Semester-1

EED-113   **BASIC ELECTRICAL ENGINEERING**   **L T P**
                                                                3 1 3

Electric Circuits
Introduction to linear and non-linear circuits, circuit elements, various sources and source transformation, star delta transformation, solution of D.C. circuits using Kirchoff's laws, signal wave forms and passive elements specifications, basic theorems, generation of A.C. sinusoidal voltage and currents, average and r.m.s. values, Form factor and peak factor, phasor representation, phasor in polar, rectangular and exponential forms, terminal relationship for pure passive elements and their combination in series and parallel.
Analysis of single phase series, parallel and series-parallel circuits. Active and reactive power, p.f. and volt-ampares, frequency response and Q-factor. Analysis of balanced three phase a.c. circuits - Introductory concept, voltage, current and power in three phase balanced circuits.
Introduction to Domestic Electric Wiring and Storage Batteries.

Electromagnetic and Transformer
Magnetic circuit concept, B-H curves characteristics of magnetic materials, practical magnetic circuits, magnetic circuits with D.C. and A.C. excitation, hysteresis and eddy current losses.
Magnetic force, self and mutual inductances, Faraday`s laws, Lenz`s Law, statically and dynamically induced emfs, energy stored in magnetic fields. Principle of Transformer operation, construction & equivalent circuit of transformer.

Measuring Instruments
Introduction to galvanometer (Moving coil and moving iron), ammeter, voltmeter, wattmeter, energy meter, use of shunt and multiplier.

Electrical Machines
Fundamentals of D.C. and A.C. machines.

BOOKS/REFERENCES:

1) Fundamentals of Electric Circuits by Charles K Alexander and Matthew N. O. Sadiku, TMH Publication, 2nd Edition, 2009.
2) Electrical Engineering Fundamentals by Vincent Del Toro, PHI Publication, Second Edition
3) Electrical Technology by H Cotton, CBS Publishers and Distributors,7th Edition, 2005
4) Basic Electrical Technology by A.E. Fitzgerald, McGraw Hill Publication

Semester-2

EED-124   ELECTRICAL ENGINEERING MATERIALS   L T P
3 1 0

Atoms and aggregates of atoms: Introduction to electron configuration of atoms, quantum numbers, Energy bands in solids, chemical bonding in solids.

Dielectric properties of insulators: Dielectric properties in static field, atomic interpretation of dielectric constant of monoatomic gases, qualitative remarks on the dielectric constant of polyatomic molecules, internal field in solids and liquids, ferroelectric materials, spontaneous polarization, piezoelectricity, behavior of dielectrics in alternating fields, frequency dependence of the electronic and ionic polarizability, complex dielectric constant of non dipolar solids, dipolar relaxation, dielectric losses.

Magnetic properties of materials: Introduction, magnetization from a macroscopic viewpoint, orbital magnetic dipole moment and angular momentum of simple atomic models, induced dipole moments, detailed classification of magnetic materials, spontaneous magnetization and Curie-Weiss law, ferromagnetic domains and coercive force, antiferromagnetic materials, ferrimagnetic materials.

The conductivity of metals: Introduction, relaxation time, collision time and mean free path, electron scattering and the resistivity of metals, heat developed in a current carrying conductor, thermal conductivity of metals, superconductivity, effect of frequency and magnetic field on superconductivity and applications.

Semiconductor materials: classification, chemical bond in Si and Ge and its consequences, conductivity of intrinsic semiconductors, carrier densities in n-type semiconductors, p-type semiconductors, Hall effect and carrier density, carrier densities in semiconductors, drift currents and diffusion currents, the Einstein relation, n-p junction rectifier, thickness and capacitance of the junction barrier, n-p-n junction transistor.

References:
1. Electrical engineering materials by A.J.Dekker ; P.H.I.
2. Electrical engineering materials by Seth and Gupta; Danpat Rai and Sons

Semester-3

EED-212 **NETWORK ANALYSIS** **L T P**
                                      3 1 3

Introduction
Review of circuit analysis using nodal and mesh analysis, solution by classical method and Laplace transform, analysis of special signal waveforms, duality of networks. Network theorems - Superposition and Reciprocity theorem, Thevenin's and Norton's theorem, Millman's theorem, maximum power transfer theorem, compensation, Tellegan's theorem, analysis of circuits using theorems.

Transient Analysis of Networks
Network elements, Transient response of R-L, R-C, R-L-C for DC and sinusoidal excitation, Initial condition, Solution using differential equation approach and Laplace transform method.

Coupled Circuit
Self inductance, Coefficient of coupling, dot convention analysis of coupled circuits, analysis of single tuned & double tuned circuits.

Network Functions
Introduction, driving point and transfer functions, poles & zeros and their significance, network functions for one port and two port networks, time domain behavior from the pole-zero plot.

Two-Port Network
Introduction, different parameters and relationship between different parameters, inter-connections of two port networks, open circuit and short-circuit impedances and ABCD constants, image impedance, image parameters.

BOOKS/REFERENCES:

1) Network and Systems by D. Roy Chowdhury,Wiley Eastern
2) Engineering Circuit Analysis by W. H. Hayt and J.E. Kemmerly, McGraw Hill
3) A Course in Electrical Circuit Analysis by M. L. Soni and J.C. Gupta, Dhanpat Rai & Sons
4) Network Analysis by Van Valkenburg, Prentice Hall of India Pvt. Ltd., New Delhi,
5) Modern Network Synthesis by M. E. Van Vallkenburg, Wiley Eastern
6) Electronic devices and Circuit theory by R.L. Boylestad and L. Nashelesky, PHI

EED-213   DIGITAL ELECTRONICS & LOGIC DESIGN

L   T   P
3   1   3

Number system & Codes
Binary, Octal, Hexadecimal number systems and their interconversion, Binary Arithmetic (Addition, Subtraction, Multiplication and Division), Diminished radix and radix compliments, BCD codes, 8421 code, Excess-3 code, Gray code, error detection and correction, Hamming code.

Logic Gates, Boolean Algebra & Logic Families
Axiomatic definition of Boolean Algebra, Basic Theorems and properties of Boolean Algebra, Boolean Functions, Canonical and Standard forms, Digital Logic Gates. Various Logic Families like TTL and ECL etc., working and their characteristics, MOS and CMOS devices.

Combinational Logic Design
The map method, Two, Three, Four and Five variable maps, Sum of products and Product of Sums Simplification, NAND and NOR implementation, incompletely specified functions, Ex-OR functions, The tabulation method, Determination of Prime implicants, Selection of Essential Prime implicants, The cube notation, Sharp operation, Iterative Consensus, Generalized Consensus, Minimization of Multiple output switching functions, Determining Prime implicants using Generalized Consensus, Finding a Minimum cover, Breaking cyclic and similar structures.

MSI and PLD Components
Binary adder and subtractor, Multiplexers, Decoders / Demultiplexers, Read Only Memory, Programmable Logic Arrays, Programmable Array Logic. Implementation of Combinatorial Logic using these devices.

Synchronous Sequential Logic
Introduction, Flip-flops, Triggering of Flip-flops, Analysis of locked sequential circuits, state reduction and assignment, Flip-flop Excitation tables, Design procedures, Design of counters and registers, Hazards and Glitches, Race conditions, incompletely specified cases.

BOOKS/REFERENCES:

1) Digital Design by M. Morris Mano, Prentice Hall of India. 2003
2) Logic Design with Pascal by Thomas Downs and Mark F Schulz Van Nostrand Reinhold

EED-214   ELECTRICAL & ELECTRONIC MEASUREMENTS

L   T   P
3   1   3

Errors & Accuracy
Static error, Static calibration, Error calibration curve, Limiting errors, Relative limiting errors, Types of errors- Gross Errors, Systematic Errors, Random (Residual) Errors, Accuracy and precision, Static sensitivity, Linearity, Hysteresis, Threshold, Dead Time, Resolution of instrument, loading effects, Introduction to measurement standards.

Electrical & Magnetic Measurements
Introduction, D'Arsonval galvanometer, moving iron & moving coil instruments, Electrodynamometer, Electrostatic Instruments, Induction type energy-meter, wattmeter. Determination of B-H curve and Hysteresis loop.

Resistance Measurements
Methods of measurement of low, medium and high resistance, measurement of earth resistance, localization of cable faults by Murray and Varley loop test.

Inductance and capacitance Measurements
Measurement of inductance and capacitance by A.C. Bridge methods, Q-factor and dissipation factor. Sources of errors in bridge circuits, Shielding of bridge elements, Wagner Earthing Device.

Measurement of Power Factor and Frequency
Single phase, three phase Electrodynamometer type power factor meter. Moving iron Power factor meters, Types of frequency meter, mechanical resonance type, Electrical resonance type, Ratio meter type.

Potentiometers
Basic D.C. potentiometer circuit, Modern form of D.C. potentiometer, measurement of voltage, current, Resistance and calibration of voltmeter & ammeter using D.C. potentiometer, volt ratio box, A.C. potentiometers and their applications.

Instrument Transformers
Introduction, Use of Instrument transformers, Ratios, Basic constructional features of C.T.and P.T., ratio & phase angle errors, Reduction of Errors.

BOOKS/REFERENCES:

1) A Course of Electrical and Electronic Measurements and Instrumentation by A.K. Sawhney, Dhanpat Rai & Sons, 1993.
2) Electronic Instrumentation and Measurement Techniques by W.D. Cooper & A.D. Helfrick, Prentice-Hall India.
3) Electrical Measurement & Measuring Instruments by E.W. Golding, Wheeler Publishing, 5th Edition, 1994.

EED-215   ELECTROMAGNETIC FIELD THEORY

L   T   P
3   1   0

Introduction
Review of vector analysis: scalar & vector products: gradient, divergent and curl of a vector and their physical explanation-Transformation amongst rectangular, cylindrical and spherical co-ordinate systems.

Electrostatics
Coulomb's law, electric field intensity from point charges, field due to continuous distribution of charges, Gauss's law, Electric displacement and displacement density potential function, potential field of a point charge, Laplace's and Poison's equations.

Magnetostatics
Magnetic field intensity and magneto motive force, Ampere's Circuital law, Energy stored,Biot-Savart law, vector potential, magnetic dipole.

Time Dependent Fields
Ampere's work law in differential vector form, continuity of currents, conduction and displacement current. Maxwell's equations and their interpretations, boundary conditions. Wave equations, sinusoidal time varying fields, uniform plane wave in dielectric and conductor media, skin effect and depth of penetration, reflection and refraction of plane waves at boundaries for normal and oblique incidence surface impedance.

Energy Flow and Poynting Vector
Poynting's theorem, interpretation of E x H, simple application, complex poynting vector.

Guided Waves
(a) Transmission line theory from the circuit concept, properties; constants; transmission line equations; infinite line; reflections in transmission lines; voltage, current and impedance relations-open and short circuit lines; Experimental determination of line constants. Standing wave ratio; impedance matching, quarter and half wave lines, single stub and double stub matching; circle diagram - Smith chart.
(b) Waves between parallel planes: Transverse Electric waves, Transverse magnetic waves; characteristics of TE & TM waves; Transverse Electromagnetic waves; velocity of propagation; Attenuation in parallel plane guides; wave impedance.

BOOKS/REFERENCES:
1) Electromagnetic waves & Radiating systems, E. Jordan, Prentice-Hall, 1950.
2) Principle and applications of Electromagnetic fields by R.Plonsey and R.E.Collin,McGraw-Hill Book Co.,New York,1961
3) Applied Electromagnetics by M.A. Planus, Mc Graw-Hill Book Co,1978

Semester-4

EED-221   **ELECTRICAL MACHINES-I**

                                                                L   T   P
                                                                3   1   3

Transformers
Construction, Theory and operation, E.M.F. equation, phasor diagram, rating of transformers, equivalent circuit, open and short circuit tests, back to back test, voltage regulation and efficiency, auto-transformers, three winding transformer, parallel operation of single phase and three phase transformers, three phase transformer connections, phasor groups, three phase to two phase and six phase conversion, Harmonics and excitation phenomenon, inrush current phenomenon.

Basic Concepts of Rotating Electrical Machines
Constructional details of various rotating machines, Introduction to Lap and wave windings, EMF generation, Effect of chording and distribution of winding on EMF, Harmonics in generated emf, MMF produced by distributed winding.

Energy Conversion
Principle of electromechanical energy conversion, energy stored in a magnetic field system, singly and doubly excited systems.

DC Machines
Action of commutator, E.M.F. generated in armature, Torque in DC machines, Methods of excitation, armature reaction, MMF and flux density waveform of DC Machines, Commutation process, interpoles and compensating windings. Basic performance equations of DC machine. Magnetization and operating characteristics of DC generators and DC motors, DC motor starting and speed control, Ward Leonard system, losses and efficiency, applications of DC motors.

BOOKS:
1) Electrical Machinery by P.S. Bhimbra, Khanna Publishers, Delhi,7th Edition,2004
2) Electric Machinery by A.E.Fitzerald, C.Kingsley and S.D.Umans, Tata McGraw Hill,6th Edition, 2002
3) Theory of AC Machinery by A.S.Langsdorf, Tata McGraw Hill,2nd Edition,1955
4) Electrical Machines by Ashfaq Hussian, Dhanpat Rai & Company,2nd Edition,2002.
5) Electrical Machinery Fundamentals by S. J. Chapman, McGraw Hill,New York,2nd Edition,1991

EED-222   **POWER SYSTEM**

L   T   P
3   1   0

Introduction

Basic structure of power system, sources of electric energy: conventional and non-conventional; cogeneration, combined heat and power, captive power plants, distributed generation.

Load characteristics and economic aspects

Commonly used terms and factors, curves useful in system operation and planning, economics of power factor improvement, interconnection of power stations and tariffs.

Transmission Line parameters

Types of conductors, Ampere's law, inductance of a conductor, inductance of a single phase line, inductance of a three-phase line, inductance of three-phase double circuit line, bundled conductors, skin effect , proximity effect, Guy's theorem, Capacitance of single phase line, capacitance of a three-phase line, capacitance of double circuit three phase line, effect of earth on capacitance.

Transmission Line Performance

Classification of lines, models, circuit constants of transmission lines: short, medium and long lines; Ferranti effect, power flow through a line, sending and receiving end power circle diagram, reactive power generation/absorption of line, compensation and voltage control.

Insulators for overhead transmission lines

Types of insulators, ratings, voltage distribution across suspension insulators, string efficiency, methods to improve string efficiency.

Mechanical Design of transmission line

Calculation of sag and tension, equivalent span length and sag, effect of ice and wind loading, stringing chart, sag template, conductor vibrations and vibration dampers.

Corona and Radio interference

Critical voltages, corona loss, advantages and disadvantages of corona , factors affecting corona loss, effect of corona on line design, radio interference.

Insulated Cables

Cable conductors, insulating materials, insulation resistance, electrostatic stress in cables, grading of cables, capacitance of a three-core cable, dielectric loss, dielectric power factor, classification of cables.

Distribution System

Effect of voltage on transmission efficiency, Kelvin's law, radial and ring main distributors, interconnectors, methods of feeding distributors, ac distribution, three-phase, four wire distribution system, stepped and tapered mains.

 BOOKS/REFERENCES:

1) Electric Power systems by C.L. Wadhwa, New Age international, New Delhi,4th Edition,2006.
2) Electric Power generation transmission and distribution by S.N. Singh, Prentice-hall of India, Private Limited,New Delhi,2nd Edition,2008.
3) Electric Power Distribution System Engineering by Turan Gonen, McGraw Hill, New York 2nd Edition, 2007.
4) A course in Electrical Power by M.L.Soni, U.S.Bhatnagar and P.V.Gupta, Dhanpat Rai & Sons, New Delhi, 1963
5) Elements of Power System Analysis by W.B. Stevenson McGraw Hill,4th Edition, 1982
6) Power System Engineering by D.P. Kothari and I.J. Nagrath, Tata McGraw Hill, New Delhi, ,2nd Edition,2008.
7) Electric Power Systems by B.M.Weedy, 3rd Edition, John Wiley, London 1987
8) Electrical Power Systems by Ashfaq Hussain, 4th Edition CBS Publication
9) Power System Analysis by Hadi Saadat Tata Mc Graw Hill, New Delhi, 2nd Edition,2002.

EED-223   **POWER ELECTRONICS**

L   T   P
3   1   3

Characteristics of Various Solid State Devices
Power diode, Power transistor, MOSFET, Thyristor & its two transistor model, Triac, Gate turn off thyristor (GTO), insulated gate bipolar transistor (IGBT), comparison of switching power devices, turn on & turn off characteristics, driver circuits.

AC to DC Converters
Natural commutation, single phase and three phase bridge rectifiers, semicontrolled & fully controlled rectifiers, dual converters, effect of load and source inductance, inverter operation.

DC to DC Converters
Thyristor choppers, voltage, current and load commutation, step up and step down Choppers, basic principles of switch mode power supplies, buck, boost and buck-boost converters.

DC to AC Inverters
Voltage source inverters, single phase inverter, three phase inverter, harmonic reduction techniques and PWM techniques, current source inverter.

AC to AC Converters
Single phase & 3-phase AC voltage controllers using thyristors , phase control and integral cycle control, AC choppers, single phase cyclo-converters, applications, effects of harmonics & electromagnetic interference.

BOOKS/REFERENCES:

1) Modern Power Electronics by B.K.Bose, IEEE Press, New York,1992.
2) An Introduction to Thyristor and their applications by M.Ramamoorty, East West Press,New Delhi, 2nd Edition, 1997.
3) Power Electronics by P.S.Bhimbra, Khanna Publishers, Delhi, 4th Edition,2006.
4) Thyristorised Power Controllers by Dubey, Doradla, Joshi and Sinha, New age International Publishers, New Delhi, 1996.
5) Power Electronics-Circuits, Devices & Applications by M.H. Rashid, Pearson Education,3rd Edition, 2004

EED-224   MICROPROCESSOR ARCHITECTURE AND INTERFACING

	L	T	P
	3	1	3

Introduction to Microprocessors and Microcomputers

Evolution of microprocessors, Architectural advancements of microprocessors, single-chip microcomputers, large and small computers, microprocessor applications

Microprocessor Architecture

Intel 8085, ALU, timing & control unit, registers, opcode & operands, Instruction cycle: fetch operation; execute operation, machine cycle and state, instruction & data flow. Timing diagram: for op-code fetch cycle, memory read, I/O read, memory write & I/O write, Interrupts in 8085, RST instructions, multiple interrupts and priorities.

Instruction Set and Programming

Instruction and data formats, Addressing modes, status flags, Classification of instructions: Data transfer group, Arithmetic group, Logical group, Branch, Stack, I/O and Machine control group. Assembly language programs using 8085 instruction set, such as addition, subtraction, shift left, shift right, multiplication, division and involving loops, arrays, subroutines and stacks.

Memory Interfacing

Types of memory, ROM & its types, RAM & its types, address decoding, interfacing of memories.

Peripheral Devices and Interfacing

Data transfer schemes: synchronous data transfer, asynchronous data transfer, interrupt driven data transfer, DMA transfer,8257 DMA controller, programmable interrupt controller (PIC) Intel 8259, programmable peripheral interface (PPI) Intel 8255, programmable interval timer Intel 8253, programmable communication interface Intel 8251.

Applications of 8085 Microprocessor

Introduction, analog to digital Converter (ADC), Interfacing of ADC 0808/0809 and sample and hold to microprocessor 8085, display of decimal numbers and alphanumeric characters, Microprocessor based measurement of Electrical quantities- Frequency, phase angle and power factor, voltage, current. Interfacing of transducers to measure and display the non- electrical quantities such as temperature, water level and speed of motor etc.

BOOKS/REFERENCES:

1) Microprocessor Architecture, Programming and Applications with the 8085/8080A, by R.S.Gaonkar, Merrill Pub. Co., 2nd Edition, 1989
2) Introduction to Microprocessor by A.P.Mathur, TMH, 3rd Edition, 2006
3) Fundamentals of Microprocessors and Microcomputers by B.Ram, Dhanpat Rai & Sons,4th Edition, 1993.
4) Microprocessors Comprehensive Studies by Naresh Grover, Dhanpat Rai & Sons
5) Microprocessor Microcomputer and their Applications by A.K.Mukhopadhyay, Alpha Science International Ltd.,3rd Edition, 2007

EED-225 NETWORK SYNTHESIS AND FILTER DESIGN

L T P
3 1 0

Elements of Network Synthesis
Review of Network Functions, Network realizability, Hurwitz Polynomials, Positive real functions, Properties of RC, RL & LC networks, Foster and Cauer forms of realization.

Network Graph Theory
Definition, Graph, Tree, Basic cut- set & tie-set matrices for planer networks-loop and nodal method of analysis of networks with independent and dependent Voltage & current source, Duality & dual networks.

Passive filters and Attenuators
Classification of filters, characteristics impedance and propagation constant of pure reactive network, Ladder network, T section, π section, terminating half section. Low pass, High pass, Band pass & Band reject filter design concepts. Design of constant-K, m derived filters. Composite filters. Attenuation, Types of Attenuators, T-type and π- type Attenuators

Operational Amplifiers & Active Filters
Basic OP-AMP, Differential amplifier, Emitter coupled Differential Amplifier, transfer characteristics of differential OP-AMP, IC operational Amplifier, Offset error voltage and currents, Temperature drift of input offset voltage and current.

Active filter concept Butterworth and Chebyshev approximations, Normalized specifications, Frequency transformations, Frequency and impedance denormalisation, Types of frequency selective filters, Linear phase filter.

Introduction to PSPICE and Network analysis

BOOKS/REFERENCES:

1) Network and Systems by D. Roy Chowdhury,New Age International Publishers
2) Network Theory –Analysis and Synthesis by Samarjit Ghosh Prentice Hall of India Pvt. Ltd., New Delhi
3) Network Analysis by Van Valkenburg, Prentice Hall of India Pvt. Ltd., New Delhi,
4) Circuit and Networks by A Sudhakar and Shyammohan S Palli, McGraw Hill.
5) A Course in Electrical Circuit Analysis by M. L. Soni and J.C. Gupta, Dhanpat Rai & Sons
6) Network Theory and Filter Design by Vasudev K. Aartre, New age international publisher,[2nd] Edition,2003

EED-226   **ANALOG ELECTRONICS**

L   T   P
3   1   0

 LOW FREQUENCY TRANSISTOR AMPLIFIER:- Equivalent circuit of BJT using h-parameter for CB, CE and CC & configuration, calculation of transistor parameter for CB, CE & CC using h-parameters, comparison of transistor amplifier configuration.

 MULTISTAGE AMPLIFIER: General cascaded system, RC coupled amplifier and its frequency response, merits and demerits, cascode amplifier, Darlington compound configuration, multistage frequency effect.

 HIGH FREQUENCY RESPONSE OF TRANSISTOR AMPLIFIER: High frequency model for CE configuration, approximate CE high frequency model with resistive load, CE short circuit current gain, HF current gain with resistive load.

LARGE SIGNAL AMPLIFIER: Analysis and design of class A, B, AB amplifiers, push pull amplifiers, transformer less output stages, distortion calculations.

TUNED AMPLIFIER: General behaviour of tuned amplifiers, resonance-series and parallel resonant circuit, calculations of circuit impedance at resonance. Variation of impedance with frequency, Q-factor of a circuit & coil, Band width of series & parallel resonant circuit, advantages and disadvantages of tuned amplifiers, Single tuned amplifiers, voltage gain & frequency response of single tuned amplifiers, double tuned amplifiers, Analysis & design of class C amplifiers.

FEEDBACK AMPLIFIER: Feedback concept, characteristics of negative and positive feedback,Effect of negative and positive feedback on input impedance, output impedance, gain, and noise and frequency response, circuit operation and analysis of different oscillators.

BOOKS/REFERENCES:

1) Electronic Devices & circuit-II by A.P. Godre & U.A. Bakshi.
2) Electronic Devices & Circuit by G.K.Mithal
3) Integrated devices & circuits by Millman & Halkias.
4) Electronic Devices & circuit theory by R. Boylestad.

Semester-5

EED-311   **PROTECTION AND SWITCHGEAR**

$$\begin{array}{ccc} \textbf{L} & \textbf{T} & \textbf{P} \\ \textbf{3} & \textbf{1} & \textbf{3} \end{array}$$

Per-Unit System

Change of base, per unit quantities in three phase system, selection of base values, base quantities in terms of KV and MVA, per unit load impendence, advantages of per unit representation, one-line diagrams, preparation of impendence and reactance diagrams.

Fault Analysis

Type of faults and their occurrence, symmetrical short circuit on the terminals of an unloaded generator, unsymmetrical faults on the terminals of an unloaded generator, faults on power system and their simulation.

Introduction to Power System Protection

Abnormal operating conditions, protective system and its attributes, system transducer, various principles of power system protection.

Protection of Transmission Lines

Over current protection through fuse, thermal and over current relay, IDMT relay and application on distribution feeder, directional over current relays, differential and percentage differential protection, distance protection of transmission lines through impedance, reactance and mho relay, comparison between distance relays.

Transformer Protection

Over current protection, percentage differential protection, incipient faults in transformers, inter-turn fault, protection against over fluxing.

Bus- Bar Protection

Differential protection of bus bars

Generator Protection

Various faults and abnormal operating conditions, protection against unbalanced loading, over speeding, loss of excitation, loss of prime mover.

Advance Protective Systems

Carrier aided protection of transmission lines, static comparators as relays, synthesis of various distance relays using static comparators, numerical protection.

Circuit Breaker

Arc initiation and arc quenching theories, circuit breaker ratings, air circuit breaker, minimum oil circuit breaker, bulk oil circuit breaker ,air blast circuit breaker, SF6 circuit breaker and vaccum circuit breaker. **BOOKS/REFERENCES:**

1) Elements of Power System Analysis by W.D. Stevenson McGraw Hill,4th Edition, 1982.
2) Modern Power System by D.P. Kothari and IJ Nagrath, 3rd edition Tata McGraw Hill New Delhi,2007.
3) Electrical Power system by Ashfaq Hussain, 3rd edition, Vikas Publisher, 1982.
4) Power System Analysis by Hadi Saadat Tata Mc Graw Hill, New Delhi,2nd Edition,2002.
5) Switchgear and Protection by Sunil S.Rao, B.Ravindernath & M.chander ,Khanna Publishers, Delhi,10th Edition,1992
6) Power System Protection and Switchgear by Wiley, John Wiley & Sons Canada, Limited, 1977.

EED-312   ELECTRICAL MACHINES -II

<div align="right">

L   T   P
3   1   3

</div>

Polyphase Induction Machines
Theory of three phase induction motors, Principle of operation, slip, phasor diagram, equivalent circuits, expression for torque, maximum torque, starting torque and output power, torque-slip and power-slip characteristics, Circle diagram, Predetermination of characteristics from the circuit diagram, Drawing circle diagram from design parameters and no load and blocked rotor test data, power factor control of three phase induction motor, Starting of Induction motors, Speed control of induction motor, Cogging & Crawling, applications of poly-phase induction motors.

Single Phase Induction Motors
Principle of operation on the basis of double revolving field theory, Equivalent circuit, performance calculations and characteristics, Starting methods, Maximum starting torque conditions in single phase induction motors, Hysteresis motor, Reluctance motor and stepper motor.

Synchronous Machines
Types of Exciters for synchronous machines, flux and MMF phasor diagrams for cylindrical rotor synchronous machines, Armature reaction, open and short circuit characteristics, Leakage reactances, Synchronous reactance, Phasor diagram under loaded conditions, operating characteristics of alternators and their ratings, Predetermination of regulation by EMF and Potier triangle methods for non-salient pole alternators, Steady state power flow equations, Power angle characteristics, Constant excitation and constant power output, Circle diagram for synchronous machines. Two reaction theory for salient pole alternators and pre-determination for regulation, slip test, V curves, Hunting and its suppression, Starting of synchronous motor, Synchronous condenser.

Parallel Operation of Alternators
Synchronization of alternators by dark lamp method, Parallel operation of alternators, Alternator on infinite bus bar, Effect of change of excitation and prime mover inputs.

BOOKS/REFERENCES:

1) Electrical Machinery   by P.S. Bhimbra, Khanna Publishers, Delhi,7th Edition,2004
2) Electric Machinery by A.E.Fitzerald, C.Kingsley and S.D.Umans, Tata McGraw Hill,6th Edition,2002.
3) Generalized theory of Electrical Machines by P.S.Bhimbra, Khanna Publishers Delhi,5th Edition,2003.
4) Theory of AC Machinery by A.S.Langsdorf, Tata McGraw Hill,2nd Edition,1955
5) The Performance and Design of Alternating Current-Machines by M.G.Say, Pitman Publishers,2nd Edition, 1952

EED-313   **SIGNALS AND SYSTEMS**

L   T   P
3   1   0

Introduction
Continuous and discrete time signals and systems, their classification. interconnections of systems, systems with and without memory, causality, stability, linearity and time invariance.

Linear Time Invariant Systems
Introduction, discrete LTI systems, Convolution, unit impulse response and convolution integral representation of LTI systems, properties of LTI systems, Stability, causal LTI systems described by difference equation, singularity functions.

Fourier Series Representation
Introduction, Fourier series representation for continuous time periodic signals, convergence of Fourier series,properties of continuous time Fourier series, Fourier series representation of discrete time periodic signals, properties of discrete time Fourier series, response of LTI systems to complex exponentials

Continuous -time Fourier Transform
Introduction, convergence of Fourier transform, properties of continuous time Fourier transform, systems described by linear constant coefficient differential equations.

Discrete- time Fourier Transform
Introduction to DTFT, convergence of the Fourier transform, Gibbs phenomenon, properties of DTFT, system described by linear constant coefficient difference equations.

Time and Frequency Characterization of Signals and Systems
Introduction, magnitude and phase representation of Fourier transform of signals, magnitude and phase representation of frequency response of LTI system, Linear and nonlinear phase, group delay, log magnitude plot, time domain and frequency domain aspects of ideal and non-ideal filters.

Sampling
Introduction, sampling theorem, zero order hold for reconstruction of a signal from its samples, frequency aliasing, sampling of discrete time signals, decimation and interpolation.

BOOKS/REFERENCES:

1) Signals and Systems by Oppenheim, Willsky & Hamid Nawab,2nd Edition, Pearson Education, New Delhi,2006.
2) Digital Signal Processing by Proakis and Manolakis, Pearson Education, 4th Edition,2009.
3) Digital Siganl Processing by Sanjit K Mitra, McGraw-Hill,3rd Edition, 2006

EED-314   TRANSDUCERS & SIGNAL CONDITIONING

L   T   P
3   1   3

Transducers
Introduction, classification, Mechanical devices as primary detectors, Basic requirements of a transducer, Electrical transducers, Type of transducers for measuring displacement, strain, vibration, pressure, Flow, temperature, force, torque, liquid level, Humidity, P. H. value, velocity (angular & linear), acceleration, Basic principles of resistive transducers, Inductive transducers, capacitive transducers, Thermoelectric transducers, Piezoelectric transducers, Hall effect transducers, Electromechanical transducers, Photoelectric transducers, Digital transducers.

Signal Processing Circuits
Introduction, ideal op-amp, Operational amplifier specifications, Zero crossing detector, Zero crossing detector with Hysteresis, inverting and non-inverting amplifiers, Voltage-follower, adder, subtractor, integrator, Differentiator, voltage to current converter, current to voltage converter, Phase shifter circuit, Absolute-Value circuit, Peak detector, AC to DC converter, logarithmic converter, Differential-amplifier, Instrumentation amplifier, Analog Modulators & demodulators.

Data Display and Recording Systems
Introduction to Analog and digital display methods, Analog Recorders, C.R.O., digital input-output Devices, Digital frequency meter, Digital Voltmeter.

Data Transmission and Telemetry
Introduction, Methods of data transmission, General telemetering system, Electrical telemetering systems, Transmission channels and media, Multiplexing in telemetering systems, Characteristics of Frequency division multiplexing, Time-division multiplexing,

Data Acquisition and Conversion
Introduction, signal conditioning of the inputs, single channel D A S, Multi-channel D A S, Data Conversion, Multi-plexer, S/H circuit, A/D converter.

BOOKS/REFERENCES:

1) Murty, D.V.S., Transducers and Instrumentation, Prentice–Hall of India Private Limited, 2nd Edition, 2008.
2) Instrumentation Devices & Systems by C.S. Rangan, G.R. Sarma, V.S.V. Mani ,TMH NewDelhi,2nd Edition,2006.
3) A course in Electrical & Electronic Measurements & Instrumentation by A.K.Sawhney, Dhanpat Rai & Sons
4) Operational Amplifiers and Linear Integrated Circuits by Robert F. Coughlin & Frederick F. Driscoll, (PHI) India. Prentice-Hall of India, New Delhi, 6th ed., 2001
5) Measurement Systems (application & Design) by Ernest O. Doebelin, Tata McGraw-Hill, New Delhi, 5th Edition, 2004

EED-315   MICROELECTRONICS & INTEGRATED CIRCUITS

L T P
3 1 0

Monolithic Techniques: Silicon refining for EGS, Crystal growth methods, Wafer preparation, Lithography, Oxidation, Etching, Diffusion, Ion-implantation, Metallization, Interconnection, Monolithic component fabrication: monolithic resistors, capacitors, diodes, BJT, MOS, etc; Testing and Packaging, Yield losses, Introduction to Surface Mount Technology and devices(SMT & SMD).

Integrated Circuits: Linear Integrated Circuits, Advantages and limitations of integrated circuits over discrete component, Classification of IC's, Bipolar and MOS techniques. Hybrid IC Technology: Thick film technology, Thick film processes, thin film technology, thin film processes.

Differential Amplifiers: Emitter coupled differential amplifiers, its configurations, Differential amplifiers with Swamping resistors, Constant current bias, Current mirror, Cascading of differential amplifiers, Level translator, Introduction and block diagram of Operational amplifier.

Specialized IC Applications: Active filters: Introduction and classification, Basic low pass and high pass Butterworth filters, Higher order filters, Band pass filters, Band reject filters, multiple feedback filter, Oscillators: Phase shift oscillator, Wien bridge oscillator, Quadrature oscillator, Introduction to integrated circuit timer, Operating modes of 555 timer and its applications, Phase locked loops, Power amplifiers and Voltage regulators.

BOOKS/REFERENCES:

1) Integrated Electronics-Analog and Digital Circuit Systems, Millman and Halkias.
2) Integrated Circuits, Botkar.
3) Op-amps & Linear Integrated Circuits, Robert F. Coughlin & Frederick F. Driscoll.
4) Op-amps & Linear Integrated Circuits, Ramakant A. Gayekwad.
5) VLSI Technology, S.M. Sze.
6) VLSI Fabrication Principles, Gandhi S.K John Willey & Sons.
7) Linear Integrated circuits, D.R. Chaudhar

Semester-6

EED-321   **CONTROL ENGINEERING**

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L   T   P
3   1   3

</div>

Introduction
Control system, servo-mechanism, open loop and closed loop systems, mathematical modeling of physical systems, mechanical and electrical system analogy, signal flow graphs, Block diagram representation and reduction techniques, feedback and non feedback systems, regenerative and degenerative feedback, effect of variation of system parameters on system performance, advantages of feedback.

Control Components
General block diagram of a control system, a.c. and d.c. Servomotors, a.c. tachometer, synchro transmitter and receiver, synchro pair as control transformer, a.c and d.c position control system, stepper motor.

Time Domain Analysis
Introduction, standard input signals, Response of 1st and 2nd order systems, time domain specifications i.e. rise time, peak time, delay time, peak overshoot, settling time steady state error etc., different types of feedback systems, Steady state errors for unit step, unit ramp and unit parabolic inputs, Effect of addition of zero to the system.

Stability Analysis
Introduction, concept of stability, conditions for stable system, asymptotic, relative and marginal stability, Routh-Hurwitz criterion for stability.

Root Locus Technique
Introduction, concepts of root locus, construction of root loci, and various rules pertaining to locus diagram development

Frequency Domain Analysis and Stability
Introduction, Relation between time and frequency response for 2nd order system, Bode plot, construction procedure for bode plot, gain cross over and phase cross over frequency, gain margin and phase margin, Nyquist plot and Nyquist stability criterion.

Control System Design
Introduction, Selection and realization of basic compensators like lead, lag and lag-lead compensators etc, Introduction to PID Control.

BOOKS/REFERENCES:

1) Discrete time Control Systems by K. Ogata, Prentice Hall International, 2nd Edition, 1995.
2) Control System Engineering by Nagrath and Gopal,New Age International, 4th Edition, 2006
3) Automatic control Systems by B.C. Kuo, John Wiley & Sons, New Delhi, 8th Edition, 2009.

EED-322   **POWER SYSTEM ANALYSIS**

L   T   P
3   1   3

Introduction
Nature and scope of power system studies, power system restructuring, power system computation and control.

Power system Components modeling
Mathematical model of transmission lines, tap changing transformer, generator and loads.

Topological Analysis of Power Networks
Primitive impedance and admittance matrices, system graph for transmission network, relevant concepts in graph theory, network representation, network matrices, network reduction.

Bus Impedance Algorithm
Partial network, addition of link(s), addition of branch(es), removal of elements, implementation of bus building algorithm, 3-phase Z-bus formation.

Short Circuit Studies
Types of faults, short circuit studies of large power system networks, calculating system conditions after the occurrence of fault, direct short circuit i.e. bolted faults. Comparison between symmetrical components and phase coordinate, method of short-circuit studies.

Power Flow Studies
Mathematical model of power flow studies, Solution techniques: Gauss-Seidel method, Newton-Raphson method, fast decoupled load flow method, comparison of solution technique.

Stability Studies
Types of stability, swing equation, point by point method, mathematical models for transient stability simulation, direct numerical integration method.

BOOKS/REFERENCES:

1) Computer Techniques in Power System Analysis by MA Pai, 2nd edition, Tata McGraw Hill, New Delhi.
2) Advanced Power System Analysis and Dynamics by LP singh, 3rd edition,New Age International
3) Modern Power System Analysis by DP Kothari & IJ Nagrath, Tata McGraw Hill, New Delhi.3rd Edition,2007.

EED-323   **DIGITAL SIGNAL PROCESSING**

L T P
3 1 0

Introduction
Basic elements of digital signal processing, comparison of analog and digital signal processing, multi-channel and multi-dimensional signals, random and deterministic signals, FIR and IIR systems, recursive and non-recursive systems, correlation of discrete time signals.

Discrete Fourier Transform and Fast Fourier Transform
Frequency domain sampling and reconstruction of discrete time signals, DFT, DFT as linear transformation, frequency analysis of signals using DFT, properties of DFT, circular convolution, linear filtering methods based on DFT, overlap save and overlap add method, FFT algorithms, decimation in time and decimation in frequency algorithms, applications of FFT algorithms, linear filtering approach to computation of the DFT, Goertzel algorithm.

Implementation of Discrete Time Systems
Structures for the realization of LTI systems, recursive and non-recursive realization of FIR systems, structures for FIR systems, direct form, cascade form, frequency sampling and lattice structures, structures for IIR systems, direct form, signal flow graphs and transposed structure, cascade, parallel form and lattice structures.

Design of FIR Digital Filters
Introduction, LTI systems as frequency selective filters, Paley-Wiener theorem, characteristics of frequency selective filters, design of linear phase FIR filters, design of digital filters by placement of poles and zeros in z-plane, digital resonators, Notch filters, Comb filters and all pass filters, design of linear phase FIR filters using windows and by frequency sampling method.

Design of IIR Digital Filters
Introduction, design of IIR filters from their analog counterparts, design using approximation of derivatives, impulse invariance, bilinear transformation and matched z-transformation, frequency transformations in analog and digital domains, design of digital filters based on least squares method, design of IIR filters in frequency domain.

BOOKS/REFERENCES:

1) Digital Signal Processing by Proakis and Manolakis, Pearson Education,4th Edition,2009.
2) Theory and Application of Digital Signal Processing by Rabiner and Gold, Prentice-Hall, 1975.
3) Digital Signal Processing by Sanjit K Mitra, McGraw-Hill, 3rd Edition, 2006
4) Digital Signal Processing by Oppenheim and Schafer, Prentice-Hall, 1975

EED-324   **ELECTRIC DRIVES**

L   T   P
3   1   0

Introduction
Introduction to an electric drive system, parts of electric drive system, choice criteria

Dynamics of Electric Drives
Dynamic equations of an electric drive, torque equations, multi-quadrant operation, type of loads, energy loss during transients and load equalization.

Electric Drive Control
Control of electric drives, modes of operation, speed control, open & closed loop drives, current limit control, torque limit control, position, PLL and speed control.

Selection of Motor Drive Rating
Selection of motor rating – thermal model of motor, classes of duty and determination of motor rating for different classes of drive operation duty.

DC Motor Drives
DC motor drive – starting, braking, transient analysis, speed control, controlled rectifier converters for DC drives and chopper fed DC drives.

AC Motor Drives
Induction motor drive – starting, braking, transient analysis, speed control, ac controller fed induction motor, voltage source inverter, current source inverter and cyclo converter fed induction motor drive.

FHP Drives
Introduction to FHP electric drive system. Brushless DC, stepper and reluctance motor.

BOOKS/REFERENCES:

1) Fundamentals of Electrical Drives by G.K. Dubey, Alpha Science International Ltd.,2nd Edition,2001
2) Modern Power Electronics & Drives by B.K. Bose, Prentice Hall PJR,2002
3) Electric Drives- Concept and Applications by Vedam Subrahmanyam, TMH Ltd.,1994.
4) A First Course in Electrical Drives by S.K.Pillai, New Age International (P) Limited,2nd Edition,2004.

EED-326   ESTIMATION AND COSTING PRACTICE

L   T   P
1   0   3

Introduction:
Electrical symbols and standards, Indian electricity rules and acts, electrical appliances, switches and fixtures, light and fan circuit, power circuit and alarm circuits. Electrical diagrams, single line diagram, schematic diagrams, and wiring diagrams. Design and drawing of panel boards.

Design and drawing
Design and drawing of light and fan circuits and alarm circuits for simple, specific and emergency requirements. Alarm circuits with relays. Illumination engineering, design of light schemes for hotels, parks and street lighting etc.

Motor Control circuits:
Starting of ac motors, stopping of motors, basic control circuits for motors.

Estimating and Costing of Electrical Installations:
Introduction, load calculation, conductor size calculations, selection of energy meter, main switch, distribution board and number of circuits and sub-circuits. Costing of electrical installation for small, medium residences, large installations like public buildings and commercial establishments.

Design, estimation and costing
Design, estimation and costing of HT and LT lines overhead as well as underground with complete list of material including labour charges and wastage etc.

Estimating and costing
Estimating and costing of 11KV, 33KV and 66KV substation along with transformers.

Reference:

1. Electrical Design Estimating and Costing by: K. B. Raina, New Age International
2. Electrical Estimating and Costing by: Surjit Singh, Ravi Deep Singh, Dhanpat Rai & Company

Semester-7

EED-411   **ENERGY AUDITING AND MANAGEMENT**

L   T   P
3   1   0

Energy Scenario
Energy needs of growing economy, Long term energy scenario, Energy pricing, Energy sector reforms, Energy and environment: Air pollution, Climate change, Energy security, Energy sonservation and its importance, Energy strategy for the future, Energy conservation Act-2001 and its features.

Energy Management and Audit
Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments

Material and Energy Balance
Facility as an energy system, Methods for preparing process flow, Material and energy balance diagrams.

Financial Management
Investment-need, Appraisal and criteria, Financial analysis techniques- Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis, Financing options, Energy performance contracts and role of ESCOs.

Electrical System
Electricity tariff, Load management and maximum demand control, Power factor improvement, Distribution and transformer losses. Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, energy efficient motors. Light source, Choice of lighting, Luminance requirements, and Energy conservation avenues

BOOKS/REFERENCES:

1) Handbook on Energy Audit and Environment Management by Abbi, Y.P. and Jain, S.,, Teri Press, 2006.
2) Energy Conservation by P.Diwan and P.Dwivedi, Pentagon Press, 2008.
3) Handbook of Energy Audits by A.Thumann, W.J.Younger, T.Niehus, CRC Press,8th Edition, 2008.

EED-412   **MODERN CONTROL SYSTEMS**

L   T   P
3   1   0

State Variable Analysis and Design
Introduction, concept of state, state variable and state model, state space representation of systems, block diagram for state equation, Transfer function decomposition, direct, parallel and cascade decomposition, solution of state equations, concept of controllability and observe ability, controller design using pole placement by state feedback, controller design using state observer.

Sampled Data Control System
Introduction, digital control systems, quantization concept, data acquisition, conversion and distribution system, z-transform, Important properties, inverse z-transform, difference equation and solution using z-transform, Impulse sampling and data hold, reconstruction of original signals from the sampled version, pulse transfer function for open loop and closed loop systems, mapping between z-plane and s-plane, stability analysis using Jury's test, bilinear transformation and Schur-Cohn criteria, state space representation of discrete time systems and solution of discrete time state equations.

Non Linear Systems
Introduction, different non-linearities, phase plane method, singular points, stability of nonlinear systems, construction of phase trajectories, phase plane method, concepts of describing function method, stability analysis using describing function method, jump resonance phenomena, Liapunov and Popov stability criterion.

Advanced Control Systems
Introduction to adaptive control, robust and H-infinity control.

BOOKS/REFERENCES:

1) Discrete time Control Systems by K. Ogata, Prentice Hall International, 2nd Edition, 1995.
2) Control System Engineering by Nagrath and Gopal,New Age International, 4th Edition, 2006
3) Digital Control Systems by B.C. Kuo, Oxford University Press.
4) Design of Feedback Control systems by Stefani Shahian and Savant Hastetter, Oxford Press, 4th edition.

EED-413   **ELECTRICAL MACHINE DESIGN**

L   T   P
3   1   3

Principles of Design of Machines

Specific loadings, choice of magnetic and electric loadings, Real and apparent flux densities, temperature rise calculation, Separation of main dimension for DC machines, Induction machines and synchronous machines.

Heating Cooling and Ventilation

Heating and cooling of machines, types of ventilation, continuous and intermittent rating.

Design of Transformers

General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling tubes, calculation of losses, efficiency and regulation, forces winding during short circuit.

Three Phase Induction Motors

General considerations, output equation, choice of specific electric and magnetic loadings, efficiency, power factor, number of slots in stator and rotor, elimination of harmonic torques, Design of stator and rotor winding, slot leakage flux, leakage reactance, equivalent resistance of squirrel cage rotor, magnetizing current, efficiency from design data.

Alternators

Types of alternators, comparison, specific loadings, output co-efficient, design of main dimensions.

Introduction to Computer Aided Electrical Machine Design.

BOOKS/REFERENCES:

1) The Performance and Design of D.C. Machines by Clayton A.E, Sir I. Pitman & sons, Ltd.,2nd Edition,1938.
2) The Performance and Design of A.C. Machines by M.G. Say, Pitman,2nd Edition 1952.
3) A course in Electrical Machine Design by Sawhney A.K., Dhanpat Rai & Sons,5th Edition,1984.

DEPARTMENTAL ELECTIVE -I
EEE-414(a)   **TRANSFORMER ENGINEERING**   **L**   **T**   **P**
                                                                 3   **1**   **0**

Introduction to Transformers
Transformer Types, Transformer Losses, Operating Principles, Instrument Transformers, Transformer Construction, Auto -Transformer, Transformer connections.

Transformer Maintenance
Insulation Testing, High Potential Testing, Turns Ratio Testing, Polarity Testing, Power Factor, Excitation Current, DC Winding Resistance, Polarization Recovery, Insulating Fluid, Dielectric, Dissolved Gas Analysis.

Materials for Transformers
Insulating oil, insulating paper, pressboard, and wood, insulated   copper conductor for windings, crepe paper, sealing materials, and cold – rolled grain oriented electrical steel sheet.

Winding and Insulation
Types of windings, surge voltage, heat transfer, insulation design.

Cooling
Air Cooled Oil-Immersed, Water-Cooled, Forced-Oil Cooling, Self-Cooling with Air Blast Temperature Limits, Transformer loading.

Magnetic Circuit
Materials, design of magnetic circuit, optimum design of core.

Tap Changers
Off - circuit tap changer, on load tap changer, automatic control of tap changer.

Transformer Auxiliaries
Buchholz relay, temperature indicators, oil level indicators, oil preservation systems.

BOOKS/REFERENCES:

1) Transformers by BHEL, Bhopal, Tata McGraw Hill.
2) Transformer Engineering by SV Kulkarni and SA Khaparde Marcel & Dekks Inc.
3) Transformer Engineering design and practices, SV Kulkarni, SA Khaparde, Marcel Dekker Inc New york.
4) Electrical Machines by J. Nagrath & D.P.Kothari, Tata McGraw Hill
5) Electrical Machines by Husain Ashfaq , Dhanpat Rai & Sons
6) Electric Machine and Tranformers by Irving L.Kosow, Prentice Hall of India.
7) Fundamentals of Electrical Machines by B.R. Gupta & Vandana Singhal, New Age International
8) Electric Machinery by A.E. Fitggerald, C.Kingsley Jr and Alexander Kusko, McGraw Hill, International Student Edition.
9) The Performance and Design of DC machines by A.E. Clayton, Pitman &Sons
10) The Performance and Design of AC machines by M.G. Say, Pitman & Sons
11) Theory of Alternating Current Machinery by Langsdorf , Tata McGraw Hill.

DEPARTMENTAL ELECTIVE-I

EEE-414 (b)   **IMAGE PROCESSING**

L   T   P
3   1   0

Introduction
Digital image representation, Fundamental steps in image processing, Elements of Digital Image processing systems, Elements of visual perception, Image model, Sampling and quantization, Relationship between pixels, imaging geometry.

Image Enhancement
Enhancement by point processing, Sample intensity transformation, Histogram processing, Image subtraction, Image averaging, Spatial filtering, Smoothing filters, Sharpening filters, Frequency domain: Low-Pass, High-Pass, Homomorphic filtering.

Image Compression
Coding redundancy, Inter-pixel redundancy, fidelity criteria, Image compression models, Error-free compression, Variable length coding, Bit-plane coding, Loss-less predicative coding, Lossy compression, Image compression standards, Fractal Compression, Real-Time image transmission, JPEG and MPEG.

Image Segmentation
Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region oriented segmentation, Use of motion in segmentation, Spatial techniques, Frequency domain techniques.

Spatial Operations and Transformations
Spatially dependent transform template and convolution, Window operations, 2-Dimensional geometric transformations.

Pattern Recognition
Classification and description, Structure of a pattern recognition system, feature extraction, Classifiers, Decision regions and boundaries, discriminant functions, Supervised and Unsupervised learning, PR-Approaches statistics, syntactic and neural.

BOOKS/REFERENCES:

1) Digital Image Processing by R. Gonzalez and R. E. Wood, Pearson Education.2nd Edition,2002.
2) Introductory Computer Vision and Image Processing by Adrian Low, McGraw Hill,1991
3) Pattern Recognition-Statistical, Structural and neural approach by Robert Schalkoff and John Willey & Sons,2007
4) Digital Image Processing by W.K. Pratt,Johm Wiley and Sons,New York,3rd Edition, 2001
5) Fundamentals of Digital Image Processing by A. K. Jain, Pearson Education, 2005

DEPARTMENTAL ELECTIVE-I

EEE- 414(c)   PROGRAMMABLE LOGIC CONTROLLERS AND APPLICATIONS

L T P

3 1 0

PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming Equipment, programming formats, construction of PLC ladder diagrams, Devices connected to I/O modules.

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils, drill press operation. Digital logic gates, programming in the Boolean algebra system, conversion examples Ladder Diagrams for process control: Ladder diagrams & sequence listings, ladder diagram construction and flowchart for spray process system.

PLC Registers: Characteristics of Registers, module addressing, holding registers, Input Registers, Output Registers.

PLC Functions: Timer functions & Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions

Data Handling functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR & Sweep functions and their applications, Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two-axis & three axis Robots with PLC, Matrix functions.

Analog PLC operation: Analog modules& systems, Analog signal processing, Multi bit Data Processing, Analog output Application Examples, PID principles, position indicator with PID control, PID Modules, PID tuning, PID functions.

BOOKS/REFERENCES:
1. Programmable Logic Controllers- Principles and Applications by John W. Webb & Ronald A. Reiss, Fifth Edition, PHI
2. Programmable Logic Controllers- Programming Method and Applications by J R.Hackworth &F.D Hackworth Jr. Pearson, 2004
3. Programmable Logic Controllers by Frank D. Petruzella Third Edition, (McGraw Hill Publishing Company)
4. Introduction to Programmable Logic Controllers by Gary Dunning (Thomas learning Australia)
5. Programmable Logic Controllers by Bolton, W, Newnes, Ed.4, 2006.

DEPARTMENTAL ELECTIVE -I

EEE- 414 (d)   DEREGULATION OF POWER SYSTEM

L   T   P
3   1   0

1. **Introduction:** Basic concept and definitions, privatization, restructuring, transmission open access, wheeling, deregulation, congestion management components of deregulated system, advantages of competitive system.

2. **Transmission Pricing:** Marginal pricing of Electricity, nodal pricing, zonal pricing, embedded cost, postage stamp method, contract path method, boundary flow method, MW mile method, MVA-mile method, Comparison of different methods.

3. **Deregulation of Power Sector:** Separation of ownership and operation deregulated methods, pool model, pool and bilateral trades model, multilateral trade model, ancillary services.

4. **Deregulation Scenario:** England and Wales, Norway, China, California, New Zealand and Indian Power System.

BOOKS/REFERENCES:

1) Power system Restructuring and deregulation edited by Loi Lei lai John Wiley & Sons Ltd.
2) Understand Electric Utilities and Deregulation by Lorrin Philipson and H Lee willis,CRC PRESS, 2005
3) Restructured Electrical Power System operation, Trading and Volatility by Mohammad
4) Shahidehpour and Muwaffaq Alomoush, Marcel Dekker Inc, New Delhi.
5) Power System Restructuring Engineering and Economics by Marija llic, Francisco Galiana and Lestor Fink, Kluwer Academic Publisher, USA, 2000

DEPARTMENTAL ELECTIVE -II

EEE-415(a) INTRODUCTION TO OPTIMIZATION METHODS

L   T   P
3   1   0

Introduction
An overview of optimization problems, some simple illustrative examples

Linear Programming
Introduction, graphical method, simplex method, method of artificial variables, alternate optima, redundancy in linear programming, degeneracy and cycling, the simplex tableau in condensed form.

Nonlinear programming
Introduction, Lagrange multipliers, Karaush-Kuhn-Tucker (KKT) optimality conditions, convexity, sufficiency of the KKT conditions, Duality and convexity.

Approximation Techniques
Introduction, line search methods, gradient based methods, approximation under constraints.

Dynamic Programming
Sequential optimization; Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality; Recursive equations – Forward and backward recursions; Computational procedure in dynamic programming (DP); Discrete versus continuous dynamic programming; Multiple state variables; curse of dimensionality in DP

BOOKS/REFERENCES:
1) Introduction to optimization by Pablo Pedregal, Publisher: Springer
2) Numerical optimization with applications by Suresh Chandera, Jaydeva, and Aparna Mehta Publisher, Narosa
3) An Introduction to optimization by Edvin K.P. Chong, and Stanislaw H. Zak Publisher, John Wiley
4) Optimization theory and practice by Mohan C. Joshi and Kannan M Moudgalya Publisher,Narosa

DEPARTMENTAL ELECTIVE -II
EEE-415(b) ARTIFICIAL NEURAL NETWORK AND FUZZY SYSTEMS

L T P
3 1 0

Introduction
Biological foundation, mathematical model of biological neuron, types of activation function, feed-forward and feedback ANN models.

Learning Paradigms
Supervised and unsupervised learning, learning rules, single layer and multilayer perceptron model, error back propagation learning algorithm, pattern classification, clustering, Kohonen self-organizing feature map, radial basis function network, support vector machines, Hopfield network, Associative memory and BAM, applications of ANN models to engineering problems.

Fuzzy Sets and Theory
Crisp sets, fuzzy sets, fuzzy set operations, properties, membership functions, measures of fuzziness, fuzzification and defuzzification methods, fuzzy relations, operation on fuzzy relations, fuzzy numbers and arithmetic, fuzzy implications, approximate reasoning, systems based on fuzzy rules, fuzzy inference.

Fuzzy Control Systems
Introduction, fuzzy logic controllers with examples, special forms of fuzzy logic models, classical fuzzy control problems.

Hybrid Intelligent Systems
Genetic algorithms, neuro-fuzzy systems, adaptive neuro-fuzzy inference system, evolutionary neural networks, fuzzy evolutionary systems

BOOKS/REFERENCES:

1. Introduction to Artificial Neural Systems by Jacek M Zurada,West Publisher,1992.
2. Neural Computing: Theory and Practice by Philip D. Wasserman,Van Nostrand Reinhold, 1989.
3. Neural Networks –Algorithms, Applications, and Programming Techniques by Freeman, J. A. and D. M.Skapura, application and programming Techniques, Pearson Education,3rdEdition,2008.
4. Neural Networks: A Comprehensive Foundation by Simon Haykin, Prentice Hall, Upper Saddle River, NJ, 2nd Edition, 1999.
5. Artificial Intelligence: A guide to intelligent systems, second edition by Michael Negnevitsky , Pearson education ltd.
6. Essentials of Fuzzy Modeling and Control by Ronald R. Yager and Dimitar P. Filev, John Wiley & Sons Inc,1994.
7. Fuzzy System Theory and its applications by T. Terano K Asai and M. Sugeno, Academic Press,1992.
8. Neural Networks, Fuzzy logic and genetic Algorithm: Synthesis and Applications by Rajasekaran S. and Pai G. A.Vijaylakshmi Pal, PHI New Delhi.

DEPARTMENTAL ELECTIVE -II

EEE-415 (c)   POWER SYSTEM OPERATION AND CONTROL

L   T   P
3   1   0

Power System Control Centres
Aim of control centre, planning objective, functions of control centres, central facilities, communication, telemetry, emergency control.

Economic Dispatch
Characteristics of power generation unit; cost curves, incremental cost curve, heat rate curve, incremental efficiency, constraints in economic operation of power system, optimal allocation of total load among different units, derivation of kron's loss formula, optimal allocation of total load when transmission losses are considered.

Load Frequency Control
Types of alternator exciters, exciter modeling, modeling of alternator, static performance of AVR loop, dynamic performance of AVR loop, compensation in AVR loop, automatic load frequency control, types of turbine representation, steady state performance of the speed governing system, complete structure of primary ALFC loop and its responses, secondary ALFC loop and its performance, extension of ALFC loop to multi-area system, tie-line power flow model, static and transient responses of two area system, application aspects of primary and secondary ALFC loop, interfacing of AGC with economic dispatch.

Grounding System
Resistance of grounding system, design principles of substation grounding system, neutral grounding, ungrounded system, resonant, solid, resistance, reactance, earthing, transformer grounding, neutral grounding practice.

HVDC Transmission
Limitation of AC transmission system, advantages and disadvantages of HVDC transmission, type of HVDC links, main components of HVDC transmission.

Travelling Waves

Propagation of surges, energy and power of a surge, velocity of travelling waves, reflection and refraction of waves, line connected to cable, reflection and refraction at a T-junction, junction of several lines, attention and distortion of travelling waves. Brewley Lattice diagram, repeated reflections.

BOOKS/REFERENCES:

1) Power System Analysis by Hadi Saadat Tata Mc Graw Hill, New Delhi,2nd Edition,2002.
2) Power System Analysis Operation and Control by Abhijit Chakrabarti and Sunita Halder, 3rd Edition, PHI New Delhi
3) Electrical Power Systems by Ashfaq Hussain, CBS publication, 5th edition, 2009.

4) Electric Power Generation Transmission and Distribution by S.N. Singh, Prentice Hall of India, Private Limited, New Delhi, 2006.

5) Switchgear and Protection by Sunil S.Rao, B.Ravindernath & M.chander ,Khanna Publishers, Delhi,10th Edition,1992
6) Power System Protection and Switchgear by Wiley, John Wiley & Sons Canada, Limited, 1977.

DEPARTMENTAL ELECTIVE-II

EEE-415(d)   ADVANCED ELECTRICAL MACHINES

L   T   P
3   1   0

Introduction
Review of Transformers, Induction Machines, Synchronous Machines, DC machines and their applications.

Stepper Motors
Introduction, Construction and Principle of Stepper Motors, Step Angle Types of Stepper Motors – Variable Reluctance Stepper Motors, Multi-stack VR Stepper Motor, Permanent-Magnet Stepping Motor, Hybrid Stepper Motor, Summary of the Stepper Motors, Applications.

Permanent-Magnet DC Motor
Construction and Principle, Performance and Speed Control, Low-inertia DC Motors, Shell-type Low-inertia DC Motor, Printed-circuit (Disc) DC Motor- Main features, Advantages, Disadvantages and Applications.

Permanent-Magnet Synchronous Motors
Construction and Performance, Applications, Synchros, Types of Synchros- Control Transmitter, Control Receiver, Control Transformer, and Control Differential, Voltage Relations, Applications of Synchros, Torque Transmission and Error Detection.

Switched Reluctance Motor
Construction and Working Principle of Switched Reluctance Motor, Advantages and Disadvantages, Applications, Comparison between VR Stepper Motor and SR Motor.

Servomotors
DC Servomotors, AC servomotors, Two-phase AC servomotor, Three-phase AC servomotors

BOOKS:
1) Electrical Machinery   by P.S. Bhimbra, Khanna Publishers, Delhi,7th Edition,2004
2) Electric Machinery by A.E.Fitzerald, C.Kingsley and S.D.Umans, Tata McGraw Hill,6th Edition, 2002
3) Electrical Machines by Ashfaq Hussian, Dhanpat Rai & Company,2nd Edition,2002.
4) Electrical Machinery Fundamentals by S. J. Chapman, McGraw Hill,New York,2nd Edition,1991

DEPARTMENTAL ELECTIVE-II

EEE-415(e)   POWER PLANT ENGINEERING AND MANAGEMENT

L   T   P
3   1   0

Introduction:
Different types of Power generation technologies and power plants, thermal power plants, hydro power plants, nuclear power plants, wind power plants, solar power plants: Performance of power plants in energy generation and economics of power generation.

Electric generators:
Basic construction and classification, working principles, performance characteristics, losses, efficiency and testing of generators. Latest state of art in power generation technologies.

GAS TURBINES:
Introduction, thermodynamics of axial flow turbine, degree of reaction, preliminary design procedure for turbine stage, determination of turbine stage efficiency, axial flow turbine performance, compressor, turbine matching, radial inflow gas turbine, thermodynamic processes in radial inflow gas turbine.

Hydro TURBINES:
Types of hydro turbines, impulse and reaction turbines, suitability according to type of head, cavitation, performance characteristics, efficiency and losses in hydro turbines and testing of turbines.

WIND TURBINES:
Introduction to wind power, actuator theory, types of wind turbines, wind turbines characteristics and preliminary design analysis, variable speed performance of wind turbines, micro and nano- wind turbines, wind turbine applications.

Power Plant Management:
Dam safety management, function of SLDC and NLDC in power plant management and efficient operation. Various strategies for power generation management and demand /load management for a typical power pool or a complex grid. Efficient grid management approaches.   Role of energy exchanges in energy management, advantages and limitations. Smart grids.

Reference:
1. Generation of Electric Energy by: B.R. Gupta, S. Chand & Co.
2. Power System Stability Vol. I, II, III by: E.W. Kimbark, John Wiley & Sons, Inc.
3. Fundamentals of Turbo machinery by: William W Perg, John Wiley & Sons, Inc.
4. A Course in Power Plant Engineering by S. C. Arora, S. Domkundwar, Dhanpat Rai
5. Wind Power Plants: Fundamentals, Design, Construction and Operation by: By Robert Gasch, Jochen Twele, Springer

Semester-8

EED- 421   **HIGH VOLTAGE ENGINEERING**

L T P
3 1 3

Introduction

Levels of voltages, Electrical Insulation and Dielectrics, Importance of Electric Field Intensity in the Dielectrics, Types of Electric Fields, Degree of Uniformity of Fields (Schwaiger Factor), Stress Control.

Gaseous Dielectrics

Properties of atmospheric air and SF_6, Related ionization Process, Properties of vacuum, Related ionization Process, Development of Electron Avalanche, Breakdown Mechanisms, Townsend's Mechanism, Streamer Mechanism, Breakdown in Uniform Fields (Paschen's Law), Breakdown of gaseous dielectrics in Weakly Non-uniform and the limiting value of η, Development of 'Partial Breakdown' (PB) in Extremely Non-Uniform Fields, Breakdown characteristics' in air with stable PB (corona).

Liquid and Solid Dielectrics

Classification and Properties of Liquid Dielectrics, Classification and Properties of Solid Dielectrics, Permittivity and Polarization in Dielectrics, Insulation Resistance, Conductivity and Losses in Dielectrics, Partial Breakdown Phenomenon in Dielectrics, Partial Breakdown Phenomenon on the Surfaces of Soild and Liquid Dielectrics and degradation due to PB.

Breakdown in Liquid and Solid Dielectrics

Measurement of Intrinsic Breakdown in solid dielectrics, Thermal and other Breakdown Mechanisms in extremely non-uniform fields, Comparison of the development of breakdown in extremely and weakly non-uniform fields and the requirement of time for breakdown in solid dielectrics.

Generation of High Test Voltages

Methods of generation of Power Frequency high test voltage, Transformers in Cascade, Resonance Transformers, Generation of high dc voltage, Voltage Multiplier Circuits and Ripple Minimization, Sources of over voltages and Standard Lightning and Switching wave shapes, Impulse Voltage Generator, Analysis of Single Stage Circuit, Multistage Impulse Generator and their Triggering Methods.

Measurement of High Test Voltages

Peak High Voltage measurement techniques, Sphere gap; Construction; Effects of earthed objects and atmospheric conditions, Electrostatic Voltmeters, Principle and Construction, Potential Dividers, their types and applications,

Non-destructive High Voltage Testing and Quality Control

Measurable properties of dielectrics, Measurement of Dielectric properties with Schering Bridge and Megaohm meter, Parital Breakdown (PB) Measurement Techniques in Dielectrics/ Equipment.

Insulation Coordination and Over Voltages in Power Systems

Over voltages and Basic insulation level design.

BOOKS/REFERENCES:

1) High Voltage Engg. by M.S.Naidu and V.Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, 3rd Edition, 2004.
2) High Voltage Engg. by E.Kuffel and M. Alldullah, Pergamon Press, Oxford, 1970.
3) High Voltage Engineering, E.Kuffel and Zaengal, Second edition, Butterworth-Heinemann, 2000.

EED-422   COMMUNICATION SYSTEMS

L T P
3 1 0

Introduction to Communications Systems

Communication process, sources of information, communication channels, base band and pass band signals, representation of signals and systems, switched communication systems.

Continuous-Wave Modulation

Amplitude modulation (AM), frequency spectrum of the AM wave, representation of AM, power relations in the AM wave, AM detector, vestigial side-band modulation, Frequency spectrum of Frequency Modulation (FM) and Phase, Modulation, generation of FM (direct and indirect method), demodulation of FM signal, Tuned Radio-Frequency (TRF) receiver, Super heterodyne receiver.

Pulse Modulation

Sampling process, Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM), Time Division Multiplexing (TDM), Frequency Division Multiplexing (FDM).

Digital Modulation Techniques

Quantization process, Pulse Code Modulation (PCM), Differential Pulse Code Modulation (DPCM), Delta Modulation (DM), Adaptive Delta Modulation, Amplitude –Shift Keying (ASK), Frequency-Shift Keying (FSK), Phase-Shift
Keying (PSK).

Advanced Communication Systems

Computer communication system, Introduction to satellite communications, mobile communication, microwave communication links, Basic Radar System, Radar range, Pulsed Radar System, Plane position indicator, Tracking Radar, Moving target indicator (MTI), Picture Signal transmission and Reception, Facsimile-transmission and reception, Television scanning process, Inter laced scanning, composite video signals, vestigial side band modulation, TV Camera systems-image orthicon and vidicon, Basic principle of colour television.

BOOKS/REFERENCES:

1) Communication Systems by Simon Haykin and <u>Michael Moher</u>, Wiley India Pvt Ltd, 5th Edition,2009
2) An Introduction to Analog and Digital Communications by Simon Haykin, John Wiley & Sons,2008.
3) Principles of Communication Systems by H. Taub and D.L. Schilling, McGraw-Hill,2nd Edition, 1986
4) Electronic Communication Systems by George Kennedy, Tata McGraw Hill,4th Edition,2008
5) Principles of Communication Engineering by Anokh Singh, S.Chand & Company Limited, 2006.

EED-423   ADVANCED MICROPROCESSOR SYSTEMS AND MICROCONTROLLERS

L   T   P
3   1   3

Introduction
Evolution of Microprocessors and Microcontrollers, Multiprogramming, Multi-user System, Batch processing, Multi-tasking, Multiprocessor, Machine language, Assembly language, High-level language, Modular programming, structured programming, Microprogramming.

8086 Microprocessor
CPU architecture, PIN diagram and signal description for 8086, operating modes of 8086, Minimum mode 8086 based system, Maximum mode 8086 based system, instruction format, addressing modes of 8086, instruction set of 8086, memory and I/O interfacing, interrupts, Assembler directives, 8086 assembly language programming using loop instructions, jump instructions, programming using conditional & unconditional jumps, compare, rotate instructions, addition, subtraction, multiplication & division instructions etc.; Intel 80x86 Family of Processors: Intel 80186,Intel 80286, Intel 80386, Intel 80486,Pentium microprocessor, Advanced Pentium microprocessor, Numeric Data Processor 8087, architecture and interfacing of NDP 8087 to microprocessor 8086.

Micro Controllers
Introduction, functional block diagram of Intel 8051/8031 microcontroller, Memory organization in Intel 8051/8031 microcontroller, Memory and I/O interfacing in Intel 8051/8031 based system, Examples of memory and I/O interface in 8031/8051 based system, Addressing modes, Instruction set of Intel 8051/8031, Assembly language programming, Assembler Directives; Peripheral devices and interfacing, parallel data transfer schemes, Serial data communication in 8051 microcontroller, DAC interface, ADC interface, Application examples of Intel 8051 microcontroller, Intel 8096 microcontroller, architecture and SFRs of 8096, Trends and developments in microcontrollers.

BOOKS/REFERENCES:

1) Microprocessor and Interfacing (Programming and Hardware) by Douglas V.Hall, TMH India.
2) Microcontrollers Principles and Applications by Ajit Pal, PHI , New Delhi
3) Microprocessors & Microcontrollers by A. Nagoor Kani , First edition, RBA Publications
4) Microcomputer systems: the 8086/8088 family by Yu-cheng Liu & Glenn A.Gibson, PHI
5) Microprocessor 8086 Programming & Interfacing by A. Nagoor Kani , First edition, RBA Publications
6) 8051 Microcontroller by J. Aayla, PHI, New Delhi.

DEPARTMENTAL ELECTIVE-III

EEE-424 (a)   PROBABILITY, RANDOM VARIABLES, AND STOCHASTIC PROCESSES

L   T   P
3   1   0

Introduction to Probability Theory
Meaning of probability, definitions, set theory, probability space, conditional probability, probability of repeated trials and combined experiments, asymptotic theorems.

Concept of Random Variable, and functions of one random variable
Introduction, distribution, and density functions, conditional distributions, and total probability. Functions of one random variable and their distribution, and density functions, Mean, Variance, Moments, and characteristic functions.

Two Random Variables and their functions
Joint (bi-variate) distributions, one function of two random variables, two function of two random variables, joint moments of two random variables, joint characteristic functions, conditional distributions and mean square estimation

Two Random Variables and their functions
General concepts, characteristic functions, mean square estimation, stochastic convergence and limit theorems, random number meaning and generation.

Stochastic Processes
Definitions, system with stochastic inputs, power spectrum, mean square estimation; prediction, filtering.

BOOKS/REFERENCES:

1) Probability, Random Variables and Stochastic Processes by Papoulis,TMH,4th Edition,2002.
2) Modern Probability Theory and its Applications by E. Parzen, Wiley, 1992
3) An Introduction to Probability Theory and its Applications by W. Feller, Wiley,2nd Edition,1971.
4) Probability and Statistics with Reliability and Queuing and Computer Science Applications by K. S. Trivedi, PHI Learning,1st Edition, 2009.

DEPARTMENTAL ELECTIVE -III

EEE-424 (b)   PROCESS MODELING AND CONTROL

L   T   P
3   1   0

General Concepts
Review of general concepts, terminology, applications of process control. Simulation and Modeling: Importance of simulation, Mathematical modeling, Process dynamics of fluid flow and heat transfer systems, Mass transfer dynamics and distillation column, Reaction kinetics of chemical processes.

Advanced Control Schemes
Structure, analysis and application of Cascade control, Selective control, Ratio Control, Design of steady state and dynamic Feed forward controller, Feed forward combined with feedback control, Structure, analysis and applications of inferential control, dead time and inverse response compensators, Concepts and applications of Adaptive control, Model reference adaptive control, Self tuning regulator .

Design of Multi-loop Controllers
Interactions and decoupling of control loops. Design of cross controllers and selection of loops using Relative Gain Array (RGA)

Real Time Control
Characteristics and classes of real-time systems, program classification: sequential, multi tasking, real time, concurrency and synchronization, design strategies

Distributed Computing Systems
Distributed processing issues in distributed data base systems.

BOOKS/REFERENCES:
1) Process Systems Analysis & Control by Donald R.Coughanowr. Mc Graw – Hill International Editions,2nd Edition.
2) Design of feedback Control System by <u>Raymond T. Stefani</u>, Oxford University Press, 4th Edition, 2002
3) Modern Control System Theory by Gopal M, New Age International (P) Ltd,New Delhi, 2nd Edition, 2005

DEPARTMENTAL ELECTIVE -III

EEE-424 (c)   **DESIGN OF FEEDBACK CONTROL SYSTEMS**

                                                    L   T   P
                                                    3   1   0

Control System and Analysis:
Differential equations, Lap lace Transforms, Transfer functions of linear systems, Transient response characteristics and system stability, Disturbance and Sensitivity, Transient performance and effects of zeros.

Frequency Domain Design:
System Bode plot, Open loop and closed-loop behavior in frequency domain, Frequency response analysis, Gain and Phase Margins.

Classical Control Design Techniques:
Introduction to system design using compensators, Root locus rules, Root locus compensation design, Lead, Lag, Lead-Lag compensation, PI, PD and PID controllers, Feedback compensation, Feed forward control.

State Space Design of Systems:
Introduction to state space formulation, Concepts of controllability and observability, Full state feedback control design, Observer design, Integrated full state feedback and observer design.

BOOKS/REFERENCES:

5) Discrete time Control Systems by K. Ogata, Prentice Hall International, 2nd Edition, 1995.
6) Control System Engineering by Nagrath and Gopal,New Age International, 4th Edition, 2006
7) Digital Control Systems by B.C. Kuo, Oxford University Press.

DEPARTMENTAL ELECTIVE-III

EEE- 424 (d)   ADVANCED POWER ELECTRONICS

L T P
3 1 0

AC to DC Converters
Harmonic analysis of output voltage and input current for 2-pulse and 6 pulse controlled rectifiers and methods of reducing these harmonics, Multi-pulse rectifiers.

DC to AC Converters
Analysis of output voltage waveforms of single phase and three phase voltage source inverters. Methods of reducing output harmonics.

Resonant Converters
Classification, basic resonant converter, loads resonant converter, resonant switch converter and zero voltage switching.

Power Conditioners and UPS
Power line disturbances, generation of harmonics, harmonic standards and recommended practice, power conditioners and uninterruptible power supplies, EMI & EMC related issues, mitigation methods

Motor Drive Applications
Converters for adjustable speed DC motor and induction motor drives. Methods of improving voltage, current profile of an electric drive, latest trends in the drive performance control.

BOOKS/REFERENCES:

1) Power Electronics by Nedmohan, Undeland and Riobbins, John Wiley India, publishers,Delhi,3rd edition,2006
2) Thyristorised Power Controllers by G.K.Dubey, Wiley Eastern, 1986
3) Modern Power electronics & Drives by B.K.Bose, Prentice Hall, PJR
4) Power Electronics by P.S.Bhimbra, Khanna Publishers, Delhi (4th edition)
5) Control of Electrical Drives by Werner Leonhard, Springer, International Publication,3rd Edition, 2001.
6) An introduction to thyristors and their applications by M. Ramamoorty, Macmillan, 1978

DEPARTMENTAL ELECTIVE -III

EEE- 424 (e)   **DESIGN OF HYDRO POWER STATION**

                                                                  L   T   P

                                                                  3   1   0

Layout & Planning of Hydro Power Plant: Introduction, layout of power house, types of hydro power schemes, stages of investigation, PFR, DPR, hydrology, water availability and water conductor system. Penstocks, types, penstock supports, trash racks.

Power Potential Estimation of Hydro Power Plants: Head, dependability analysis, layout of electrical equipments in hydro power station, selection of number of units, capacity of power plant and energy generation, and economics of the hydro power plant.

Turbines: Introduction, types of hydraulic turbines and their suitability for power plant, governing of turbines, electro hydraulic governors, time constants of governors and their importance, testing of hydraulic turbines, cavitation, silt erosion.

Hydro Generators: Introduction, construction and types of hydro generators, specifications of hydro generators, characteristics of hydro generators, general arrangement of water wheel generators: large horizontal shaft generators, vertical and reversible generators, low speed generators, umbrella type, brakes and jacks, losses, insulation and temperature limits, testing of generators, generator cooling and ventilation, fire protection, design of auxiliary and grounding systems, switchyard equipments, transformers and circuit breakers.

Stability of Hydro Power Plants: Special features of hydro power plant stability.

BOOKS/REFERENCES:

1) J. Guthrie Brown, Hydro Electric Engineering: Vol.I,II,III ; Blackie & Son Ltd., London. Nigam, A Hand Book of Hydro Electric Engineering, Nem Chand Publishers, Roorkee.
2) B.R.Gupta, Generation of Electrical Energy, S. Chand & Co.
3) M.V.Deshpande, Elements of Electrical Power Station ,Design, Ah Wheeler & Co Ltd.
4) Kothari & Nagrath, Electrical Machines, TMH.

DEPARTMENTAL ELECTIVE-IV

EEE-425 (a)   **POWER QUALITY AND HARMONICS**

L   T   P
3   1   0

Introduction: Introduction to power quality, voltage quality. Overview of power quality, Power quality phenomena and classification of power quality issues.

Power quality measures and standards-THDTIF-DIN-message weights-flicker factor-transient phenomena-occurrence of power quality problems-power acceptability curves-IEEE guides, EMC standards and recommended practices.

Harmonic Device Modeling: Harmonics background, basic concepts, Fourier analysis. Harmonics-individual and total harmonic distortion-RMS value of a harmonic waveform-triplex harmonic-important harmonic introducing devices-Transformer, Three phase power converters-arcing devices-saturable devices. Harmonic distortion due to fluorescent lamps. Effect of power system harmonics on power system equipment and loads.

Modeling of networks and components under non-sinusoidal conditions-transmission and distribution systems-shunt capacitors-transformers-electric machines-ground systems-loads that cause power quality problems-power quality problems created by drives and impact on drives.

Harmonic Mitigation: Harmonic resonance, Impedance Scan Analysis- Passive filtering. Introduction to active power filtering. Control methods for single phase APFC.

Grounding: Grounding and wiring –introduction-NEC grounding requirements-reasons for grounding-typical grounding and wiring problems-soklutions to grounding and wiring problems.

TEXT BOOKS/REFERENCES:
1. Electric Power Quality, G. T. Heydt
2. Power System Harmonic Analysis, J. Arrillaga, B. C. Smith, N. R. Watson & A. R. Wood
3. Understanding Power Quality Problems, Math H. Bollen.
4. Power System Quality Assessment, J. Arrillaga.
5. IEEE standard on electrical grounding

DEPARTMENTAL ELECTIVE-IV

EEE- 425(b)   **BIOMEDICAL INSTRUMENTATION**

L T P
3 1 0

Bioelectric Signals and Electrodes
Biometrics, physiological systems of the body and problems in measuring a living system.

Physiological Transducers
Pressure transducers, body temperature transducers, pulse sensors, respiration sensors, bioelectric potentials, bio-potential electrodes.

Biomedical Recorders and Display Systems
Block diagrams of electro cardiograph, phonocardiograph, electroencephalograph and electro-myograph.

Patient Monitoring Instruments
Block diagram of patient monitoring system, Basic cardiac arrhythmias and ambulatory monitoring instruments, measurement of heart rate, blood pressure, temperature and respiration rate.

Patient Safety
Physiological effects of electric current, electric shock hazards from electrical equipment, methods of accident prevention.

Biomedical Telemetry
Single/multi-channel telemetry system and applications of telemetry in patient care.

Modern Imaging Systems
X-ray machine and X-ray computed tomography, basic magnetic resonance imaging components, basic ultrasonic imaging system, computer applications in biomedical instrumentation.

BOOKS/REFERENCES:

1) Biomedical Instrumentation and Measurements by Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, (PHI) New Delhi,2nd Edition,1980.
2) Hand- book of Biomedical Instrumentation by R.S. Khandpur (TMH) New Delhi,2nd Edition, 2008
3) Biomedical Instruments: Theory and Design by Walter Welkowitz, Sid Deutsch and Metin Akay, Academic Press, 2nd Edition,1992

DEPARTMENTAL ELECTIVE-IV

EEE- 425(c)   REACTIVE POWER CONTROL & FACTS DEVICES

L T P
3 1 0

Fundamentals of ac power transmission, transmission problems and needs, emergence of FACTS-FACTS control considerations, FACTS controllers.

Principles of shunt compensation – Variable Impedance type & switching converter type- Static Synchronous Compensator (STATCOM) configuration, characteristics and control.

Principles of static series compensation using GCSC, TCSC and TSSC, applications, Static Synchronous Series Compensator (SSSC).

Principles of operation-Steady state model and characteristics of a static voltage regulators and phase shifters- power circuit configurations.

UPFC -Principles of operation and characteristics, independent active and reactive power flow control, comparison of UPFC with the controlled series compensators and phase shifters.

BOOKS/REFERENCES:

1. Song, Y.H. and Allan T. Johns,'Flexible ac transmission systems (FACTS)',
     Institution of Electrical Engineers Press, London, 1999.
2. Hingorani ,L.Gyugyi 'Concepts and Technology of flexible ac transmission
    system', IEEE Press New York, 2000 ISBN –078033 4588.
3. IEE Tutorials on 'Flexible ac transmission systems' published in Power
    Engineering Journal, IEE Press, 1995.

DEPARTMENTAL ELECTIVE-IV

EEE-425 (d)   **OPTIMAL CONTROL THEORY**

L   T   P
3   1   0

Introduction
Optimal control problem, classification of optimal control problems, performance measures for optimal control problems, selection of performance measures.

Static Optimization
Static optimization problem formulation, direct method, Lagrange multiplier method, optimization without constraints, optimization with equality constraints.

Calculus of Variation
Fundamental concepts, Euler-Lagrange equation for different two point boundary value problems with free or fixed final condition, Dynamic optimization with equality and nonequality constraints, Pontryagin minimum principle, optimization using gradient method and steepest descent method.

Linear Quadratic Regulator Problem
Problem formulation for continuous time systems and discrete time systems, Matrix-Riccati equation, output regulator and tracking problem.

Multistage Optimization Process
Introduction to multistage decision process, principle of optimality, Dynamic Programming based optimization, Hamilton-Jacobi-Bellman principle.

Constrained Optimal Control Problems
Time optimal control of LTI systems, problem formulation, solution of time optimal control problem, Bang-Bang control, Fuel optimal control problem, Energy optimal control problem.

BOOKS/REFERENCES:

1) Modern Control System Theory by Gopal M, New Age International (P) Ltd, New Delhi, 2nd Edition, 2005
2) Optimum Systems Control by Sage A. P. and White C.C, Prentice Hall, 2nd Edition,1977
3) Optimal Control by Anderson B.D.O., Moore J.B Prentice Hall 1971
4) Optimal Control Theory by Kirk D.E, Courier Dover Publications, 2004