuit, mutual inductance, dot convention, Analysis of series and parallel coupled circuits, Energy stored in coupled circuits. Problems.

Principle of Transformer – E.m.f. equation, Transformer on No-load and On Load, Equivalent circuit of transformer.

Nonlinear circuit analysis – Nonlinear resistances and inductances, series and parallel combination of linear and nonlinear resistances and inductances, Application of graphical techniques.

Three -phase A.C. circuit – Three phase A.C. balanced circuits, Balanced supply with three wire and four wire. Three phase power measurement.

Unbalanced system, Definition of power factor for unbalanced system, Analysis of unbalanced three phase system by symmetrical components.

Ferro-resonance phenomenon.

Non-sinusoidal periodic waves – Harmonics, Generation of harmonics by nonlinear circuit elements, Harmonic decomposition of periodic waves, r.m.s. and average values. Harmonics in three -phase system.

Reference Books:

1. Advanced Electrical Technology – H. Cotton
2. Electrical Technology – Hughes
3. Alternating Current Circuits – Kerchner and Corcoran
4. Fundamentals of Electrical Engineering – Ashfaq Husain
5. Applied Electricity for Engineers – Bessonov
6. Electrical Engineering Fundamentals – V. Del Toro
7. Electrical Science- Choudhury, Chakraborty and Chatterjee
8. Theory and Practice of Alternating Current Circuits – A.T. Dover

(EE/ET/T/122) ELECTRONICS-I

Elementary Physics: Semiconductor Materials; Intrinsic and Extrinsic Type; Characteristics of P-N Junction. Basic Semiconductor Devices: P-N Junction Diode; Schottky Diode; Zener Diode; Bipolar Transistor; JFET; MOSFET. Modelling of Semiconductor Devices: Hybrid parameters. Biasing: CE, CB and CC Transistor Configuration; JFET and MOSFET. Feedback amplifiers: Characteristics of Negative and Positive Feedback. Transistor Power Amplifiers: Class A, AB, and Complimentary Symmetry. Operational Amplifiers: Characteristics; Inverting, Non-Inverting, Summing and Differentiating Amplifiers; Integrator and Differentiator; Voltage Comparator; Precision Rectifier; Sample and Hold; Study and application of integrated circuit like 741. Waveform generators: Sine, Square, Triangular and Sawtooth. Opto-Electronics: Elementary Physics; LED; LCD; Photo-Diodes; Photo-Transistors; LDR; 7-Segment and Alpha-Numeric Displays; Opto-Isolators and Interrupters.

(EE/Math/T/123) MATHEMATICS-IIIF

Second order differential equation with variable coefficients. Ordinary point and regular singularity of second order linear differential equations, series solutions. Bessel functions, Legendre polynomials and their orthogonal properties.

Partial differential equations: Solution of one dimensional wave and diffusion equations and Laplace's equations of two dimensions by method of separation of variables.

Integral transforms: Laplace transform and Fourier transform, Properties and applications to differential equations. Discrete Fourier transform, Z-Transform, applications to difference equations.

Complex analysis: Functions of a complex variable, limits, continuity and differentiability. Cauchy-Riemann equations for complex integration; Cauchy's fundamental theorem, Cauchy's integral formulae, Taylor's Theorem, Laurent's theorem, Singularity, Residue Theorem, Contour Integral.

Reference Books:

(Feedback from Mathematics Dept is awaited)

(AM/ME/T/3) STRENGTH OF MATERIALS

(Feedback from Mechanical Engg Dept is awaited)

Uniaxial stress field, Thin pressure vessels, Torsion (inclusive of Helical spring), shear force and Bending moment, Bending and shear stress in beams, Deflection beams, Energy methods in Strength of Materials, Problem of Plane stress and strain, Theories of failure, Buckling of columns.

Reference Books:

(EE/ME/T/124) THERMODYNAMICS AND HEAT POWER ENGINEERING

(Feedback from Mechanical Engg Dept is awaited)

Ideal or perfect gases: laws, properties, equation of state, gas constants, internal energy and enthalpy of perfect gas, P-V and T-S planes, P-V relations, work done, Heat transferred. Laws of thermodynamics Adiabatic, Isothermal and polytropic processes, Carnot, Otto and Diesel cycles. Vapour formation at constant pressure: saturated and superheated steam, enthalpy of steam throttling, steam table, P-V, T-S, diagrams, steam cycles, pump work, thermal efficiency. Basic laws of heat conduction, general heat conduction equation, boundary conditions, one dimensional heat conduction equation solutions, electrical analogy.

Reference Books:

(Ph/T/2B) PHYSICS-2B

42 lecture hours in semester + help room

1. Wave particle duality, de Broglie waves and uncertainty principle, Concept of wave function and its physical interpretation. normalization, 1-D Schrödinger equation –1- D (infinite) potential well. Time dependent Schrodinger equation for a free particle, stationary states. (9)
2. Postulates of quantum mechanics, expectation values of physical observables, energy eigen values and eigen functions for particle in a box, Square well potential, reflection and transmission coefficient in potential barriers. (8)
3. Statistical description of a system of particles, Phase space, Microstates and macrostates, Boltzmann's formula for the entropy, Boltzmann distribution function (derivation not reqd.) Classical ideal gas, Equipartition theorem and its applications. (9)
4. Time-varying field, Faraday's law of electromagnetic induction, Transient phenomena in electric circuits (series L-R, series C-R), Electrical oscillations in L-C circuit. Alternating voltage applied to series L-C-R circuit and the idea of electrical resonance. (8)
5. Generalization of Ampere's circuital law, Maxwell's equations, Poynting theorem, Poynting vector. Maxwell's wave equation in free space and its solution. (8)

(Ph/S/2) PHYSICS LABORATORY-II

Students have to perform experiments from the following list.

1. Determination of Young's modulus by Flexure method.
2. Determination of moment of inertia of a cylindrical body.
3. To determine co-efficient of viscosity by Capillary flow method.
4. Determination of co-efficient of linear expansion by optical lever method.
5. Determination of focal length of a concave lens by combination method.
6. Determination of refractive index of the material of the glass prism by prism spectrometer.
7. To find the wavelength of a monochromatic light by single slit.
8. To find the wavelength of a monochromatic light by Newton rings.
9. Determination of Galvanometer resistance by half - deflection method.
10. Determination of Galvanometer resistance by Thomson's method.
11. To find high resistance by Galvanometer deflection method.
12. To measure mechanical equivalent of heat, J by electrical method (Joule's) using copper calorimeter (radiation correction to be done).
13. To compare two low resistances by drop of potential method.
14. To determine resistance per unit length of a wire by using Carey Foster bridge.
15. To estimate strength of current by using copper voltmeter.
    a) To compare the EMF's of two cells by using a potentiometer
    b) To measure current by using a potentiometer
16. To measure the horizontal component of earth's magnetic field using deflection and vibrating magnetometers.

(AED/ME/S/1) ADVANCED ENGINEERING DRAWING

True length, development of surface of simple objects. Threaded joint & riveted joints, cotter/knuckle joint. Pulley, shaft coupling.

(Feedback from Mechanical Engg Dept is awaited)

(WS/ME/S/12B) WORKSHOP PRACTICE-XII (Machine Shop)

Introduction to machine tools - lathes, drilling machines, shaping machines, planning machines, slotting machines, milling machines, grinding machines; machine shop work involving different operations by using the above mentioned machines through making of jobs. Experiments on: Study of the speed structure of a lathe, study of apron mechanism and calibration of feeds in a lathe. Study and grinding of various cutting tools.

(Feedback from Mechanical Engg Dept is awaited)

(EE/S/121) COMPUTER FUNDAMENTALS

Study of basic computer system: Essential parts and their interconnection.

Study of MS-DOS.
Study of WINDOWS and a few applications like MS-WORD, MS-EXCEL etc.
Developing algorithms for programming with branching, looping, arrays etc and their implementation in BASIC/FORTRAN.
Basic concepts of Database Management Systems.
Basic concepts of computer network.

Theory – 19 pds. Sessional- 12 pds. TOTAL- 31 pds.

III. Second Year First Semester

(EE/T/211) CIRCUIT THEORY

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 . Applications of network theorems in steady state & transient domains. 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. Elements of realisability and synthesis of one port network.

Reference Books:

1. Network Analysis, M.E.Van Valkenburg (Prentice Hall), 3rd Edition.
2. Engineering Circuit Analysis, W.H.Hayt, J.E.Kenmerly, S.M.Durbin,(TMH), 6th Edition, 2002.
3. Network and Systems, Ashfaq Husain,(Khanna Book Publisher), 2000.
4. Network and Systems, D.Roychowdhury,(New Age International) ,2001.
5. Modern Network Analysis, F.M.Reza & S.Seely, McGraw Hill.

(EE/T/212) BASICS OF NUMERICAL METHODS AND PROGRAMMING

Number representation, machine precision, round off and truncation error, accuracy of numerical calculation on digital computers. Solution of simultaneous linear equation, evaluation of determinant and matrix inversion by direct approach e.g., Gaussian elimination, Gauss Jordan elimination, L-U factorisation, and Q-R factorisation method and iterative approach e.g., Jacobi, Gauss-Seidel and Relaxation methods. Ill-conditioned system, vector and matrix norm, condition number. Eigen values and Eigen vectors. Roots of non-linear algebraic equation using iterative methods, e.g., bisection, false position, secant and Newton-Raphson methods. Finding roots of non linear simultaneous equations by Newton Raphson method. Interpolation and curve fitting, piecewise-linear interpolation, polynomial interpolation, Lagrange polynomial interpolation, Newton's forward, backward and divided difference interpolation formulas and errors. Least square curve fitting. Numerical integration, Newton-Cotes Integration

formulas, Trapezoid rule, Simpson's rules, Mid point rule, Romberg integration and Gauss quadrature. Numerical differentiation, first and the second derivative, Richardson's Extrapolation. Ordinary differential equation, Euler's method, modified and extended Euler's method, Runge Kutta's method, predictor-corrector method. Milne's method.

C: Concept of flow chart and algorithm – C character set, constant and variables – operaters in C – input/ output statements – control statements – Arrays – Functions – Pointers & Structures – Preprocessors & Macros – Memory management – File handling – Linked lists.

C++ : - Introduction to OOP in C ++ : - Tokens – Functions in C++ - Classes and objects – Constructors & Deconstructors – inheritance – Polymorphism – File handling – Templates.

Reference Books:

1. Applied Numerical Methods for Engineers using Matlab and C: Robert J. Schiling and Sandra L. Harris, Thomsom Asea Pte. Ltd.
2. Introductory Methods of Numerical Analysis - Sastry.
3. Programming with C – Gottfried
4. ANSI C – Balaguruswamy
5. Working with C – Y. Kanetkar
6. Turbo C++ - R. Lafore
7. C++ - Balaguruswamy

(EE/T/213) ELECTRICAL MEASUREMENT & MEASURING INSTRUMENTS

Classification of electrical measuring instruments, general feature of indicating instruments: controlling, damping, balancing. Galvanometer: dynamics, sensitivity, D'Arsonval galvanometer, Ballistic galvanometer, Vibration Galvanometer, PMMC instrument, temperature compensation, rectifier type instrument, Moving iron instrument, errors and compensations, electrodynamometer type instrument, extension of instrument range: - shunt, multiplier, Capacitive voltage divider power measurement for DC ,single and three phase AC circuit low power factor wattmeter, wattmeter connections and errors, Induction type energy meter: characteristics, errors and their compensation, current transformer(C.T.) , potential transformer (P.T.); testing and calibration of measuring instruments.

Measurement of medium resistance using Wheatstone bridge , Series and Shunt type ohmmeter .Measurement of high resistance using Megohm bridge and Megger .Measurement of phase / power factor using electrodynamometer type and moving iron type instrument. Measurement of frequency using electrical resonance type and ratio type instrument. Kelvin double bridge, 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, transducers: RTD, thermistor, thermocouple, laws of thermocouple circuits, cold junction compensation, strain gauge.

Reference Books:

1. Electrical Measurement & Measuring Instrument : by Golding & Widdis
2. Electrical Measurement : by F. K. Harris
3. Electrical Measurement Analysis : by Ernest Frank
4. Alternating Current Bridge Networks : by Hague & Foord
5. Basic Electrical Measurement : by M. B. Stout
6. Electrical Measurement : by C. T. Baldwin
7. A Course in Electrical & Electronic Measurements & Instrumentation by A.K. Sawhney
8. Electronic & Electrical Measurements & Instrumentation by J.B. Gupta

(EE/ET/T/214) ELECTRONICS-II

Oscillators: Wien bridge, Colpitts, Hartley, Phase Shift and Quadrature; VCO; Applications using Op-amp. Multivibrators: Monostable, Bistable and Astable; Implementation using 555 Timer. Special Connections: Darlington Pair; Bootstrap; Schmitt Trigger; Constant Current Sources and Sinks. Transistor Voltage Regulators: Series and Shunt Circuits; Study of integrated circuit like 7805. Basic Digital Logic: Characteristics of TTL, LSTTL, CMOS and HCMOS Logic Families; Tri-State Logic. Number Systems: Different Number Systems; Addition, subtraction, multiplication and division methods. Combinational Logic: Implementation using Gates; Minimization of gates using K-Map. Sequential Logic: RS, JK, T and D Flip Flops; Counters; Cascading of Counters; Shift Registers with Serial and Parallel Inputs and Outputs; Cascading of Shift Registers; Latch, Encoder, Decoder and Display Drivers.

(EE/T/215) ELECTRICAL MACHINES I

PART – I

General introduction to electrical machines : Faraday's laws of electromagnetic induction, Fleming's rule and Lenz's Law. Principle of operation of generators and motors. Space distribution of flux density and time variation of voltage. Flux wave in dc and ac machines. Magnetic curves and their relevance.

DC Machines : Detailed construction and operating principle. Materials used for D.C. machines. Function of commutator and brush system. Induced emf in dc machine. Separate, Shunt, Series and Compound excitation. Losses and efficiency. Voltage build up of dc shunt generator. DC motoring action. Torque developed in dc motor.

Armature windings, Equalisers. Armature reaction & its effects, mmf distribution, compensating windings, Interpoles, Laminated yoke construction. Commutation, sparking, brushes, interface film.

DC Generators – Characteristics with different excitation systems, voltage regulation, parallel operation.

DC Motors – Characteristics and applications of Separate, Shunt, Series and Compound motors, methods of starting, speed control, equivalent circuit. Series-parallel operation of motors.

Introduction to Permanent Magnet dc machines.
Testing of dc machines – Swinburne test, Hopkinson's test, Brake test. Tests specified as per standards.

PART – II

1-phase Transformers : Construction and basic principle of operation. Core type and shell type. Materials used for core, winding and insulation. EMF equation. Core loss, copper loss and Leakage reactances. Harmonics in magnetizing current and magnetizing in-rush current. Generalised derivation of electrical equivalent circuit from magnetic structure. Equivalent circuit referred to primary. Phasor diagram. Parallel operation. Effects of changes of frequency and voltage on transformer performance.

Dry-type and oil cooled type. Natural and forced types of cooling. Tank and radiator construction, operation. Transformer oil. Transformer accessories, eg., conservator, breather, Bucholtz relay, bushing, etc.

Power and Distribution Transformers, all-day efficiency.

Testing of transformers : Polarity of windings, OC and SC test, separation of losses, determination of equivalent circuit parameters. Regulation, efficiency,

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

Special Transformers : Current transformers, Pulse Transformers.

Reference Books:

1. AC Machines : Puchstein, Lloyd & Hunte
2. Advanced Electrical Technology: H. Cotton

3. Performance and Design of Alternating Current Machines: M.G. Say
4. Principles of Alternating Current machinery: Lawrence
5. Performance and Design of DC machines: Clayton & Hancock.
6. Advanced Electrical Technology: H. Cotton
7. Electrical Machinery : P. S. Bimbhra
8. Electrical Machinery : A. E. Fitzgerald & C. Kingsley
9. Electric Machines : I. J. Nagrath & D. P. Kothari
10. Electrical machines: P.K. Mukherjee & S. Chakravorti

(EE/ME/T/216) PRIME MOVERS FOR ELECTRICAL SYSTEMS

IC engines: Principles of operations of IC engines, Classifications, working cycles, supercharging, fuel injection and fuel ignition, performance. Steam and gas Turbines: Principles of turbines, Classifications, steam and gas turbine cycles, efficiency, power and specific fuel consumption, impulse turbine, reaction turbine, multi stage turbine, governing of steam turbines. Hydraulics and hydraulic turbines: Fluid properties and fluid statics, fluid kinematics, conversation equation, fluid dynamics, flow through closed conduits, Classification of hydraulic turbines, turbine size, Pelton wheel, Francise turbine, Kaplan turbine, Specific speed of a turbine, comparison of turbines, performance of turbines-constant head, constant speed and constant efficiency curves, governing of hydraulic turbines. Wind Turbines: Different terms and definitions, types of wind turbines, P-V characteristics.

Reference Books:

(Feedback from Mechanical Engg Dept awaited)

(EE/S/211) E. E. LABORATORY – I

Selected Experiments in Electrical Machines, Control Systems, Power Systems and Measurements & Instrumentation Laboratories.

(EE/ME/S/212) M. E. LABORATORY – I

Selected Experiments in Applied Mechanics Laboratory.

(Feedback from Mechanical Engg Dept awaited)

(MDD/ME/S/1) MACHINE DESIGN AND DRAWING (using CAD)

Basic idea of design, factor of safety, modes of failure, theories of failure, design under static and fatigue loading. Design of Cotter/knuckle Joint, threaded and riveted joint, eccentric loading. Shaft coupling (rigid / flexible). Belt-pulley drive. Pressure vessel.

(Feedback from Mechanical Engg Dept awaited)

Theory – 20 pds. Sessional- 09 pds. TOTAL- 29 pds.

IV. Second Year Second Semester

(EE/T/221) ELECTRICAL INSTRUMENTATION

General measurement system. Introduction to transducers. Signal conditioning systems for transducers. Linearization of sensors.

Measurement of displacement using linear variable differential transducers (LVDTs). Null reduction techniques. Phase compensation circuits. Phase sensitive demodulation. Synchronous demodulation. Introduction to rotary variable differential transducers (RVDTs).

Capacitive transducers: variable air gap, variable plate overlap, variable dielectric. Level gauge. Thickness gauge. Humidity sensor. Capacitive microphone. Signal conditioning circuits for capacitive transducers: reactive bridges, transformer ratio bridges, multivibrator circuits, op-amp based circuits.

Piezoelectric transducers. Fundamental concepts, materials, charge sensitivity, voltage sensitivity. Force/displacement transducers. Buffer amplifiers, charge amplifiers. Static and dynamic responses. Accelerometers.

Measurement of flow. Hot wire anemometers: constant-current and constant-temperature varieties for measurement of static and dynamic flow. Dynamic compensation. Electromagnetic flowmeters: dc, ac and interrupted dc excitation for magnet system. Ultrasonic transit-time flowmeters: ultrasonic link, wetted-type and non-wetted type varieties.

Force balance transducers. Fundamental concepts. Accelerometers. Static and dynamic responses.

Pressure transducers. Primary sensing elements: bourdon tube, diaphragm, bellows. Electronic pressure gauges. Capacitive pressure transducers.

Radiation pyrometers: Importance of pyrometers. Stefan-Boltzmann law and Planck's law. Total radiation pyrometer: Fery's arrangement. Selective radiation pyrometers: disappearing filament system.

Magnetostrictive transducers. Basic concepts. Torque measurement using magnetostrictive sensing.

Active filters. Filter approximations Techniques: Butterworth, Chebyshev. Realization of Active Filter circuits. State-variable filter. Switched capacitor filter circuits.

Data Converters. DAC: Binary-weighted register, R-2R ladder. DAC characteristics & specifications. DAC errors. ADC: Successive-approximation, Dual-slope, Delta-sigma. ADC codes and errors.

Waveform display devices & applications: CRT, LCD, LED.

PLL and its applications.

Power System Transducers and meters: Sampling wattmeter, Time division multiplier wattmeter, Hall effect wattmeter, Wattmeter using analog multiplier IC. Digital energy meters.

Reference Books:

1. Measurment Systems-Application and Design: Doebelin
2. Transducers and Instrumentation: D. V. S. Murty
3. Principles of Measurement Systems: Bentley
4. Operational Amplifiers: Clayton and Winders
5. Instrument Transducers: Neubert
6. Principle of Industrial Instrumentation: Patranabis
7. Electronic Data Converters: Anvekar & Sonde
8. Analog and Digital Filters: Design and Realization. H. Y. F. Lam
9. Passive and Active Filters: Theory and Implementations: W. K. Chen
10. Digital Principles & Applications : by Malvino & Leach
11. Modern Electronic Instrumentation & Measurement Techniques : by Helfrick & Cooper
12. Principles of Electronic Instrumentation, D. Patranabis
13. Data conversion handbook, Analog Devices Inc., Elsevier.

(EE/T/222) ELECTRICAL MACHINES II

PART – I

M.M.F. of poly phase distributed winding; Winding factors of distributed winding ; production of rotating magnetic field. Induced e.m.f & its frequency : relationship to no. of poles; synchronous speed; slip, slip speed and slip frequency, mechanical and electrical angles. Types of ac machine windings.

Three-phase induction motor : Construction of IM and materials used. Squirrel cage and Slip-ring rotor construction. Operating principle ; slip. Per-phase equivalent circuit. Phasor diagram. Equations for torque. Torque-speed & torque-slip characteristics. Effect of change in rotor resistance in slip-ring machine and slip power recovery. Deep bar and Double cage rotor. Pole changing motor. Methods of starting and speed control.

No-load and blocked rotor test : determination of equivalent circuit parameters. Separation of losses. Circle diagram.

Space harmonics : Crawling & cogging.

Tests as per standards.

Operation of the induction machine as a generator.

PART – II

Polyphase connections : Star, Delta and Open-delta connections.

Polyphase Transformer : Construction and basic principle of operation. Core type 3-limb & 5-limb construction and shell type. Flux distribution. Tertiary windings. Vector groups. Graded insulation and shielding for HV. Tap changer principles, types and operation. Parallel operation, unbalanced loading, capacity calculations.

Tests as per standards.

Special connections : T connection. Phase shifting connections. Scott and Le-Blanc connection, 3-phase to 1-phase transformation.

Three-phase auto-transformers: different connections.

Reference Books:

1. AC Machines : Puchstein, Lloyd & Hunte
2. Advanced Electrical Technology: H. Cotton
3. Performance and Design of Alternating Current Machines: M.G. Say
4. Principles of Alternating Current machinery: Lawrence
5. Electrical Machinery : P. S. Bimbhra
6. Electrical Machinery : A. E. Fitzgerald & C. Kingsley
7. Electric Machines : I. J. Nagrath & D. P. Kothari
8. Electrical machines: P.K. Mukherjee & S. Chakravorti

(EE/T/223) ELECTRICAL ENGINEERING MATERIALS

Atomic structure: Rutherford's Model and Bohr's Model related to simple Hydrogen atom; Nuclear binding energy and mass defect. Wave nature of matter: Wave mechanical theory of atomic structure; Energy states. Atomic bonding: Stable interatomic distance; Ionic, covalent, metallic and Van der Waals Bonding. Crystal Structures: Unit cells; FCC, BCC and diamond structures; crystal defects. Electron energy levels: Band theory of solids; Conductors, Insulators and Semiconductors. Properties of insulating materials: Mechanical, Chemical and Thermal; Electrical properties: Volume and surface resistivity, dielectric constant, dielectric dissipation factor and dielectric strength. Polarization of dielectrics: Non-polar and polar dielectrics; Electronic, relaxation, ionic and dipole polarization; Classification of dielectrics by polarization mechanism; Dielectric polarization and permittivity. Dielectric Materials: Solid, liquid and gaseous. Gaseous dielectrics: Properties of pure and mixed gases, breakdown phenomena. Liquid dielectrics: Natural and synthetic dielectrics; Factors influencing dielectric properties of liquids. Solid insulating materials: Natural and synthetic resins; elastomers; fibrous materials; ceramic materials; mica and micanites. Varnishes, compounds, oil-paper insulation and impregnating process. Composite

insulating materials: Advantages of using composite insulation; Concept of reinforced materials; Base and filler materials; Applications.

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.. 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.

Reference Books:

1. Electrical Engineering Material by A.J. Dekker
2. Electrical Engineering Material by B.M. Tareev
3. Dielectric Materials and applications by A. Von Hipple
4. Transistors : D.L. Croissette

(EE/T/224) SIGNALS & SYSTEMS

PART - I

General concept of Systems: Classification. Differential equation of Systems. Definition of Linear Time invariant (LTI) Systems. Laplace Transform (LT) methods for solving linear differential equations with constant coefficients. Concept of transfer function. Open-loop and closed-loop systems. Poles and zeros. Bode Plots. Time response of First and second order systems. Time-domain specifications. Concept of damping ratio and natural frequency. Effect of addition of poles and zeros.
Modeling of Dynamic Systems: Mechanical systems (including rotary systems, gears, articulated systems, Electromechanical systems, DC motors, moving coil speakers, ballistic galvanometers, Thermal systems (first order and second order models), Electric circuit analogues. Modeling of LTI systems using operational amplifiers. Simulation of differential equations with operational amplifiers. Amplitude scaling and Time Scaling. Linear Algebra. State variable representation of systems: Normalization of linear equations. Concept of state variables. Representation in standard forms. Concept of state trajectories. Time response of second order systems.

PART-II

Classification of signals: deterministic & random signals, continuous-time(CT) & discrete-time (DT) signals, Power & Energy signals, causal & non-causal signals. Time-domain operations on CT signals. Mathematical descriptions of deterministic CT signals, Singularity functions. Impulse (Dirac Delta) function and its properties. Decomposition of simple aperiodic waveforms in terms of singularity-function components. Convolution Integral: analytical & graphical convolution, properties of convolution. Review of Trigonometric Fourier Series for CT periodic signals. Exponential Fourier Series and Line- Spectra. Gibbs phenomenon. Properties of Fourier Series. CT Fourier Transform & Integral. Generalized Fourier Transform. Parseval's theorem. Properties of Fourier Transform. Power Spectral Density of periodic signals. Energy Spectral Density. Concept of autocorrelation functions for deterministic signals. Frequency response of LTI systems: Definitions, significance, frequency responses of first-order & second-order systems. Causality: Paley-Wiener criterion, frequency response of ideal filters. Linear-phase systems. Invertibility of LTI systems. Stability concepts. Introduction to discrete-time signals, impulse modulation. Preliminaries of Z-transform.

Reference Books:

1. Simon Haykin and Barry Van Veen, "Signals and Systems" .
2. B.P. Lathi, "Principles of Linear Systems and Signals" (International Version).
3. Tarun Kumar Rawat, "Signals and Systems".
4. P. Ramesh Babu, "Signals and Systems".
5. F.F. Kuo, "Network Analysis and Synthesis".
6. B.C. Kuo, "Automatic Control Systems".
7. I.J. Nagrath and M. Gopal, "Control System Engineering".
8. D.K. Lindner, "Introduction to Signals and Systems"
9. S.Dasgupta, "Control System Theory".

(EE/T/225) POWER SUPPLY SYSTEMS

Structure of Power System – Generation, transmission and distribution. Power generating stations – different types. Steam power stations: Main parts and working, types of boilers and their characteristics. Characteristics of steam turbines and alternators. Main flow circuits of steam power station. Power station auxiliaries, cooling system of alternators. Starting up and shut down procedures of thermal units. Gas-turbine power stations- Main parts, plant layout and Bryton cycle operation. Combined cycle generation & Co-generation. Nuclear power stations- Layout of nuclear power station, types of power reactors, main parts and control of reactors, nuclear waste disposal, radioactivity and hazards. Hydroelectric stations: Arrangement and location of hydroelectric stations, principles of working, types of turbines and their characteristics, Pumped storage plants. Coordination of operation of different power stations . Substation - Classification of substations, Major equipments in Substation, Busbar layouts. Power distribution system: Primary and secondary distribution, types of conductors in distribution system, comparison of distribution systems. Distributor design, radial and ring main, current and voltage profiles along a distributor, economics of feeder design. Electrical wiring and installation - Domestic, commercial and industrial wiring, estimation of main, submain and subcircuit wiring. Earthing practice. Testing of installation. Special lighting connections. Conductors, Fuse and disconnecting devices.

Reference Books:

1. Powerplant Technology by M.M.El-Wakil, McGraw Hill
2. Power Station Engineering & Economy by B.G.A. Skrotzki & W.A.Vopat, Tata McGraw Hill
3. A Course in Power Plant Engineering, by Arora & Domkundwar, Dhanpat Rai
4. Elements of Electrical Power Station Design, by M.V.Deshpande, Wheeler
5. Electric Power Distribution System Engineering , by Turan Gonen
6. Transmission & Distribution ,by H.Cotton

(EE/T/226)SEQUENTIAL SYSTEMS & MICROPROCESSORS

Part -I

Sequential Circuits. State machines and State diagrams. Present State Table, Next State Table.
Concepts of Synchronous, Asynchronous, Linear Sequential Machine. Time driven, Event driven and Time/Event driven sequential systems. Statement List, Process timing diagram, Function sequence, Chart, Mode Chart, Start Chart. Case Studies.
Relay logic and switching algebra
Ladder diagram representation of sequential systems.
Design of elementary sequential systems.
Petrinet representation and case studies
Memory Interfacing : Memory Map, Address decoding, word-size expansion, capacity expansion.
Algorithmic Sequential Machines
Design of Direct Addressed and Indirect Addressed ROM based Sequential systems, Case Studies.
Design of Input Forming Logic of the State Machine using Direct -Addressed and Indirect Addressed Multiplexers. Case Studies.
State Assignment for Minimisation of Output Forming Logic. State assignment to eliminate output glitches.
Microprocessor as an FSM/ASM.

Part -II

Microprocessor Architecture : Address / Data and Control lines, Timing diagrams, Internal registers, Interrupt mechanism (Hardware/Software), DMA mechanism - [NB. Study mainly based on Intel 8085 and other popular microprocessors].

Detailed description of a typical 8-bit Microprocessor (preferably 8085).

Interfacing with support chips : Programmable Peripheral Interface (8255), Programmable time/counter (8253), Programmable UART (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, multisegment display, ADC/DAC

Assembly Language Programming of 8 bit Microprocessor : 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, Brief overview of 16-bit Microprocessors (Intel, Motorola).

Reference Books:

1. Ramesh S. Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085A/8080A, Wiley Eastern Limited.

2. David J. Comer, Digital Logic and State Machine Design, Hold, Rinehart and Winston.

(EE/S/221) E. E. LABORATORY – II

Selected Experiments in Electrical Machines, Control Systems, Power Systems and Measurements & Instrumentation Laboratories.

(EE/S/222) COMPUTER PROGRAMMING LABORATORY

Programming in C.

Concept of Object Oriented Programming: Programming in C++.

Solving Electrical Engg. Problems by C and C++.

(EE/ET/S/223) ELECTRONICS LABORATORY

Selected experiments on analog and digital electronic circuits.

(EE/ME/S/224) M. E. LABORATORY – II

Selected Experiments in Heat power and Hydraulics Laboratory.

(Feedback from Mechanical Engg Dept awaited)

Theory – 18 pds. Sessional- 12 pds. TOTAL- 30 pds.

V. Third Year First Semester

(EE/T/311) DIGITAL SIGNAL PROCESSING

Analog Signal Processing versus Digital Sgnal Processing. Review of Sampling. Aliasing. Frequency domain representation of uniformly-sampled signals. Anti-alias filter. Power and energy sequences. Odd and even sequences.Causal, anticausal and two-sided sequences. Periodic sequences. Time-domain operation on sequences--- time-scaling, time-reversal, time-shifting. Review of Z-transform and its properties. ROCs of Z-transforms. Mapping between z-plane and s-plane. Discrete-Time Fourier Transform and its properties. Parseval's formula. Discrete-time LTI systems, Z-transfer function. Discrete-time convolution, its properties and interconnection of LTI systems. Recursive and Non-recursive systems. Z-Transforms Of Causal Sequences & Time Domain Behaviour. FIR and IIR systems. Ideal interpolation formula for reconstructing analog signals from their samples. DAC employing zero-order hold. Image rejection post-filtering, compensated reconstruction filter. Design of IIR filters: Standard transformation techniques- Impulse invariant transformation, Bilinear transformation, Mapping of differentials, Matched z-transformation. Structures for IIR filters: Direct form, cascade realization, parallel realization, transposed structures, ladder structure. Finite-wordlength effects in digital IIR filters, limit cycles.

Introduction to Discrete Fourier transform (DFT): Fourier series for a periodic signal, Fourier series for a periodic discrete sequence, discrete Fourier transform (DFT), inverse discrete Fourier transform (IDFT). Properties of DFT: periodicity, symmetry. Computation of DFT. Fast Fourier transform (FFT): radix-2 decimation in frequency in-place FFT algorithm. Comparison of DFT and FFT. Applications of FFT.

FIR digital filters. Distortion less transmission of signal through a filter: linear phase characteristic. Concepts of phase delay and group delay. Linear phase digital filter. Properties of linear phase digital filter: periodicity, symmetry. Design of digital filter by Fourier series method. Frequency response of digital filters, realization problems. Direct realization of linear phase FIR digital filters, effect of truncation of impulse response, circular complex convolution integral, Gibbs phenomenon. Common window functions for linear phase FIR filter design: Bartlett, Hamming, Hann, Blackman. Frequency domain characteristic of common window functions. Design of brick-wall type low pass, high pass, band pass FIR digital filters. Design of linear phase FIR filters by the frequency sampling method. Design of optimum equiripple linear phase FIR filters. FIR digital filters for off-line analysis for one-dimensional (1-D) and two-dimensional (2-D) data. 2-D finite impulse sequence of digital FIR filter.

Digital signal processors. Processor architecture: Von Neumann architecture, Harvard architecture, modified Harvard architecture. TMS320C25 processor: architecture, multiply/accumulate operation, benchmarks.

Introduction to image processing: gray image as a 2-D continuous function of space. Image filtering: a 2-D filtering problem, FIR image filters for low pass and high pass filtering. Contrast enhancement by histogram equalization.

Reference Books:

1. Digital Signal Processing: Principles, Algorithms & Applications – J.G. Proakis and M. G. Manolakis.
2. Signals and Systems-- Simon Haykin and Barry Van Veen .
3. Network Analysis and Synthesis--- M.E. Van Valkenburg
4. Principles of Linear Systems and Signals (International Version)- B.P. Lathi.
5. Discrete-Time Signal Processing--- Oppeinham, Schaffer and Buck.
6. Digital Signal Processing-- P. Ramesh Babu.
7. Digital Signal Processing: A Computer Based Approach – S. K. Mitra.
8. Digital Signal Processing – J. R. Johnson.
9. Digital Image Processing – Gonzalez and Woods.

(EE/T/312) ELECTRICAL MACHINES III

PART – I

Single-phase induction motors: Construction and operating principle of split-phase and capacitor-start-capacitor-run 1-phase induction motors. Operating characteristics.

Construction and operating principle of capacitor-start-induction-run induction motors. Winding of 1-phase induction motor. Operating characteristics. Double revolving field theory, Cross field theory. Equivalent circuit, phasor diagram.

Shaded-pole type motor : Construction and operating principle. Operating characteristics.

Repulsion start 1-phase induction motor : Operating principle. Operating characteristics.

AC Commutator motors : Transformer and rotational emf's in phase and commutator windings. Expression for torque and power. Action of commutator as frequency converter. Study of the AC Plain Series motor, its phasor diagram, commutation, brush emf's, design features. Use of compensating and compole winding to improve power factor and commutation.

PART – II

Synchronous generator : Stator construction, Cylindrical rotor and salient rotor construction. Principle of operation. Armature reaction, its effect on load power factor. Alternator regulation. Synchronous reactance. Prediction of regulation by various

methods. Two-reaction Theory. Damper windings. Short circuit, Transient and sub-transient reactances. Determination of Xs, Xd, Xq, X_1, X_2, X_0, Xd', Xq', Xd", Xq". Methods of voltage control and schemes for excitation systems.

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. Synchronous induction motor. Operation as synchronous condenser.

Introduction to Permanent Magnet synchronous machines.
Tests as per standards.

Reference Books:

1. *AC Machines : Puchstein, Lloyd & Hunte*
2. *Advanced Electrical Technology: H. Cotton*
3. *Performance and Design of Alternating Current Machines: M.G. Say*
4. *Principles of Alternating Current machinery: Lawrence*
5. *The Performance and Design of A.C. Commutator Motors: E. Openshaw Tay*lor
6. *Electrical Machinery : S. K. Sen*
7. *Electrical machines: P.K. Mukherjee & S. Chakravorti*

(EE/T/313) POWER SYSTEM PLANNING AND DESIGN

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. 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. Underground Cables – Construction of cables, single and multicore cables, different types, capacitance of belted cables, dielectric loss in cables, heating of cables. 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. Line representation – Representation of short, medium and long lines , Pai and T models. A,B,C,D constants of transmission lines and their measurement. Travelling wave interpretation of long line equations, tuned lines.

Reference Books:

1. Power System Analysis by J.J.Grainger & W.D.Stevension, McGraw Hill
2. Power System Engineering, by I.J.Nagrath & D.P.Kothari, Tata McGraw Hill
3. Electrical Power Systems, by Ashfaq Husain, Vani educational Books
4. Elements of Power System Analysis, by W.D.Stevension, McGraw Hill

(EE/T/314) LINEAR CONTROL SYSTEM

Part I

Introduction to Control Systems: Classification of control systems with examples.

Properties of Control Systems: Stability, steady-state & transient errors, disturbance rejection, insensitivity and robustness. Errors and Error constants, System types.

Time response of system: Time domain specifications, Ramp response of second order system, concept of dominant poles, Time response with NMP zeros.

Review of frequency domain methods: Bode and Nichols plots. Frequency Domain Specifications in open loop and closed loop and their significance, Concept of Bandwidth (3 dB BW & 90 degree BW) and Cut-off frequency, Effect of addition of poles and zeros on Bandwidth.

Control system components: Position and velocity sensors and encoders, servomotors and voice coil actuators.

Case Studies: Performance analysis of remote position control system and generator voltage regulation.

Basic Control actions: Proportional, integral, derivative, and their combinations.

Design and compensation of control systems in frequency domain: Lag compensator, lead compensator, lead-lag compensator and lag-lead compensator.

Part II

Review of Matrix Algebra: Rank of matrix, Generalised matrix inverse, eigenvalues, eigenvector, computation of function of matrix.

Stability of linear systems: Routh-Hurwitz criterion, Nyquist criterion. Stability margins.

Root locus analysis. Effects of system gain and additional pole-zeros on stability.

Block diagram representation of control systems: block diagram reduction and signal flow graph analysis.

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. Alternative representations in state space (cascade form, parallel form, controllable canonical form, observable canonical form). Elementary concept of controllability & observability.

Reference Books:

1. Norman S. Nise, Control Systems Engineering, 6th edition, Wiley, 2011.
2. I.J.Nagrath and M.Gopal, Control Systems Engineering, 5th edition, New Age International, 2009.
3. Benjamin C. Kuo and Farid Golnaraghi, Automatic Control Systems, 9th edition, Wiley; 2009.
4. M. Gopal, Control Systems Principles and Design, 3rd edition, Tata Mgraw Hill, 2008.
5. Naresh K. Sinha, Control Systems, 3rd edition, New Age International, 2004.
6. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, 12th Edition, Prentice Hall, 2011.
7. Sushil Das Gupta, Control system theory, Khanna Publishers, 1987.

(EE/T/315) FIELD THEORY

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, Physical interpretation of gradient, divergence theorem, 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. Magnetic field intensity, Lorentz force, Motoring and generating principles,Physical interpretation of curl and stoke's theorem, Ampere's law in both integral and differential forms, Scalar and Vector magnetic potential and deduction of Biot-Savart's law and its application for different current cofiguration, 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. Faraday's Law of electromagnetic induction,Maxwell's field equations, Displacement current density and continuity equation, Electromagnetic wave equations in loss-free and lossy media, Plane and polarized waves and their propagation as solutions of wave equation,propagation,attenuation and phase constants,intrinsic impedances, Poynting's vector, Poynting's theorem,Power flow through electromagnetic media, Elements of wave guide and radiating systems (antenna), Diffusion equation for eddy currents and skin effect.

Reference Books:

1. Engineering Electromagnetics: W.H.Hayt

2. Electromagnetics: Kraus & Carver
3. Electromagnetic Theory and application: P.Mukhopadhyay
4. Electromagnetics: Edminister

(EE/T/316) PROGRAMMABLE LOGIC & MICROCONTROLLER

Part -I

Programmable Logic Controllers (PLC) : Architecture and functional components, I/O Processing Methodologies, Programming Languages. Sequence Function Chart, Ladder Diagram, PLC input/output Diagram. Case Studies.
Programmable Logic Devices : Concepts of PLA, PAL and FPGAs, Architecture, Basic Design Process.
Introduction to VHDL language basics. Modelling combinational and sequential logic systems. Simulation and tasting.
Types of FPGAs
Xilinx solutions : Xilinx CPLDs and applications areas.
JTAG Development and Debugging Support.

Part -II

Microprocessor vs. Microcontroller, Architecture of MCS51 microcontroller, PIC microcontroller family, features, Architecture, Memory organization: program memory (ROM, PROM, E^2PROM) and data memory (RAM, FLASH), Register organization, Various modules like Timer, ADC, capture, compare, PWM, serial, External interface: inter-chip communication standard (I^2C, SPI), device interface (switch, keyboard, LED, seven-segment display, alpha-numeric and graphic LCD, external E^2PROM, external serial and parallel interface), PIC Development System, Assembler and Cross-compiler, Programming methodology, Advanced microcontroller: 16-bit and 32-bit, VHDL model of microcontrollers, IP cores.

Reference Books:

1. Introductory VHDL: From Simulation to Synthesis by Sudhakar Yelamanchilli, Pearson Education.

2. A VHDL Primer by J. Bhasker, Pearson Education.

3. PIC Microcontroller and Embedded Systems: Using assembly and C for PIC 18 by Muhammad Ali_Mazidi, Rolin McKinlay and Danny Causey, Pearson Education.

4. Fundamentals of Microcontrollers and Applications In Embedded Systems (with the PIC18 Microcontroller Family) by Ramesh Gaonkar, Penram International Publishing (India) Pvt. Ltd.

5. The 8051 Microcontroller and Embedded Systems: Using Assembly and C, by Muhammad-Ali_Mazidi, Janice Gillispie Mazidi and Rolin McKinlay, Second Edition Pearson Education.

6. Programming and Customizing the PIC Microcontroller by Myke Predko - Third Edition, Tab Electronics.

(EE/S/311) E. E. LABORATORY – III

Selected Experiments in Electrical Machines, Control Systems, Power Systems, High Voltage and Measurements & Instrumentation Laboratories.

(EE/S/312) ELECTRICAL MACHINE DESIGN – I

Design of 1-phase transformers, lifting magnets and reactors.

Reference Books:

1. A.K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai & Co.
2. V.N. Mittle, A. Mittal, "Design of Electrical Machines", Standard Publishers Distributors.
3. R.K. Agarwal, "Principles of Electrical Machine Design", S.K. Kataria & Sons.

(EE/S/313) MICROPROCESSOR AND MICROCONTROLLER LABORATORY

Hand on experience with different microprocessor and microcontroller systems and their interfaces.

Theory – 18 pds. Sessional- 9 pds. TOTAL- 27 pds.

VI. Third Year Second Semester

(EE/T/321) INTRODUCTION TO STATISTICAL AND PROBABILISTIC METHODS

Review of probability concepts, rules of probability, conditional probability, Bayes' formula. Concept of random variables, probability distributions. Moments of random variables, moment generating functions. Discrete distributions: Binomial and Poisson. Continuous distributions: Uniform, Exponential, Gaussian, lognormal, Chi-Square, Gamma, Weibull, Rayleigh. Bivariate data. Joint probability distribution. Concept of correlation and covariance. Correlation coefficient: properties, calculations, interpretations and usage. Applications in electrical engineering.

Introduction to random process. First-order and second-order statistics, ensemble averages. Auto correlation and cross correlation. Concepts of stationarity and ergodicity. Spectral density: energy spectral density and power spectral density. Concept of white noise. LTI systems with random inputs. Innovations representation of a stationary random process. Applications in electrical engineering.

Sampling theory – sample mean, sample variance. Parameter estimation: point estimates, criteria of good estimators, maximum likelihood estimators. Interval estimates, statistical confidence, concept of confidence interval. The Bayes estimation. Statistical hypothesis testing: null hypothesis and alternative hypothesis, tests for differences in means, differences in variances. Significance levels. Two-tailed and one-tailed tests. Type I and Type II errors. Large sample and small sample tests for statistical significance using Normal and Chi-Square distribution. Fitting theoretical distributions to sample frequency distributions.

Regression: concepts of regression. Properties of linear regression. Least squares estimators of the regression parameters, distribution of the estimators, statistical inferences about the regression parameters. Weighted least squares. Polynomial regression.

Introduction to analysis of variance. Goodness of fit: Chi-Square test, Kolmogorov-Smirnov test, least-squares test. Nonparametric hypothesis tests: the sign test, the signed rank test.

Statistical analysis of measurement errors and uncertainties. Types of errors: gross errors, systematic errors, instrumental errors, environmental errors, observational errors, random errors. Statistical treatment of data: histogram, mean, measures of dispersion, average deviation, standard deviation, variance. Probable error. Limiting error. Uncertainty analysis and treatment of single sample data: concept of uncertainty distribution and uncertainty interval. Propagation of uncertainties.

Reference Books:

1. Probability, random variables, and random signal principles – Peyton Z. Peebles, Jr.
2. Probabilistic Methods of Signal and System Analysis – George R. Cooper and Clare D. McGillem.
3. Probability, Random Variables and Stochastic Processes – Athanasios Papoulis and S. U. Pillai.
4. Introduction to Probability and Statistics for Engineers and Scientists – Sheldon M. Ross.
5. SCHAUM'S Outline Series: Theory and Problems of Probability and Statistics – Murray R. Spiegel.
6. Statistical Methods (Part I and Part II) – N. G. Das.
7. Modern Electronic Instrumentation and Measurement Techniques – Albert D. Helfrick and William D. Cooper.

(EE/T/322) POWER ELECTRONICS

PART – I

Major Power semiconductor devices like Diode, SCR, GTO, Triac, Bipolar Power Transistor, Power MOSFET, IGBT - their type variations, important parameters, internal and equivalent circuits, Safe Operating Area. Drive techniques and isolation of drive pulses. Protection including fuses, snubbers and clamps. Steady and switching power loss in devices : its effect & minimization. Cooling and Heat-sinks.

Principles of buck, boost and buck-boost Choppers. Methods of voltage control : PWM & PFM techniques.

Push-pull, Half-bridge and Bridge inverters. Methods of voltage control : dc bus variation and PWM.

SCR forced commutation techniques and their application to choppers and inverters. Current Source Inverters.

Principles of isolated dc/dc converters and SMPS.

PART – II

Input and output characteristics of common rectifier topologies : Single-phase half-wave and full-wave Diode rectifiers with R, RL, RC and RLE load. Study of same with highly inductive load. Effect of Free-wheel diode. Output average voltage for 'm' pulse diode rectifier. Three-phase half-wave and full-wave Diode rectifiers with highly inductive load. Introduction to higher pulse rectifier systems and use of Inter-Phase Reactor.
Single-phase half-wave and full-wave SCR rectifiers with R, RL and RLE load. Study of same with highly inductive load. Effect of Free-wheel diode. Output average voltage for 'm' pulse SCR rectifier. 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 voltage ripple & 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 operation of the Cyclo-converter.

Reference Books:

1. N. Mohan, T.M. Undeland & W.P. Robbins, "Power Electronics", John Wiley & Sons.
2. V. Subrahmanyam, "Power Electronics", New Age International (P) Ltd.
3. M.H. Rashid, "Power Electronics", 3rd Edition, Prentice-Hall of India Pvt. Ltd.
4. B.W. Williams, "Power Electronics", Macmillan.
5. P.C. Sen, "Modern Power Electronics", Wheeler Publishing.
6. P. S. Bimbhra, "Power Electronics", 4th Edition, Khanna Publishers
7. P.C. Sen, "Power Electronics", Tata McGraw-Hill Publishing Co. Ltd.
8. G.K. Dubey, S.R. Doradla, A. Joshi & R.M.K. Sinha, "Thyristorised Power Controllers", Wiley Eastern Ltd.

(EE/T/323) POWER SYSTEM PERFORMANCE

Per-Unit representation of Power system– Selection of base quantities, percent and per unit values, advantage of per unit system. AC Transmission – Power flow through a line, power circle diagram, line charts, active power flow and voltage control in transmission system. Line loadability and voltage dependence. Power flow in interconnected systems and load flow analysis – Gauss –Seidel method. Symmetrical fault analysis . Elements of HVDC Power transmission. Basic concept of active and reactive power control of Synchronous generator. Interdependence of active power with frequency and reactive power with voltage and concept of decoupling. Speed Governing System: Description of Speed Governor, Speed changer and main components of speed governing system, principle of operation. Load frequency control: Representation of speed governing system, effect of governor droop on load sharing among generators ,dependence of load on frequency, system inertia. Modeling and analysis of single area load-frequency control, supplementary control, concept of control area. Multi area load frequency control problem and concept of tie line control. Reactive power control: Role of excitation system, main & pilot exciters, description of different types of excitation systems. Economic operation of power plant – cost curves, heat rate, incremental rate, economic load sharing among generating units. Power system stability: Steady state and transient stability, Swing equation and its numerical solution, equal area criterion for transient stability, , improvement of transient stability.

Reference Books:

1. Power System Analysis, by J.J.Grainger & W.D.Stevension, McGraw Hill
2. Power System Engineering, by I.J.Nagrath & D.P.Kothari, Tata McGraw Hill

3. Electric Energy System Theory, by O.I.Elgard, Tata McGraw Hill
4. Elements of Power System Analysis, by W.D.Stevenson, McGraw Hill.
5. Power System Analysis, by A.R.Bergen & V.Vittal, Pearson Education

(EE/T/324) PROCESS INSTRUMENTATION AND CONTROL

Part I

Introduction to process control loop and salient components. Process control terminology. Process instrument diagram. Self-regulating and non self-regulating processes.

Controller implementation. Electronic analog P, PI, PD, PID controllers. Pneumatic controllers: baffle-nozzle amplifiers, relay valve, pneumatic P, PI, PD, PID controllers.

Introduction to digital controllers. Concept of sampling. Digital P controller, digital PI controller employing rectangular and trapezoidal integration, digital PD controller employing backward difference algorithm, digital PID controller. Provision for anti-integral windup and anti-derivative kick. Auto/Manual modes of operation. Incremental form of PI/PID controller. Bumpless transfer. Design of controllers with auto-tuning method employing relay feedback.

Signal transmission systems in process control loop. Analog voltage/current transmission standards. Digital serial transmission standards: RS-232C, RS-422, RS-423, RS-485. Importance of transmission noise. MODEM based signal transmission.

Importance of time delay in process control loop. Practical examples. Smith predictors/controllers.

Final control elements in process control loop. Types of Actuators: Pneumatic, Electrical, Hydraulic. Positioners. Pneumo-electric converters. Linear and rotary actuators. Linear pneumatic actuators with and without positioners. Control valves: single stem and double stem sliding valves, butterfly valves, ball valves. Valve sizing. Methods of fluid control: variable delivery, bypass.

Part II

Concept of Processes and Units: Process statics, steady state operating point, mass and enthalpy balance.

Modelling of process dynamics: Modelling of simple Industrial processes. Standard first order process model with delay, time and frequency response of standard first order process model with delay.

Single loop control of standard first order process plants: P, PI, PD and PID control, Controller tuning, Frequency domain design, Ziegler-Nichol's and other empirical tuning methods.

Feedforward control: configurations, advantages, limitations and industrial applications.

Multiloop and Cascade control: configurations, interaction and decoupling, industrial applications.

Ratio control: principles, configurations including cascade configuration.

Case study: Boiler Control.

Reference Books:

1. Principles and Practice of Automatic Process Control - Smith and Corripio
2. Principles of Process Control - Patranabis
3. Automatic Process Control - Eckmann
4. Process Control Systems - Shinskey
5. Process Systems Analysis and Control - Coughanowr & Koppel
6. Chemical Process Control – Stephanopoulos
7. Process Dynamics and Control – Dale E. Seborg, Thomas F. Edgar and Duncan A Mellichamp

(EE/T/325) ELECTRICAL UTILISATION & ILLUMINATION ENGINEERING

PART – I

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, **c**lassification of furnaces and ovens. Industrial application areas.

Resistance Heating : 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 Heating : basic principles and applications.

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

Dielectric Heating : basic principles and applications.

Principle of Thermostat control for cooling.

Storage Batteries : common types and their characteristics. Principles of charging, modes of charging, eg., tickle, float, boost, constant current, constant voltage etc. Charge termination methods, common charger types. Temperature compensation of charging voltage. Battery size estimation.

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.

PART – II

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, Distribution photometer. Computation of lumen output from Luminaire from luminous intensity distribution-zone factor, zonal lumen, Integrating Sphere. Lamps-general classification, incandescent, tungsten halogen,fluorescent, compacty fluorescent-construction, principle of operation,features etc. Ballast-its function, electromagnetic and electronic type-principle of operation. Luminaire-its function and classification. Elemnetary lighting deisgn-design parameters,BIS recommendation, general indoor lighting design by Lumen method. Concepts of energy efficient lighting design and payback calculation.
Elements of Outdoor Lighting.

Reference Books:

1. H. Partab, "Art & Science of Utilisation of Electrical Energy", Dhanpat Rai & Sons.
2. G.W. Vinal, "Storage Batteries", John Wiley & Sons Inc.
3. N. Mohan, T.M. Undeland & W.P. Robbins, "Power Electronics", John Wiley & Sons.
4. P.C. Sen, "Power Electronics", Tata McGraw-Hill Publishing Co. Ltd.
5. P.C. Sen, "Modern Power Electronics", Wheeler Publishing.
6. G.K. Dubey, S.R. Doradla, A. Joshi & R.M.K. Sinha, "Thyristorised Power Controllers", Wiley Eastern Ltd.
7. Lamps and Lighting – Edited by J.R.Coaton and A.M.Marsden, 4th Edition, Arnold
8. Lighting for energy efficient luminous environments- Ronald N.Helms & M Clay Belcher.
9. Lighting-D.C..Pritchard
10. Applied Illumination Engineering, Second Edition, Jack L Lindsey, Prentice Hall
11. Illumination Engineering from Edison lamp to the laser – J.B.Murdoch, Macmillion Publishing company.

(EE/T/326) HIGH VOLTAGE ENGINEERING

High voltage power transmission and distribution. Insulators: Type of insulators and their applications, voltage distribution and string efficiency of disc insulators. Corona: Theory of corona formation, corona loss and radio interference. Overvoltage phenomena: Lightning and switching surges. Travelling waves: Reflection and refraction w.r.t. different type of line terminations. Overvoltage protection: Grounding practice and over-voltage due to earth fault, lightning arresters and surge suppressors. Insulation coordination scheme of open-air substation. High voltage cables: Single core, belted,

XLPE and gas-filled. Inter-sheath grading. Requirement of extra high voltage cables. Bushings: Non-condenser and condenser bushings, field distribution.

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.

Reference Books:

1. High Voltage Engineering – Kuffel and Zaengl
2. High Voltage Measurement Techniques– A.J.Schwab
3. High Voltage Engineering –D.V.Razevig
4. High Voltage Engineering – Naidu & Kamaraju

(EE/S/321) E. E. LABORATORY – IV

Selected Experiments in Electrical Machines, Control Systems, Power Systems, High Voltage and Measurements & Instrumentation Laboratories.

(EE/S/322) ELECTRICAL MACHINE DESIGN – II

Design of integral h.p dc Machine and 3-phase transformer.

Reference Books:

1. A.K. Sawhney, “A Course in Electrical Machine Design”, Dhanpat Rai & Co.
2. V.N. Mittle, A. Mittal, “Design of Electrical Machines”, Standard Publishers Distributors.
3. R.K. Agarwal, “Principles of Electrical Machine Design”, S.K. Kataria & Sons.

(EE/S/323) POWER SYSTEM DESIGN

Problems on power transmission and distribution system design.

(EE/S/324) MODELING AND DIGITAL SIMULATION LABORATORY

Introduction to Matlab/Simulink: Basic matrix operation, file operations, plotting, Matlab program development in command window. Simulation of problems on Matlab/Simulink 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.
– 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. Study on quantization error of ADC.
– FFT and Inverse FFT of harmonic rich signals.
– Design of IIR and FIR filters and study on effect of finite wordlength.
–Simulation of ?-circuit long transmission line and study of wave propagation.
– Modeling of illumination level at working plane.

Theory- 18 periods. Sessional- 12 periods. Total- 30 periods.

VII. Fourth Year – First Semester

(EE/T/411) PRINCIPLES OF COMMUNICATION ENGINEERING AND COMPUTER NETWORKS

Part I: Communication Engineering

Review of Fourier Transform and Random Process, Power Spectral Density (PSD), Auto-Correlation and Cross-Correlation Functions, Geometric Representation of Signals, Analog and Digital Signal Transmission and Reception, Channel and Noise, White Noise, Baseband and Carrier Communications.

Analog Communication: Amplitude Modulation (AM), Modulation Index, Double-Sideband -Suppressed Carrier (DSB-SC) , Conventional Double Sideband (DSB) and Single Sideband (SSB) Modulation, Demodulation of AM Signals, AM Modulators (Power-law Modulators, Switching Modulator, Ring Modulator) and Demodulators (Synchronous Demodulator, Rectifier Detector, Envelop Detector), Frequency Division Multiplexing (FDM), Angle Modulation: Frequency and Phase Modulations (FM & PM), Narrowband and Wideband FM, FM Modulators and Demodulators, Direct and Indirect FM, Balanced Discriminator, FMFB and PLL FM Demodulators, AM and FM Radio Broadcasting, Superheterodyne AM and FM Receivers.

Digital Communication: Digital Communication Systems, Communication Channels (AWGN, Bandlimited, Multipath and Fading Channels), Introduction to Baseband and Bandpass Digital Modulations, Concepts of Power Efficiency, Bandwidth Efficiency, Inter-Symbol Interference (ISI), Bit-Error Rate (BER), Formatting And Baseband Modulation, Messages, Characters, and Symbols, M-ary Communication, PAM, PDM, PPM, Pulse Code Modulation (PCM), Delta Modulation, Uniform and Non-Uniform Quantizations, Companding, Time-Division Multiplexing (TDM), Baseband Demodulation, Digital Bandpass Modulation & Demodulation (Detection), Coherent Detection, Non-Coherent Detection, Frequency Shift Keying (FSK), Binary FSK Signals (BFSK), BFSK Modulator, BFSK Coherent and Non-Coherent and Demodulators, Amplitude Shift Keying (ASK), Phase Shift Keying (PSK), BPSK, BPSK Modulator, BPSK Coherent and Non-Coherent and Demodulators, Overview of M-ary PSK, Quadrature PSK and Minimum Shift Keying (MSK).

Spread-Spectrum (SS) Modulation: Direct-Sequence (DS) and Frequency-Hop (FH) SS, Concept of Pseudo-Noise (PN) Sequences, Generation of PN Sequences, SS Modulation for Baseband Transmission, DS SS with Coherent BPSK (DS/BPSK), DS/BPSK Transmitter and Receiver, Processing Gain, FH/MFSK Transmitter, Slow Frequency Hopping and Fast Frequency Hopping.

Wireless Communications: The Cellular Concept, Personal Communication Services (PCS), Hierarchical Architecture of a Personal Communication Services Network

(PCSN), Radio Resource Management in PCS, Multiple-Access Techniques, FDMA, TDMA, CDMA, Channel Assignment, Frequency Reuse, Cell Splitting, Mobility Management, Handoff Management, Inter-Switch Handoff, Location Management, Location Update, Call Delivery and Terminal Paging, GSM (2.5 G) and UMTS (3G)Architectures.

Part II: Computer Networks

Introduction to Computer Networks: Analog vs. Digital Transmission, Nyquist and Shannon Limits, ISO/OSI Layered Architecture, OSI Reference Model.

Basics of Digital Data Transmission and Media: UTP,STP, Coax, Fiber, Modems, RS-232C, Error Detection and CRC Polynomial Codes, Encoding Schemes (NZ, NRZ, Manchester Encoding).

Local Area Networks (LAN), IEEE 802.3, 802.5 Standards, Token Ring, Token Bus, CSMA/CD, Ethernet, Hub, Switches and Bridges.

Wireless LAN: IEEE 802.11x standard.
Circuit Switching and Packet Switching, Digital Switching Concepts, ISDN, Virtual Circuits, X.25.

Network and Transport Layer, Routing and Traffic Control, Flow and Congestion Control, Internetworking, Routers and Gateways, Internet IP, Transport Protocols, TCP/IP, ATM.
Network Security.

Reference Books:

1. John G. Proakis and Masoud Salehi, Communication Systems Engineering. 2nd Edition, Pearson Education, 2008.
2. Simon Haykin, Communication Systems. 4th Edition, Wiley India Edition, 2008.
3. Bernard Sklar, Digital Communication: Fundamentals and Applications. 2nd Edition, Pearson Education, 2007.
4. Fuqin Xiong, Digital Modulation Techniques. Artech House, Boston, London, 2000.
5. Theodore S. Rappaport, Wireless Communications: Principles and Practice. 2nd Edition, Prentice Hall of India Edition, 2008.
6. Tanenbaum, Computer Networks, PHI.
7. A. Papulis and S. Unnikrishna Pillai, Probability, Random Variables and Stochastic Processes, 4th Edition, Tata McGraw-Hill, 2002.

(EE/T/412) Power System Protection and Switchgear

Analysis of asymmetrical faults in power system. General requirements of circuit breakers. Auto- reclosing feature – three pole & single pole autoreclosing. Formation of electric arc. Arc build-up and quenching theory, recovery voltage and RRRV, Arc restriking phenormena. 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. Fundamental principles of protective relays, their properties and block diagrams.

Single input relays, overcurrent, earth fault and over voltage relays. Principle and application of directional overcurrent and earth fault relays. Principle of 2-input comparison, two and rnuiti 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. Static & Digital Relaying: Generalised approach for two input and multi input comparators, Phase and amplitude comparison, inputs for different types of static distance protection, hard- ware for static relays, concept of digital relaying, main components of digital relays,ditial relaying algorithms.

Reference Books:

1. The Art And Science Of Protective Relaying, by C.R.Mason, John Wiley
2. Protective Relays – Their theory And Practice Vol-I & II, by A.R.Van. C. Warrington, john Willey
3. Power System Protection, by S.P.Patra, S.K.Basu & S.Choudhuri, Oxfort & IBH
4. Power System Protection & Switchgear, by B.Ravindranath & M.Chander, Willey Eastern
5. Switchgear & Protection, by S. S. Rao, Khanna Publishers.
6. Power System Protection, Vols.I, II & III, by Electricity Council, Macdonald & Co.
7. The J & P Switchgear Book, Johnson & Philips Ltd. Newness Butterworths.
8. Power System Protection, Vols.I, II, III & IV, by The Electricity Training Association,

(EE/T/413) ELECTRIC DRIVES

PART – I

Motor control components like contactors, relays, limit switches, etc., and example of motor control circuit like start-stop control, Star-Delta starter, forward-reverse change-over.

Drive specifications. Basic terminology : base speed, speed ratio, constant torque drive,

constant hp drive, etc. Four quadrant representation, dynamics of loading of motor with

different types of mechanical load. Heating and cooling of motors, operating duty cycles.

Choice of couplings and bearings.

Acceleration time, energy loss in starting. Effect of flywheels.

Regeneration in drives : Dynamic braking, regenerative braking, dc injection, plugging.

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.

PART – II

Solid state control of dc motors – basic principles. Armature current control with constant flux and field weakening. Simple modeling of a separately excited dc motor. Drive schemes with armature voltage feedback, IR-compensation, and tacho feedback for both constant flux and field weakening.

Solid state control of induction motors – basic principles. V/f control with constant flux and field weakening. Simple modeling of an induction motor. Drive schemes with terminal voltage feedback and slip-compensation, also with tacho feedback for both constant flux and field weakening.

Solid state control of synchronous motors – basic principles. V/f control with constant flux and field weakening. Simple modeling of a synchronous motor. Drive schemes with open loop and with position feedback.

Realisation of the total converter system for ac and dc drives using choppers, Phase controlled rectifiers, Dual converters, Voltage Source Inverters (VSI), Current Source Inverters (CSI). Current Controlled VSI and Cyclo- converters. Basic operating principles and characteristics of the schemes.

Protection schemes for overall drive systems.

Power electronic controlled starting of dc and ac motors

Reference Books:

1. Fundamentals of Electrical Drives :G.K. Dubey.
2. Power Electronics and Motor Control : W. Shepherd, L.N. Hulley & D.T.W. Liang
3. Electric Drives : N.K. De, P.K. Sen.
4. Power Semiconductor Controlled Drives: G.K. Dubey
5. Control of Electric machines:Irving L. Kosow
6. Modern Electric Traction: H. Partab.
7. A First Course on Electrical drives: S.K. Pillai
8. Electric Motor Drives: R. Krishnan
9. Electric Drives:M. Chilikin

(EE/T/414) ELECTIVE PAPER– I

(EE/T/414A) Digital Control Techniques

Introduction: Introduction,Advantages and disadvantages of digital control,Configuration of the basic digital control scheme,Examples of practical digital control systems

Review of Signal Conversion and Processing: Comparative study of basic features of Continuous-time analog signal, Continuous-time quantized signal, Sampled-data signal, and Digital signal,Sampling, quantization and coding of an analog signal,Sample-and-Hold devices and their characteristics: Sampling duration, Sampling period, Acquisition time, Aperture time, Settling time, and Hold mode droop,Choosing the minimum and maximum sampling frequency,Concept of Hold operation and Zero Order Hold (ZOH),Transfer function of ZOH,Ideal sampled signal,Discrete-time vs. Digital Control Systems,Block diagram representation of the various signals associated at different subsystems of a digital control system.

Modeling of Discrete-time Control Systems: Time-domain model-State variable model,Difference equation model,Impulse response model; Transfer Function model-Pulse Transfer Function,Transfer Function of unit delayer,Derivation of equivalent Pulse Transfer Function of Open Loop and Closed Loop system by Block Diagram reduction techniques

Time Domain Analysis and Design of Discrete-time Control System: Time response calculation of discrete time control systems (open loop and closed loop) for standard test input using Pulse Transfer Function model,,Mapping between s-plane and z-plane,Stability analysis of closed-loop systems in the z-plane,Method of testing absolute stability-The Jury stability test, Transient and Steady State response of discrete-time systems -Transient response specifications, Static error constants; Discrete-time Control system design by Root-Locus method

Frequency Domain Method of Analysis and Design of Discrete-time Systems: Bilinear transformation,,Bode diagram of discrete-time system- Gain margin and Phase margin, Design of compensators using Bode diagram for discrete-time system, Design on the W-plane and W'-plane

State-Space Analysis of Discrete Time Control System: Discrete-time state-space equations, Canonical and Diagonal forms of state-space equations, Solving discrete-time state-space equations, Similarity transformation, Discretization of continuous-time state-space equations,

Digital PID Controller Design: Conventional design, Model based design

Controllability and Observability of Discrete Time Systems: Definition of controllability for discrete-time system, Test for controllability for discrete-time system, Definition of observability for discrete-time system, Test for observability for discrete-time system,

Pole Placement and Observer Design for Discrete Time Systems: Design of a discrete-time state regulator by pole placement, Design of a discrete-time state feedback control system with reference input by pole placement, Design of full order and reduced order state observers, Compensator design by separation principle

Advanced Digital Control Systems: Basic Principles of Intelligent Control: Fuzzy Logic Control, Artificial Neural Network based Control, Neuro-Fuzzy Control. Basic Principles of Embedded Digital Control System Design.

Reference Books:

1. Katsuhiko Ogata, Discrete-Time Control Systems, (2nd ed), Prentice Hall.
2. Benjamin C. Kuo, Digital Control Systems, Holt-Saunders International Edition.
3. M. Gopal, Digital Control and State Variable Methods, (2nd ed.), Tata McGraw Hill.

(EE/T/414B) High Voltage Technique – I

Breakdown in gases, Townsend Mechanism, Paschen's Law, Streamer breakdown, Breakdown under Surge Voltages, Different types of breakdown in solid dielectrics, Different types of breakdown in liquids, Partial discharge and its measurement techniques.

Basic Equations of Electric field analysis. Electric Field Analysis by Finite Difference Method – Formulations for homogeneous medium in 2D and Axi-Symmetric Systems with equal and unequal nodal distances, Formulations for multi-dielectric media in 2D and Axi-Symmetric Systems with equal nodal distances. Electric Field Analysis by Finite Element Method – Formulations for homogeneous and multi-dielectric media in 2D and Axi-Symmetric systems. Electric Field Analysis by Charge Simulation Method – Basic formulations for homogeneous and multi-dielectric media, Types of charges and Accuracy Criteria.

Analytical Method of Electric Field Analysis – Cylinder and Sphere in uniform field. Field Utilization factors for fields around cylinders and spheres.

Field Transformations. Techniques of electric stress control.

Reference Books:

1. High Voltage Engineering–Edited by Alston.
2. High Voltage Engineering Fundamentals–Kuffel & Zaengl.
3. High Voltage Engineering–Razevig & Chourasia.

(EE/T/414C) Special Electrical Machines & Drives

PART – I

Special machines: Reluctance motor, Switched Reluctance motor, Brush-less DC motor, Hysteresis motor, Servo-motor, Stepper Motor. Electronic excitation schemes for these.

Permanent magnet dc machines. PM synchronous motor and generator, 1-phase alternator, Linear Induction motors.

Energy efficient motors.

Induction regulators : Basic principles.

PART – II

Study of the doubly-fed slip-ring machine and the induction generator for synchronization to the grid.

Microcontroller, DSP, PLC applications to motor drives.

Introduction to Artificial Intelligence application to motor drives.

Feedback system components like tachogenerators, optical encoders, hall-effect sensors. Voltage and current sensing with dc and variable frequency supply.

Reference Books:

1. W. Shepherd, L.N. Hulley & D.T.W. Liang, "Power Electronics and Motor Control",

Cambridge University Press.

2. B.K. Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia.

3. Electric Motor Drives: R. Krisnan

4. P.C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons
5. Electric machinery: Fitzgerald & Kingsley
6. Fractional & Sub-fractional Horsepower Motors: C. G. Veinott
7. Electrical machines: P.K. Mukherjee & S. Chakravorti
8. Permanent Magnet Motor Technology: J. Gieras
9. Kenjo & Nagamori
10. Hendershoot & Miller

(EE/T/414D) Advanced Instrumentation-I

Waveform-synthesizer. vector voltmeter. lock-in amplifier. Instrumentation networking techniques: GPIB, fieldbus etc. Smart sensor systems. Sensor fusion. Data Acquisition Systems. Distributed instrumentation and SCADA.
Transducers for electromagnetic variables: Rogowskii coils, Hall-probes, DCCT, flux-gate devices.
Tactile sensors. Occupancy sensors.
Special ADCs: flash, subranging, pipelined, interpolating, algorithmic. Statistical analysis of quantization-noise in ADCs. Digital Transducers.
Sampling Techniques: Synchronous and Asynchronous sampling, applications.
Correlation methods of measurement, time-averaging techniques, signal averaging. Non-linear filters: median, weighted median. System Identification techniques: deconvolution, least square and recursive least square. Regression models: AR, MA and ARMA models; applications: Lattice filters, Power Spectrum estimation.
Time-frequency analysis of signals: Short-time Fourier transform, Wavelet transform and their applications.

Reference Books:

1. B.M. Oliver & J.M. Cage--- Electronic Measurements & Instrumentation.
2. P. Z. Peebles – Probability, Random Variables and Random Signal Principles.
3. Dag Stranneby and William Walker—Digital Signal Processing and Applications.
4. Walt Kester—The Data conversion Handbook.
5. Martin U. Reissland—Electrical Measurements: Fundamentals, Concepts, Applications.
6. A. J. Schwab—High Voltage Measurement Techniques.
7. Clarence W. de Silva—Control Sensors and Actuators.
8. T.S. Rathore----- Digital Measurement Techniques.
9. J.G. Proakis and M. G. Manolakis-- Digital Signal Processing: Principles, Algorithms & Applications.
10. David L. Hall—Mathematical Techniques in Multisensor Data Fusion.
11. Monson H. Hayes--Statistical Digital Signal Processing and Modeling.
12. D.V.S. Murty—Transducers and Instrumentation.
13. R. M. Rao and A. S. Bopardikar-- Wavelet Transform – Introduction to Theory & Applications.

(EE/T/414E) Advanced Power Systems Analysis

Load flow analysis : Formulation of the load flow problem. Solution of load flow problem by Newton Raphson methods. Incorporating tapchanging transformers and phase shifters in load flow problem.

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, introduction to hydro-therrnal scheduling problem.

Transient stability: Multimachine 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.

Voltage stability problem – causes of voltage instability, Analysis of static voltage stability , Sub synchronous resonance in Power System.

Reference Books:

1. Computer Methods in Power System Analysis by Stagg & El-Abiad, Tata McGraw Hill
2. Computer Aided Power System Operation & Analysis, by R.N.Dhar, Tata McGraw Hill
3. Electric Energy Systems Theory, O.I.Elgard, Tata McGraw Hill
4. Power Generation Operation And Control, by A.J.Wood & B.F.Wollenberg, John Willey
5. Power System Engineering, by I.J.Nagrath & D.P.Kothari, Tata McGraw Hill
6. Power System Analysis, by A.R.Bergen & V.Vittal, Pearson education
7. Computer Aided Power System Analysis, by G.L.Kusic, Prentice Hall India
8. Power System Stability and Control by P. Kundur, McGraw Hill
9. Power System Stability Operation and Control by A. Chakrabarti and Sunita Halder, PHI Learning System.

(EE/T/414F) Advanced Illumination Engineering

PART – I

Visual performance evaluation; external factors of vision-visual acuity, contrast sensitivity, time, luminance, colour; visual perception; assessment of visibility level; Biological factors of lighting-circadian system; optical radiation hazards.
Illuminance calculation-illuminance as vector quantity, direct illuminance from point, linear, area sources, advanced methods of illuminance calculation, luminance, luminous exitance, non-planer illuminance – spherical, cylindrical etc., interreflected illuminance.
Photometry- types of detectors–characteristics, figures of merit etc.; detection elements- filters, cosine diffuser, imaging optics. Photometric measurements – C-Gama and B-Beta photometry; understanding of luminaire photometric test report; luminance, colour temperature, sources of errors and correction, calibration and calibration report.

Colorimetry – visual basis of colorimetry, source colour & object colour. CIE chromaticity – XYZ and UCS colour space, source and object colour specification, dominant wavelength, purity, Grassmann's law of colour mixing, CIE standard source and illuminant. Munsell colour system; colorimetric instrument – light source colorimetry and colorimetry of materials; colour rendering index-its measurement; metamerism.

PART – II

Lamp materials- filament, glass, ceramics, gases, phosphors and other metals & nonmetals; theory of gas discharge phenomena; lamp design considerations; characteristics of low & high pressure mercury-vapour & sodium-vapour lamps; modern energy saving lamps - comparative study; coloured LED & white LED – features and characteristics, features and applications; LASER – characteristics, features and applications. Optical fiber – its construction as light guide, features and application.

Ballasts & ignitors for different discharge lamps; design consideration of electromagnetic and electronic ballast for TL lamps; ballast materials.

Luminaire – design considerations, optical control schemes, design procedure of reflecting and refracting type of luminaire, testing of luminaire, Ingress Protection (IP) code, Luminaire standard – BIS recommendation.

Lighting controls:– different control equipment- on/off switch, simple automatic switches, photocell, occupancy sensor, timer, lighting contactors, dimmer, low voltage relays; communication links-line and low voltage hardware; different control strategies.

Reference Books:

1. Human Factors in Lighting – P R Boyce
2. Lighting-D.C..Pritchard
3. Lighting for energy efficient luminous environments- Ronald N.Helms & M Clay Belcher.
4. Lamps and Lighting – Edited by J.R.Coaton and A.M.Marsden, 4th Edition
5. Illumination Engineering: From Edison lamp to the LASER – J.B.Murdoch,
6. Electric Discharge Lamps – John F. Waymouth
7. Lighting Control Hand book – Craig Dilovie

(EE/S/411) E.E. LABORATORY – V

Selected Experiments in Electrical Machines, Control Systems, Power Systems, High Voltage and Measurements & Instrumentation Laboratories.

(EE/S/412) ELECTIVE PROJECT AND COMPUTATION – I

(EE/S/413) SEMINAR – I

(EE/S/414) ELECTRICAL MACHINE DESIGN – III

Design of 3-phase Induction Motor and 1-phase Induction Motor.

Reference Books:

1. A.K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai & Co.
2. V.N. Mittle, A. Mittal, "Design of Electrical Machines", Standard Publishers & Distributors.
3. R.K. Agarwal, "Principles of Electrical Machine Design", S.K. Kataria & Sons.

(EE/S/415) GENERAL VIVA VOCE

Based on the theory and sessional subjects covered under B. E. E. Programme.

Theory – 14 pds. Sessional- 12 pds. TOTAL- 26 pds.

VIII. Fourth Year – Second Semester

(EE/Gen/T/421) Economics And Industrial Management

PART I

Nature and significance of economics; Engineering economics and its importance.

Demand and Supply analysis: Laws of demand and supply; elasticity of demand and supply; demand forecasting.

Markets: its meaning and different types; Price-output determination under different market forms.

Money and its fluctuations; inflation.

Banking system in India; role of commercial banks; Reserve Bank of India and its functions.

Sources of Public Revenue-Principles of taxation.

Industrial cost and their classifications; preparation of cost sheet.

Economic efficiency; Depreciation and replacement studies.

Investment decision; present worth, annual worth, and Rate of return methods, Payback time.

Financial Accounting: Journal, Trial Balance, Trading and Profit & Loss Account and Balance Sheet.

Cost Accounting and Finance: Financial control ratio analysis and their interpretation for industrial control, Budget and budgetary control.

PART II

Fundamental concepts of management. objectives, classification and hierarchy. Management thoughts. Taylorism; Factory system of production, Introduction to management problems.

Types of business ownership, means of finance and business combinations, organization structures, committee organization, authority and responsibility, duty and span of control. Plant location, plant layout, tools and techniques of plant layout, materials - handling arrangements, vendor management.

Product development. 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.

Human relations in industry and labor compensation. Personnel management. Wage and salary administrations. Industrial Laws. Welfare and safety provisions, trade union acts. Environmental impacts.

Reference Books:

1. Production and operations management: S.N.Chari
2. " Industrial Management" by: Basu & Majmundar (Birla Pub., Newdelhi)
3. " Quantitative techniques in management" by: N.D.Vohra (Tata Mcgraw Hill)
4. "Production systems analysis and control" by : Riggs
5. "Works organization and management by: Basu, Sahoo & Dutta.

(EE/T/422) ELECTIVE PAPER– II

(EE/T/422A) Advanced Control Theory

Part - I

Robust Control Systems and System sensitivity. Stability of systems with uncertain parameters. Internal Stability. Kharitonov's methodology. Structured and Unstructured uncertainty. Performance robustness of Control Systems. Robust Tracking. H2 and H-infinity Control. H-Infinity Loop Shaping. Mu-Synthesis. Linear Matrix Inequalities (LMI). Quantitative Feedback Theory (QFT).

Part – II

Review of Non-linear systems. Phase plane method. Construction of phase Trajectories. System Analysis on phase plane. Optimal switching in Bang-Bang Control Systems. Lyapunov method of Stability Analysis. Popov's Circle Criterion. Case study in nonlinear Control. Feedback Linearization. Sliding Mode Control. Performance Analysis of Systems with Dead-time elements.

Reference Books:

1. Kemin Zhou and John C. Doyle, Essentials of Robust Control, Prentice Hall, 1999.
2. John Doyle, Bruce Francis, and Allen Tannenbaum, Feedback Control Theory, Macmillan Publishing Co., 1990.
3. Jean-Jacques E Slotine and Weiping Li, Applied Nonlinear Control, Prentice Hall, 1991.
4. Hassan K. Khalil, Nonlinear systems, 3rd edition, Prentice Hall, 2002.
5. Anand and Zmood, Introduction to Control Systems, 3rd edition, Butterworth-Heinemann Ltd., 1995.

(EE/T/422B) High Voltage Technique – II

Earthing system, electromagnetic shielding and protective fencing. Multistage impulse generator: Practical implementation of charging, multiplier and waveshaping stages. Triggering techniques: conventional and modern methods. Measurement of high voltages: voltage dividers, electrostatic voltmeters and impulse peak voltmeters. Measurement of impulse voltage: Klydanograph and computer based recording of impulse waveshape. Measurement of impulse current: Surge crest ammeter. High voltage Schering bridge. Over voltage phenomena. Ground wires and methods of lightning protection system.

Insulation Coordination: Insulation level (BIL & SIL), Statistical approach to insulation coordination, Correlation between insulation and protection levels. Laboratory high voltage testing procedure: Power frequency HV testing, Lightning impulse voltage testing. Transient Analysis: Electromagnetic transients by EMTP, Ferroresonance, Impulse Voltage distribution in transformer windings.

Reference Books:

1. High Voltage Engineering Edited by Alston

2. Insulation Coordination in high voltage electric power systems by W. Diesendorf
3. An introduction to high voltage experimental technique by Dieter Kind
4. Extra high voltage ac transmission engineering by R.D. Begamudre

(EE/T/422C) Advanced Electrical Machine Modelling & Analysis

PART – I

Energy conversion principle in single excited magnetic system and multiply excited magnetic system. Dynamic equation of magnetic systems – analytic techniques.

Space Vectors and its application to the analysis of electric machines, specially of induction motors.

Transient analysis of dc and ac Machines.

Motor behavior under asymmetrical supply voltages. Analysis of 3-phase induction motor with ac phase controlled supply.

Application of Simulation tools to machine analysis.

PART – II

Generalised theory of machines.

Principle of Vector decoupled control.

Motors problems associated with non-ideal power supplies from converter. Commutation problem and core loss in dc motors. Harmonic effects on induction motors – harmonic equivalent circuit, harmonic losses and harmonic torques.

Reference Books:

1. Power Electronic Control of AC Motors :J.M.D. Murphy, F.G. Turnbull
2. Modern Power Electronics and AC Drives: B.K. Bose
3. Analysis of Electric Machinery and Drive systems: Krause, Wasynezuk & Sudhoff
4. Transient Phenomena in Electrical machines: Paul K. Kovacs

5. Electric machinery: Fitzgerald & Kingsley

(EE/T/422D) Advanced Instrumentation-II

Introduction to non-destructive testing (NDT). NDT methods – liquid penetrant (LP) testing, eddy current (ET) testing, magnetic particle testing (MT), radiographic testing (RT), acoustic emission testing (AET), ultrasonic testing (UT). Applications.

Introduction to microelectromechanical systems (MEMS). Materials for MEMS: silicon compatible materials, other materials and substrates, material properties and physical effects. Processes for micromachining: bulk and surface micromachining. Basic fabrication process tools: epitaxy, oxidation, sputter deposition, evaporation, chemical vapor deposition, spin-on, lithography, LIGA, etching (dry, wet and DRIE etching). Design methods of MEMS structures in industrial applications, MEMS packaging.

Electrical tomographic techniques: introduction to EIT, concepts of ERT, ECT and eddy current tomography.

State-space design methods: concepts of controllability and observability, concepts of duality. Pole placement controllers. State observers.

Introduction to Kalman Filter. Discrete Kalman filter: Kalman filter gain, discrete Kalman filter algorithm, extended Kalman filter, sigma-point Kalman filter. Applications of Kalman filter in instrumentation domain.

Linear prediction and optimum filtering. Forward and backward linear prediction. Wiener filtering theory: discrete Wiener filter, discrete Wiener-Hopf equation.

Adaptive digital filters. Adaptive noise cancellors. Development of the adaptive algorithm using the method of steepest descent. The Widrow-Hoff least mean square (LMS) algorithm. Performance analysis of LMS method. Modified LMS algorithms. The recursive least square (RLS) algorithm. Recursive formulations. Comparison of LMS and RLS algorithms. Applications of adaptive digital filters.

Image enhancement and filtering: spatial domain approach and frequency domain approach. Point processing techniques: contrast stretching, gray level slicing, bit plane slicing, histogram processing. Spatial filtering: low pass filtering, median filtering, high pass filtering. Derivative filters employing gradient and Laplacian. Unsharp masking and high boost filtering. Two dimensional DFT and convolution. Frequency domain based ideal, Butterworth, and Gaussian low pass and high pass filters. High frequency emphasis filtering. Homomorphic filtering.

Image segmentation techniques. Discontinuity based and similarity based approaches. Point detection, line detection, and edge detection. Edge linking and boundary detection. Hough transform. Thresholding technique.

Introduction to digital control: direct synthesis method. Dead beat controller. Dahlin controller. Predictive controllers: single step design, model following design. Control weighting design.

Introduction to model predictive control (MPC) and internal model control (IMC).

Variable structure control (VSC): concept of switching surface, design of switching surface and switching control law. Design of sliding surface using method of equivalent control. Design of the controller by diagonalization method. Phenomenon of chattering. Concept of boundary layer and the continuation approach. Switching characteristic: ideal and practical relay control and saturation control.

An introduction to fuzzy control. Importance of fuzzy control. Fuzzy controllers in continuous time and discrete time systems. Design of discrete time fuzzy-PI and fuzzy-PD controllers.

Reference Books:

1. Digital Signal Processing: Proakis and Manolakis
2. Digital Image Processing: Gonzalez and Woods
3. Industrial Digital Control: Warwick and Rees
4. Modern Control Engineering: Ogata
5. Random Processes and Kalman Filtering: Brown and Hwang
6. Kalman Filtering: Theory and Practice using MATLAB: Grewal and Andrews
7. Practical Non-Destructive Testing: Baldev Raj, T. Jaykumar and M. Thavasimuthu
8. An Introduction to Micro-electromechanical Systems Engineering: Maluf and Williams
9. An Introduction to Fuzzy Control: Driankov, Hellendoorn, and Reinfrank
10. Systems and Control: Stanislaw Zak

(EE/T/422E) Advanced Topics In Power Systems

HVDC Operation and control : Review of HVDC converter operation, CIA. CC and CEA control characteristics.

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. Harmonic flow analysis. Power quality issues – Voltage sag, swell & interruptions, Voltage sag analysis and remedial measures.

Computer aided operation and control of Power Systems--- Concept of Energy Control Center, introduction to SCADA and EMS. Introduction to state estimation and security analysis.

Power system operation under deregulated environment.

Reference Books:

1. HVDC Power Transmission Systems – Technology & System Interaction by K.R.Padiyar, Willey Eastern
2. High Voltage Direct Current Transmission, J.Arrillaga, Peter Peregrinus Ltd.
3. Power System Protection by S.P.Patra, S.K.Basu, S.Choudhuri, Oxford & IBH
4. Power System Harmonic Analysis, by J.Arrillaga, B.Smith, N.R.Watson, A.R.Wood,John Willey
5. Direct Current Transmission, by E.W.Kimbark, Wiley Interscience
6. Understanding Facts, by N.G.Hingorani & L.Guygyi, IEEE Press
7. Computer Aided Power System Analysis, by G.L.Kusic, Prentice Hall of India
8. Power System Stability and Control by P. Kundur, McGraw Hill
9. Power System Stability Operation and Control by A. Chakrabarti and Sunita Halder, PHI Learning System.
10. Understanding Power Quality Problems by Math H. J.Bolen
11. Electrical Power Systems Quality by R. C. Dugan, M. F. McGranaghan, S. Santoso and H. W. Beaty, McGraw Hill

(EE/T/422F) Advanced Lighting Design

PART – I

Indoor lighting– zonal cavity method for general lighting design - CU determination for zonal cavities and different shaped ceilings. Bureau of Indian Standard (BIS)/National Lighting Code (NLC) for different indoor applications; selection criteria of lamps and luminaire, design considerations and design procedure.
Daylighting – characteristics and features of daylight; sky models – Indian clear sky, CIE standard general skies; daylighting concepts-sidelighting, toplighting; window design formula by Daylight Factor method; physical scale modeling of daylighting system, daylight linked artificial lighting.
Quality and quantity assessment of lighting systems – BIS recommendation of lux level; factors affecting the required quantity; evaluating the quantity of illuminance; procedures of field measurements; quality of illuminance – discomfort & disability glare – evaluation method, veiling reflection, Visual Comfort Probability (VCP).
Emergency lighting:– escape lighting, standby lighting; maintained & non-maintained lighting systems – transport lighting.

PART – II

Roadlighting – road classifications according to BIS, pole arrangements, terminology, lamp & luminaire selection, different design procedures – beam lumen method, point-by-

point method, isolux diagram method; tunnel lighting; NLC recommendations; glare assessment-Threshold Increment, Glare Control Mark.
Floodlighting- selection of floodlights-NEMA classifications, design procedure; mast/pole selection and layout; lamp & luminaire selection and aiming. NLC, CIE and IESNA recommendations; glare assessment-GR,
Sportslighting- special lighting requirements for football, cricket, badminton ground – NLC, CIE recommendations, lamp & luminaire selection, design considerations and design procedure.
Computer application in lighting design – indoor general lighting design, roadlighting design, area lighting design, plotting of isolux diagram.
Lighting energy management and economics – lighting power budget; lighting power limit; evaluation of existing system; retrofitting of lighting systems; different options for consideration; components of cost and savings; simple payback analysis; life cycle cost analysis.

Reference Books:

1. National Lighting Code 2010.
2. Lamps and Lighting – Edited by J.R.Coaton and A.M.Marsden, 4th Edition
3. Lighting for energy efficient luminous environments- Ronald N.Helms & M Clay Belcher.
4. Applied Illumination Engineering, Second Edition, Jack L Lindsey
5. Interior Lighting – J B de Boer and D Fischer
6. Road lighting – W J M van Bommel & J B de Boer
7. Energy Management in Illumination Systems – Kao Chen

(EE/T/423) SPECIAL PAPER - I

(EE/T/423A) Nonlinear And Optimal Control

Part I: Nonlinear Control

Nonlinear Models and Nonlinear Phenomena, Examples of nonlinear systems, Pendulum, Mass-Spring System, Negative-Resistance Oscillator, Hydraulic & Pneumatic Systems, Gear-Train etc., Common Nonlinearities, Some Common Nonlinear System Behaviors.

Nonlinear System Analysis: Concepts of Phase Plane Analysis, Phase Portraits, Singular Points, Symmetry in Phase Plane Portraits, Construction of Phase Portraits, Phase Plane Analysis of Linear and Nonlinear Systems, Existence of Limit Cycles,

Describing Function Fundamentals, Computation of Describing Functions, Describing Function Analysis of Common Nonlinearities, The Nyquist Criterion and Its Extension, Existence of Limit Cycles, Stability of Limit Cycles, Reliability of Describing Function Analysis.

Stability Analysis of Nonlinear Systems: Lyapunov's First Method, Lyapunov's Second Method, Lyapunov Analysis of Linear and Nonlinear Systems, Concepts of Stability for Non-Autonomous Systems, Lyapunov Analysis of Non-Autonomous Systems, Linearization Method for Non-Autonomous Systems.

Nonlinear Control System Design: Control Design Based on Lyapunov's Method, Feedback Linearization, Backstepping, Variable Structure Control with Overview of Sliding Control.

Part II: Optimal Control

Introduction to Optimal Control, Formulation of Optimal Control Problem, Characteristics of Plant, Minimum-Time Problem, Minimum-Energy Problem, Minimum-Fuel Problem, State Regulator Problem, Output Regulator Problem, Tracking Problem.

Overview of Calculus of Variations, Minimization of Functions, Minimization of Functionals, Overview of some Computing Tools: Steepest Descent Method, Fletcher-Powell Method.

The Regulator Problem: Review of Regulator Problem, The Hamilton-Jacobi Equation, Discrete-Time Linear State Regulator, Continuous-Time Linear State Regulator, Time-Invariant Linear State Regulator, Numerical Solution of Riccati Equation, Linear Regulator with a Prescribed Degree of Stability, Quadratic Weight Selection for Single Input System.

Tracking Control Scheme: The Problem of Achieving a Desired Trajectory, Finite-Time Results, Infinite-Time Results.

Properties of Regulator Systems with a Classical Control Interpretation: The Regulator from an Engineering Viewpoint, Some Classical Control Ideas: Sensitivity, Complementary Sensitivity, and Robustness, Gain Margin, Phase Margin, and Time-Delay Tolerance, Insertion of Nonlinearities, Overview of The Inverse Optimal Control Problem.

Reference Books:

1. J. E. Slotine & W. Li, *Applied Nonlinear Control*, PH International.
2. H. K. Khalil, *Nonlinear Systems,* PH.
3. M. Gopal, *Modern Control System Theory*, Wiley Eastern Limitad.
4. Brian D. O. Anderson and John B. Moore, *Optimal Control: Linear Quadratic Methods*, PH.
5. Donald E. Kirk, *Optimal Control theory – An Introduction.*
6. Stanislaw h. Zak, *Systems and Control*.

(EE/T/423B) Condition Monitoring Of Electrical System

Failure mode of electrical machines, Reliability of machines and typical tests, Instrumentation and signal processing requirement, Temperature monitoring, Chemical monitoring, vibration monitoring, Electrical techniques for current, flux and power monitoring, power transformer condition monitoring and assessment for strategic benefits. Application for AI techniques. Condition based maintenance and asset management, condition monitoring of Motor using electrical signature, Essential elements of electrical cable condition monitoring program, conditioning monitoring system of solar power plant using WEB base wireless sensors, failure modes and root cause analysis of electrical machines.

Potential cost benefits of plants, Remote monitoring of Electrical Plant, High voltage maintenance and safety, Plant insulation condition monitoring, Machines protection system, Plant monitoring by using Thermography, hydro electric power plant – on line condition system, Operation and maintenance of wind farms, condition monitoring through Non destructive testing on plant.

Maintenance Strategies: corrective maintenance, Time-based maintenance, condition based maintenance, Reliability centered maintenance.

Insulation Diagnostic Tests: Insulation resistance Test (IR), Polarization Index Test (PI), Step Voltage test, Surge Voltage Test, Power Frequency Over- Voltage Test, Partial discharge test.

Condition Monitoring of Transformers: Dissolved gas Analysis, Degree of Polarization Test, Furan Analysis. Dielectric Response Techniques in Time-Domain: Polarization and Depolarization current measurement (PDC), Recovery voltage measurement (RVM). Dielectric response Techniques in Frequency- Domain: Frequency domain spectroscopy (FDS), Sweep frequency response analysis (SFRA).

Condition Monitoring of Switchgears: Contact monitoring, Thermography, Vibration analysis, SF6 gas monitoring, Accessories monitoring.

Reference Books:

1. Condition Monitoring of Rotating Electrical Machines:- Peter Tavner, Li Ran, Jin man & Haward Shedding
2. Hand Book of Condition Monitoring – B. K. N. Rao
3. Hand Book of Condition Monitoring Techniques and Methodology – A Davis.

(EE/T/423C) Reliability Engineering

Reliability Function; Repairable and Non-repairable Systems; Markov modeling; Two state models; Series , parallel and composite systems ; MTTF, MTTR, MTBF.

Generating unit unavailability; Capacity outage probability tables; Comparison of deterministic and probabilistic criteria; Recursive algorithm for capacity model building; Recursive algorithm for unit removal.

Loss of load indices (LOLE computation); Loss of energy indices (LOEE and EIR computation).

Frequency and duration method for generating capacity evaluation; State space diagram of frequency and duration method.

Reliability of Substation- Active and passive failures; Stuck condition of breakers; Effect of failure modes; Simulation of failure modes; Evaluation of reliability indices.

Reliability of Distribution systems - Customer oriented indices; Load and energy oriented indices; Application to radial systems; Effect of lateral distribution protection; Effect of disconnectors; Effect of protection failures; Method of network reduction; Temporary and transient outages; Inclusion of weather effects; Stochastic approach.

Reliability definitions and concepts. Reliability indices and criteria: failure distribution function, reliability function, hazard function, *a posteriori* failure distribution. Probability distributions in reliability evaluation: Uniform, Gaussian, Exponential, Weibull, Gamma, Lognormal, Rayleigh, Binomial and Poisson. System reliability evaluation using probability distributions: Series systems, Parallel systems, partially redundant systems, standby systems. Reliability and Availability of Repairable Systems: Renewal Processes and Alternating Renewal Processes.

Life testing: Sequential testing (type-I censored data), Simultaneous testing (type-II censored data).

Reliability of electronic components: Resistors, Capacitors, and Semiconductor Devices.

Failure mechanisms. Accelerated life testing of electronic components, reliability prediction.

Reliability of Measurement Systems.

Software Reliability - Software failure modes; Structured programs; Program checking & testing; Software reliability statistics.

Reference Books:

1. Roy Billinton and Ronald N. Allan-- Reliability Evaluation of Engineering Systems.
2. Roy Billinton and Ronald N. Allan -- Reliability Evaluation of Power Systems.

3. Patrick D.T. & O'Connor-- Practical Reliability Engineering.
4. Allesandro Birolini-- Reliability Engineering.

(EE/T/423D) Energy Systems

Energy Resources in general, present scenario, Energy consumption and acts, Environmental aspects of Thermal, Nuclear and hydroelectric power generation, types of emission from various sectors, co-relation between emission & pollution. Kyoto protocol, and carbon credit etc. Energy audit: primary and detail auditing.

Energy management: Demand side management (DSM) and Supply side management (SSM), Supply side management through energy price control, Smart Grid – functions, features and technologies. The role of Reactive power management.

Distributed generation (DG) and Microgrids: - features of distributed generations, technical issues of DG connection at distribution voltage level. Composition of Microgrid.

Renewable energy resources: Solar- solar thermal, solar PV, wind energy- prospects and status in national and global context, principles of wind energy conversion, wind monitoring system, VAWT and HAWT, selection of site for WTGS. Geothermal, Tidal, Bioenergy- Biomass and bio gas with gasifiers etc. fuel cell. Mini and micro hydel power plant, micro turbine.

Energy storage and conservation:- Types and methods of energy storage, Energy storage setups like Chemical, Thermal, Magnetic, fly wheel storage etc. Energy conservation - Concept of co-generation, combined heat and power (CHP).

Reference Books:

1. Energy Management Handbook (6th ed. 2007) – by Wayne C. Turner & Steve Doty, the Fairmont Press, Inc.
2. Guide to energy management, 6th Ed., - by Barney L. Capehart, Wayne C. Turner, William J. Kennedy, The Fairmont Press, Inc.
3. Power Station Engineering and Economics – Skortzki, B. G. A. and Vopat W. A. McGraw Hill, NewYork.
4. Solar Energy Engg - Sayigh A. A. M - Academic Press.
5. Demand Side Management planning - Gelling C W et al. Fairmount Press, Lilbum, U S A.
6. Generation of Electrical Energy – B. R. Gupta, Eurasia Publishing House (Pvt) Ltd.

7. Non-Conventional Energy resources - D. S. Chauhan, S. K. Srivastava – New Age International Publishing.
8. Sun Power - J. C. McVeigh – Brighton Polytechnic, England.

(EE/T/424) SPECIAL PAPER – II

(EE/T/424A) Advanced Computing Techniques

Numerical solutions of Boundary Value problems: Finite Difference Method – derivation of FDM equations from Tailor series in three dimensional single and 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. Generalised function estimation techniques: Artificial Neural Networks – Perceptron, supervised and unsupervised learning, multilayer feed-forward network, error back propagation, resilient propagation, Kohonen's self-organizing map. Fuzzy Systems – Properties of fuzzy sets, fuzzy membership function, knowledge base, inference engine, defuzzyfication. Fuzzy inferencing systems, introduction to neuro-fuzzy systems.

Classical optimization techniques: Non linear programming: Necessary and sufficient conditions for optimality, convexity, Lagrangian multiplier method, KKT condition for optimality, non-linear programming algorithms, direction vector, Steepest descent method, Newton's method, Quasi Newton's methods, direct search methods. Introduction to constrained optimization problem. Linear Programming: LP problem, Simplex Algorithm, two phase method. Integer Programming: Branch and bound algorithm. Stochastic optimization techniques: Genetic Algorithms – Concept of chromosome, reproduction, Crossover & mutation, fitness function. Real coded Genetic Algorithms. Simulated Annealing technique – Annealing in metal crystalization, Boltzman distribution, Initial temparature, cooling rate, metropolis algorithm.

Reference Books:

1. Neural Networks – A Comprehensive Foundation, by Simon Haykin, Pearson education

2. Understanding Neural Network and Fuzzy Logic, by Stamatios V. Kartalopoulos, IEEE Press.
3. Fuzzy Logic with Engineering Applications, by T.J.Ross, McGraw Hill
4. Optimization Theory and Application by S.S.Rao, Wiley Eastern
5. Optimization Concepts and Applications in Engineering, by A.D.Belegundu & T.R.Chandrupatla, Pearson education
6. Genetic Algorithm in Search Optimization and Machine Learning, by D.E.Goldberg, Pearson Education

7. Simulated Annealing: Theory and Applications, by P.J.M. Van Laarhoven & E.H.L.Aarts, Kluwer Academic Publishers
1. Finite Elements for Electrical Engineers, by P. P. Silvester & R. L. Ferrari, Cambridge University Press.

(EE/T/424B) Introduction to Nano-Bio Technology

Introduction to Nanotechnology: Nanoscale dimension, Nanoscale forces, Nanoscale paradigm. Nanostructures and nanomaterials: Carbon structures and materials, Carbon nanotubes (CNT and MWNT), Organometallic compounds, Silicon structures and materials- Semiconduction, Metals and high performance alloys, Glasses and ceramics. Materials characterization tools: Atomic Force microscopy, Fluorescence microscopy, Electron Microscopy.

Semiconductor and Nanoelectronics devices: overview, Moore's Law and silicon devices, Molecular computing, Quantum effects / tunneling, Quantum devices and computing.

Nano Fabrication Techniques: Bottom-up and top-down approaches, MEMS fabrication & integration, Self-assembly, DNA arrays and templating.

Nanobiotechnology: Nano-Bio convergence, Applications of DNA microarrays-GeneChip, SNP, and protein arrays; Application of Self assembly-Protein assembly, DNA assembly / templating; Digital cells- Insilico devices, Genetic circuits. DNA computing, Synthetic Biology, Bioelectronic circuits & sensors.

Applications: Virus Detection, Radiation/Chemotherapy, Neurological functions of the brain, Biomedical engineering research.

Reference Books:

1. Nanotechnology: A Gentle Introduction to the Next Big Idea. Mark Ratner, Daniel Ratner. 2003. Pearson Education, Inc.
2. Nano Technology : Basic Science To Emerging Technology by Shalini Suri, Aph Publishing Corporation (2006)
3. NanoBioTechnology: BioInspired Devices And Materials Of The Future by Oded Shoseyov, Ilan Levy, Humana Press (2007)

(EE/T/424C) Principles Of Software Engineering

Part I

The Product: Introduction, Definition of Software,The evolving role of Software, Software characteristics, Software components, Software applications, Software myths, Software crisis, Summary

Software Process and Project Planning: Introduction, Software Engineering-The Discipline & Definitions, Software Engineering-A layered technolog: Process, Methods & Tools, Generic view of Software Engineering, The Software Process, CMM, Software Process Production Models: Sequential Models,Build & Fix,Incremental,Rapid Prototyping, Waterfall, Spiral Model, The Concurrent Development Model, The Fourth Generation Model, Summary

Software Project Planning & Estimation: Project Planning, Milestones & Deliverables, Project Scheduling, -Bar Charts & activity network, Risk Management, Configuration Management, Independent Verification & Validation, Software Estimation Techniques-COCOMO Model, -The Software Equation, - Estimating Software Maintenance Cost , Summary

Software Quality Assurance (SQA): Introduction to QA and Planning, Software Quality Assurance & Standards- Documentation Standards,. Process & Product Quality, Quality Planning, Quality Control- Quality Reviews, Software Measurements & Metrics- The Measurement Process, Product Metrics, Analysis of Measurements, Statistical Quality Assurance, Software Testing - Software Safety & Hazard Analysis, The SQA Plan, The ISO 9000 Quality Standard- The ISO Approach to QA Systems, The ISO 9001 Standard, Summary

Real-Time Software Design: System Considerations, Real-Time Systems - Integration & Performance Issues, Interrupt Handling, Real-Time Databases, Real-Time Operating Systems-Executives Real-Time Languages, Task Synchronization Communication, Case Study- Data Acquisition System, Summary

Part II

Requirements Engineering: Ward & Mellor methodology,Requirement Analysis, Requirement Elicitation, Requirement Validation,Generation of Software Requirement Specifications ,Formal Specification Techniques, State-Oriented Notations - State Chart, Mode Chart, Petri-Nets, Object-Oriented Notations- Use Case, UML, A Case Study, Summary

Software Design: Fundamental Design Concepts -Abstraction - Information Hiding - Modularity - Concurrency, Modules & Modularization Criteria- Top-Down & Bottom-up Approach- Coupling & Cohesion, Structured Analysis & Design Techniques (SADT), Data Model - Data Dictionary - ERD (Entity-Relationship Diagram), Environmental Model - Context Diagram - Event List, Functional Model- Data flow diagram (DFD) - PSPEC (Process Specification), Behavioral Model- State Transition Diagram (STD) - CSPEC (Control Specification), Summary

Distributed System Architectures: Case Study: Introduction to Client/Server systems, The Structure of C/S systems- Software Components for C/S systems - Distribution of Software Components - Linking C/S Software components - Middleware & Object Request Broker Architectures, Software Engineering for C/S Systems, Analysis

Modeling Issues, Designs for C/S Systems-Conventional design approaches, Database design, Process design iteration, Testing Issues- Overall C/S Testing Strategy- Process Design Techniques,Summary

Reference Books

1. R.S. Pressman, Software Engineering- A Practitioner's Approach, Fourth Edition, McGRAW-HILL International Editions, 1997.
2. Richard Fairley, Software Engineering Concepts, Tata-McGRAW-HILL Edition, 1997.
3. I. Sommerville, Software Engineering, Sixth Edition, Pearson Education, 2004.
4. S. Goldsmith
5. Philip A. Laplante, Real-Time Systems Design and Analysis, Third Edition, Wiley-India, 2007.

(EE/T/424D) Bio-Medical Instrumentation

Components of Man-Instrument system

Measurement of Electrical potentials and Magnetic Fields from the Body surface. Electrodes; Half-Cell Potential; Equivalent Circuits

Biopotential amplifiers; Medical isolation amplifiers; Driven-Leg ECG amplifiers

The ECG: Electrode placement; Vector cardiography; Feature extraction.

The EMG. The EEG; Event related potentials. Other body surface potentials; EOG; Electroretinogram.

Sensors commonly encountered in biomedical applications: Pressure measurements – blood pressure measurements. Electro-chemical sensors – noninvasive blood gas sensing with electrodes. Optical sensors – Pulse Oximetry

Plethysmography; volume displacement; impedance. Pulmonary Function Tests.

Ultrasound - Doppler U/S for blood and tissue velocity measurements.

Stimulation of excitable tissues; Cardiac pacing and defibrillation.

Biometrics

Biotelemetry

Digital Interfaces in measurement systems. Patient care monitoring unit. Networking. Medical Transcription. Internet based monitoring.

Tomographic Techniques: X-Ray/ CT scan, MRI, Beta-gamma scanning.

Heart-lung machine.

Dialyzer.

Bioelectric Signal Processing.

Reference Books:

1. Introduction to Instrumentation and Measurements; Second Edition; Robert B Northrop; Taylor and Francis;
2. Noninvasive Instrumentation and Measurement in Medical Diagnosis; Robert N. Northrop; CRC press.
3. Biomedical Instrumentation and Measurements, Second Edition, L. Cromwell, F.J. Weibel and E.A. Pfeiffer, Pearson
4. Handbook of Biomedical Instrumentation, R.S. Khanpur

(EE/S/421) E.E. LABORATORY – VI

Selected Experiments in Electrical Machines, Control Systems, Power Systems, High Voltage and Measurements & Instrumentation Laboratories.

(EE/S/422) ELECTIVE PROJECT AND COMPUTATION – II

(EE/S/423) SEMINAR – II

(EE/S/424) POWER ELECTRONICS DESIGN

Design of 1-phase and 3-phase rectifiers and inverters. Design of choppers, dc/dc converters and ac phase controllers. Design of related magnetic and filter circuits. Design of relay and servo stabilizers. Design of the control hardware and software for power electronic circuits. Design of interface between control and power section. Application of SPICE, MATLAB or other simulation software to power electronic circuit simulation.

Reference Books:

1. N. Mohan, T.M. Undeland & W.P. Robbins, “Power Electronics”, John Wiley & Sons.
2. P.C. Sen, “Power Electronics”, Tata McGraw-Hill Publishing Co. Ltd.

Theory – 14 pds. Sessional- 12 pds. TOTAL- 26 pds.