ELECTRICAL ENGINEERING

5th Semester				6th Semester			
Subject Code	***Theory***	***Contact hrs L-T-P***	***Credit C***	***Subject Code***	***Theory***	***Contact hrs L-T-P***	***Credit C***
MA 301 CY-301	Optimization in Engg OR Bio-Environmental Engg.	3-0-0	3	MA -301 CY- 301	Optimization in Engg OR Bio-Environmental Engg.	3-0-0	3
EE- 321 EC- 333	Power Electronics OR Microprocessor & Microcontrollers	3-0-0	3	EE- 321 EC -333	Power Electronics OR Microprocessor & Microcontrollers	3-0-0	3
IC- 321	Control System Engg.	3-1-0	4	EC- 361	Electromagnetic Theory	3-1-0	4
EE -313	Electrical Machine – II	3-0-0	3	EE -333	Power System Engg–I	3-1-0	4
IC- 311	Instrumentation & Measurement	3-0-0	3	EC -321	Digital Signal Processing	3-0-0	3
	TOTAL	**16**	**16**		**TOTAL**	**17**	**17**
Subject Code	***Practicals / Sessionals***	***L-T-P***	***Credit***	***Subject Code***	***Practicals / Sessionals***	***L-T-P***	***Credit***
EE- 371 EC- 373	Power Electronics Lab. OR Microprocessor & Microcontroller Lab.	0-0-3	2	EC- 371 EE -371	Microprocessor & Microcontroller Lab. OR Power Electronics Lab.	0-0-3	2
EE- 373	Electrical Machine Lab.	0-0-3	2	EC- 371	DSP Lab.	0-0-3	2
EE- 375	Electrical Power Apparatus Design Lab.	0-0-3	2	IC-373	Instrumentation & Control Lab.	0-0-3	2
	Total	**9**	**6**		**Total**	**9**	**6**
	Grand Total	**25**	**22**		**Grand Total**	**26**	**23**

MA-301 OPTIMIZATION IN ENGINEERING (3-0-0)

MODULE-I (15 Hours)

Two variable LP model, Graphical sensitivity analysis, The Simplex method, Computational details, Simplex algorithm, Artificial Starting solution, Degeneracy, Alternative optima , unbounded solution. Duality and Sensitivity analysis, primal Dual relation, Transportation Model, Non-traditional transportation model, Assignment model, Humgarian method, Networks, Shortest route problem, Maximal flow method.

MODULE-II (13 Hours)

Integer linear programming, Illustration Branch & Bound Algorithm, Cutting-plane algorithm, Dynamics programming, Knapsack model, Decision analysis & Game Theory, Simulation modelling, Monte-Carlo simulation for discrete events.

MODULE-III (12 Hours)

Nonlinear programming, Unconstrained optimizations, unimodal function, Necessary & sufficient conditions, Newton Raphson method, constrained algorithm, Direct search method, gradient method.

TEXT BOOKS

1. H. A Taha, Operations Research: An Introduction, Pearson Education, (7^{th} Edition); Ch-2[2.1,2.2 (2.2.1, 2.2.2), 2.3], Ch-3[3.1, 3.3, (3.3.1, 3.3.2) 3.4, 3.5], Ch-4[4.1, 4.2, 4.4 (4.4.1), 4.5 (4.5.1, 4.5.2)], Ch-5[5.1, 5.3(5.3.1, 5.3.2), 5.4(5.4.1)], Ch-6[6.1, 6.3 (6.3.1, 6.3.2), 6.4 (6.4.1, 6.4.2)], Ch-9 [9.1, 9.2(9.2.1, 9.2.3)], Ch-10 [10.3.1 Ch-14 **:**14.3, 14.4], Ch-18 [18.1**,** 18.4], Ch-20[20.1(20.1.1), 20.2 (20.2.1, 20.2.2)], Ch-21[21.1]

REFERENCE BOOKS

1. F.S Hiller, G. J. Libermen, An Introduction to Operations Research: Concepts & Cases, (8^{th} Edition), TMH Publication.
2. Kalyanmayee Dev, Optimization for Engineering Design, PHI Publications

CY-301 BIO-ENVIRONMENTAL ENGINEERING (3-0-0)

MODULE –I (22 hours)

Fundamentals of Ecology: Components and structures of Eco-system. Levels of organization in the biotic components of the Eco-system. Eco-system processes- Energy flow-primary and secondary production, tropic level, food chain & food web and Bio-magnification. Decomposition and Nutrient Cycling- Biogeochemical cycles of nature- Carbon cycle, Nitrogen cycle and Hydrological cycle.

Fundamentals of Chemistry and Microbiology

Water chemistry : Concentration expressions, mole concept and Stoichiometry. Physical & chemical properties of water. Organic chemical properties and their measurement, parameters like BOD, COD, and TOC & TOD Inorganic properties like pH, Alkalinity, Hardness, conductivity and Solubility.

Atmospheric chemistry – structure of atmosphere, chemistry of primary and secondary air pollutants.

Chemical Reaction- Chemical & Bio-chemical Reactions fundamentals of reaction kinetics, Reactor configurations and material balances.

Microbiology – Important microbes in Environmental Engineering, Microbial growth and decay rates, Aerobic & Anaerobic group of bacteria.

ENVIRONMENTAL POLLUTION

Water Pollution:- Water quality standard and parameter (Indian Standard Drinking Water Specifications, IS 10500, 1991), Physical, Chemical and Biological methods of assessment of water quality, Aquatic Pollution, Fresh Water Pollution:- Organic Pollution, Oxygen Sag Curve,

Eutrophication and Acidification, Estuarine water quality, Marine Pollution and Ground water pollution. Parameters of organic content of water quality, DO and BOD in streams, Deaeration and Reaeration kinetics in streams (Streeter – Phelps oxygen sag formula)

Air Pollution:- Primary and Secondary pollutants, units of concentration, Global air pollution-Acid rain , Global warming and ozone layer depletion. Air pollution meteorology – Ambient and Adiabatic lapse rate, Atmospheric stability Lapse rates and Dispersion, Atmospheric Dispersion.

Noise Pollution: Sources of noise, Physical properties of sound, resultant and equivalent sound levels, Noise control measures and impact of noise on human health.

MODULE-II (14 Hours)

ENVIRONMENTAL POLLUTION CONTROL

Water Treatment:- Conventional water treatment comprising of Pre-treatment – Screenings, Aeration and Equalisation Primary Treatment – Sedimentation, Coagulation, Filtration Disinferction – Chlorination, Breakpoint chlorinatioin Advanced water treatment – Fluoridation, Deflouridation, Ion-Exchange and Reverse Osmosis.

Wastewater Treatment (Domestic waste water) : Wastewater flow and characteristics Pretreatment-Screenings, Grit chamber, Equalisation and storage. Primary treatment – Sedimentation and coagulation Biological treatment (Aerobic) Activated Sludge Process (ASP) with complete mix reactor and design parameters. Biological treatment (Anaerobic)

Municipal Solid Waste (MSW) : Physical, Chemical and Energy properties of MSW, MSW Management – Composting, MSW Management – Landfill Operations

Hazardous Waste Management: Characterization, Hazardous Waste Treatment – Incineration

Industrial Air Emission Control : Gaseous Emission Control – Absorption, Adsorption and Condensation, Particulate Emission Control – Gravity Settling Chamber, Cyclone Separator, Bag Filter and Electrostatic Precipitator, Flue gas desulpherisation, NO_x Emission Control and Fugitive Emission

MODULE-III (6 Hours)

ENVIRONMENTAL MANAGEMENT

Evolution of environmental legislation in India, Environment, Development and Sustainable Development, ISO 14,000- Environmental Management Systems – Life Cycle Assessment

Elements of waste minimization- strategy-Reduction at source, Recycling/Reuse/ Recovery, Waste treatment and Disposal, Waste minimization program, Cost benefit analysis and advantage of clean technology

Environmental Impact Assessment

Stages of EIA procedure – Screening, Scoping, Environmental Impact Statement (EIS), Public Participation and Review, Generic Structure of EIA report:- Project Profile, Baseline Data Collection, Impact Prediction and Assessment, Environmental Management Plan (EMP) and Post EMP Monitoring.

TEXT BOOKS

1. Gerard Kiely, Environmental Engineering, Tata McGraw Hill Publishing Company Limited
2. Peavy, Rowe and Tchobanoglous, Environmental Engineering, Tata McGraw Hill Company Ltd.1981,(International Edition).

C.S.Rao, Environmental Pollution Control Engg., Wiely Eastern Ltd, New Delhi,1999.

EE-321 POWER ELECTRONICS (3-0-0)

MODULE-I (16 Hours)

Power Semiconductor Devices :

Power Diodes : Types, characteristics

Thyristors : SCR, Static V-I characteristics of SCR, two transistor analogy of SCR, dynamic characteristics of SCR, Gate characteristics of SCR, Thyristor ratings, DIAC, TRIAC, GRO, UJT.

Power Transistors : Power BJT, Power MOSFETS, IGBT.

Triggering Circuits : R- Triggering, R-C Triggering, UJT triggering, Design of UJT triggering circuit, Cosine law triggering, triggering circuit using pulse train.

Thyristor commutation circuits : Class-A, Class-B, Class-C, Class-D, Calss-E, Class-F commutation circuits. Series and parallel operation of thyristors, protection of thyristors : di/dt protection, dv/dt protection, design of snubber circuit, overvoltage protection, over current protection.

MODULE-II (14 Hours)

Control rectifiers (AC to Dc converter) : Single phase converters : Principle of phase control, half wave controlled rectifier with R, R-L and R-L-E load, fully controlled bridge converter with R, R-L, R-L-E load. Effect of freewheeling diode, performance measures of two pulse converters. Half controlled (semi) converter. Effect of single phase full converter with source inductance. Dual converter. **Three phase converter :** 3-phase half wave controlled rectifier with R, and R-L load, 3-phase fully controlled bridge converter with R-L load (6-puse converter), 3-phase semi converter.

MODULE-III (10 Hours)

Inverter : Series inverter, parallel inverter, single phase bridge inverter. Mc-Murray inverter, Mc-Murray bed ford inverter, concept of VSI and CSI,3-phase bridge inverter (120^0 and 180^0 conduction mode), concept of PWM inverter.

D.C. Choppers : Principle of operation, control techniques, analysis of step down chopper with R-L-E load. Step up chopper, classification of choppers (Type A,B,C,D,E,) voltage commutated chopper, current commutated chopper, load commutated chopper.

Cyclo converters : Mid point-type and bridge type cyclo converter with R and R-L load.

Applications : HVDC transmission, UPS, Arc welding,. Zero voltage switch.

TEXT BOOKS

1. Singh & Khanchandani, Power Electronics, TMH
2. P.S. Bhimbra,Power Electronics, Khanna Publication
3. M.H. Rashid,Power Electronics, Pearson Publication

REFERENCE BOOKS

1. P.C. Sen , Power Electronics, TMH.
2. V.R. Murty, Power Electronics, Oxford Publication

EC- 333 MICROPROCESSORS & MICROCONTROLLERS (3-0-0)

MODULE-I (12 Hours)

Microprocessor Architecture:- Introduction to Microprocessor and Microcomputer Architecture, Pins & Signals, Register Organization, Timing & Control MODULE, 8085 Instruction Timing & Execution. Instruction Set and Assembly Language Programming of 8085:- Instruction set of 8085,

Memory & I/O Addressing, Assembly language programming using 8085 Instruction Set, use of Stack & Subroutines. Memory Interfacing:- Interfacing EPROM & RAM Memories Interrupts:-8085 Interrupts

MODULE-II (12 Hours)

Microprocessor Based System Development Aids:- Programmable Peripheral Interface: 8255, Programmable DMA Controller: 8257, Programmable Interrupt Controller: 8259, Microcontroller (Architecture and Programming):- Introduction to 8051 Microcontrollers (Architecture, Pin description), 8051 Assembly Language Programming (JUMP, LOOP, CALL Instructions), I/O Port Programming, 8051 Addressing Modes, Arithmetic & Logic Instructions, Microcontroller Interrupts and Interfacing to 8255:- 8051 Interrupts, Interfacing to 8255

MODULE-III (12 Hours)

Intel 8086 (16 bit processors):-8086 Architecture, Addressing Modes, Instruction Format, Pins & Signals, 8086 Basic System Concept, Interfacing with Memories, 8086 Interrupts.

Intel 80386 :- Introduction to 80386 Microprocessor, Architecture, Pins & Signals, Memory System, Registers, 80386 Memory Management, Paging Technique, Protected Mode Operation, brief introduction to 80387 Math Coprocessor. Pentium Processors (Only features):- Introduction to Pentium Processors, Memory System, Input/Output System, Branch Prediction Logic, Floating Point MODULE, Cache Structure, Superscalar Architecture.

(only the features of Pentium Processor mentioned above are to be discussed)

TEXT BOOKS:

1. Ghosh & Sridhar, 0000 to 8085 -Introduction to Microprocessor for Scientists & Engineers, PHI publication (for MODULE I to MODULE-III)
2. A.K. Roy & K.M. Bhurchandi, Advanced Microprocessor and Peripherals (Architecture, Programming & Interfacing), TMH Publication (For MODULE-V to MODULE- VII)
3. Mazidi & Mazidi, The 8051 Microcontroller & Embedded Systems, Pearson / PHI

IC-321 CONTROL SYSTEM ENGINEERING (3-1-0)

MODULE-I (10 Hours)

Introduction : Basic concepts of control systems, open loop and closed loop systems, difference between open loop and closed loop systems, classifications.

Mathematical model of physical systems, transfer function, block diagram algebra, signal flow graph (SFG), Masoin's gain formula, application of SFG to control systems.

Feed back theory : Types of feedbacks, effect of degenerative feedback on control systems, regenerative feedback. Components : A.C. Servo Motor, DC servo motor, synchros,

MODULE-II (10 Hours)

Time domain analysis : Standard test signals : Step, ramp, parabolic and impulse signals. Time response of 1st order systems to unit step and unit ramp inputs. Time response of 2^{nd} order to unit step input. Time response specifications. Steady state errors and error constants of different types of control systems Generalized error series method

Concepts of stability : Necessary conditions of stability, Hurwitz stability criterion, routh stability criterion, application of routh stability criterion to linear feed back systems, relative stability.

MODULE-III (15 Hours)

Root locus techniques : Root locus concepts, rules for construction of root loci, determination of root locus, root contours. Frequency domain analysis: Introduction, bode plots, determination of stability

from Bode plots, polar plots Nyquist stability criterion, Applications of nyquist to the liner feed back system. Closed loop frequency response: Constant M circles, constant N circles, use of Nicolas chart Controllers: Introduction proportional, derivative and integral control actions, P, PI and PID controllers.

TEXT BOOKS:

1. D.Roy Choudhury, Modern Control Engineering, PHI
2. K. Ogata, Modem Control Engineering, PHI
3. L.J. Nagrath, M. Gopal, Control Systems Engineering, Third Edition,
4. New Age International Publishers. Reference Book

REFERNCE BOOKS

1. Samarjit Ghosh, Control System, Theory & Applications, Pearson Education
2. Eroni Umez Erani. System Dynamic and Control, PWS Publishing, International Thompson Publishing Company

EE-313 ELECTRICAL MACHINES-II (3-1-0)

MODULE-I (18 Hours)

DC Machine: - Armature reaction and its effects, commutation, brush shift, interpoles and compensating winding.

DC Generator: - Parallel operation of generators (shunt and series type)

DC Motor: - Speed control by voltage controlled method (Ward Leonard method), Swinburn's best, brake test and Hopkinson's test.

Transformer :

Single phase transformer : All day efficiency, back to back test, PU representation, parallel operation and load sharing.

Three phase transformer : Construction of core type and shell type transformer, three single phase transformers connected as a bank of 3 phase transformer, phasor groups, phase conversions, 3 phase to 6 phase, T-connection of two single phase transformers, parallel operation of three phase transformer, three winding transformer and its equivalent circuit.

MODULE-II (12 Hours)

Three Phase Synchronous Generator :- Short circuit ratio, voltage regulation by synchronous impedance method, MMF method and zero p.f. method. Two reaction theory, phasor diagram, slip test, power angle equation, power angle characteristics for both type alternators, synchronization of alternators, synchronizing power and torque, load sharing, loading of alternators connected in infinite bus.

Synchronous motor : Power angle characteristics of salient and non salient type, phase diagram, hunting and its remedy, uses as synchronous condenser, effect of varying field current.

MODULE-III (10 Hours)

Polyphase Induction Motor : - Determination of equivalent circuit parameter from No load and blocked rotor test, circle diagram, speed control by voltage control method, pole changing method, V/f control, rotor resistance control, voltage injection method and cascading. Cogging and Crawing, Principle of induction generator.

Single Phase Induction Motor : Double field revolving theory, shaded pole induction motor.

AC series motor : Construction and principle of operation of plain and compensated series motor, problem in commutation and their remedy. Phasor diagram, universal motor.

Special Machine : Principle of operation of reluctance motor, hysteresis motor, single and three phase induction regulator.

TEXT BOOKS

1. Nagrath and Kothari, Electrical machine, Tata Mc Graw Hill.
2. R.K. Rajput, by Electrical Machines, Laxmi Publication.
3. P.S. Bhimbra Electrical machine, Khana Publishers.

REFERENCES

1. J.B. Gupta, S.K. Kothari, Electrical Machine.
2. Chapman, Electrical Machine, Mc Graw Hill.
3. Fitzerald, Electrical Machine Kingley, Umans.
4. Sharma and Pathak, Electric Machines, Cengage Learning.

IC-315 INSTRUMENTATION & MEASUREMENT (3-0-0)

MODULE-I (10 Hours)

Classification, Absolute and Secondary instruments, indicating instruments, control, balancing and damping, construction details, characteristics, errors in measurement.

Wattmeters : Induction type, single phase and three phase wattmeter's, compensations.

Energy meters : AC Induction type single phase and three phase energy meter compensation, creep, error, testing.

Frequency meters : Vibrating reed type, electrical resonance type

MODULE-II (15 Hours)

Instrument Transformers : Potential and current transformers, ratio and phase angle errors, phasor diagram, methods of minizing errors, testing and applications

Galvanometers : General principle and performance equations of D'Arsonval Galvanometers Ballistic Galvanometer, undamped, underdamped and overdamped motion of galvanometer.

Potentiometers : D.C. Potentiometer-Crompton potentiometer, construction, standardization, application, AC. Potentiometer-Drysdale polar potentiometer; Gall Tinsley coordinate type potentiometer, standardization, application.

MODULE-III (10 Hours)

DC & AC Bridges : General equations for bridge balance, measurement of self inductance by Maxwell's bridge (with variable inductance variable capacitance), measurement of capacitance by Schering bridge, errors, Kelvin's double bridge.

Transducer : Strain Gauges, Thermistors, Thermocouples. Linear Variable Differential Transformer (LVDT) Capacitive Transducers, Peizo-Electric transducers. Optical Transducer, Torque meters, inductive torque transducers, electric tachometers, photo electric tachometers.

Electronic Instruments : CRO : Block Diagram, sweep generation, vertial amplifiers, use of CRO in measurement of frequency, phase, Amplitude and rise time of a pulse.

Digital Multimeter : Block diagram, principle of operation, Accuracy of measurement

Electronic Voltmeter : Transistor Voltmeter, Block diagram, principle of operation, accuracy of measurement : metering amplifier.

TEXT BOOKS

1. A.K. Sawhney, A Course in Elec. & Electronic Measurement and Instrumentation:

REFERENCE BOOKS

1. W.O. Cooper, Electronic Instrumentation and measurement techniques
2. Larry Jones & A foster , Chin Electronic measurement & Instrumentation systems
3. Golding & Waddis, Electronic measurement & measuring Instruments

EC- 361 ELECTROMAGNETIC THEORY (3-1-0)

MODULE – I (16 Hours)

Review of the Co-ordinate Systems: Rectangular, Cylindrical, and Spherical Co-ordinate System. Co-ordinate transformation. Gradient of a Scalar field, Divergence of a Vector field and Curl of a Vector field. Their Physical interpretation. The Laplacian. Divergence Theorem, Stokes'Theorem. Useful Vector identities.

Electrostatics: The experimental laws of Coulomb, Electric field intensity. Field due to a line charge, Sheet Charge and Continuous Volume Charge distribution. Electric Flux and Flux Density; Gauss's law. Application of Gauss's law. Energy and Potential. The Potential Gradient. The Electric dipole. The Equipotential surfaces. Energy stored in an electrostatic field. Boundary Conditions. Capacitors and Capacitances. Poisson's and Laplace's equations. Solutions of Simple Boundary value problems. Method of Images.

Steady Electric Currents: Current densities, Resistance of a Conductor; The Equation of Continuity. Joules law. Boundary Conditions for Current densities. The EMF.

MODULE – II (16 Hours)

Magnetostatics: The Biot-Savart law. Amperes' Force Law. Torque exerted on a current carrying loop by a magnetic field. Gauss's law for magnetic fields. Magnetic Vector Potential. Magnetic Field Intensity and Ampere's Circuital law. Boundary conditions. Magnetic Materials . Energy in magnetic field . Magnetic circuits.

Faraday's Law of Induction: Self and Mutual inductance. Maxwell's Equations from Ampere's and Gauss's Laws. Maxwell's Equations in Differential and Integral forms; Equation of Continuity. Concept of Displacement Current. Electromagnetic Boundary Conditions. Poynting's Theorem , Time - Harmonic EM Fields . Application to Transformer.

Plane wave Propagation : Helmholtz wave Equation. Plane wave solution. Plane wave propagation in lossless and lossy dielectric medium and conducting medium. Plane wave in good conductor, surface resistance, depth of penetration. Polarization of EM wave - Linear, Circular and Elliptical polarization. Normal and Oblique incidence of linearly Polarized wave at the plane boundary of a perfect conductor, Dielectric - Dielectric Interface. Reflection and Transmission Co-efficient for parallel and perpendicular polarizations, Brewster angle.

MODULE – III (10 Hours)

Transmission lines: Lumped-Element Circuit model of a uniform transmission line. Wave solution. Propagation constant γ and characteristic impedance Z0. Losslas line. Sending end impedance. Reflection Co-efficient & VSWR for various terminating conditions. Length of transmission line as circuit elements. Field analysis of co-ax and two-wire transmission lines. R,L,C&G parameters.

Note to Instructor: The subject can be better mastered by solving problem. Please workout as many problems as possible in the class and through assignments.

TEXT BOOKS:

1. E. C. Jordan & K. G. Balmin, Electromagnetic waves and Radiating Systems, 2nd Edition. PHI Pvt. Ltd.
2. B. S. Guru & Huseyn R. Hiziroglu. Electromagnetic Field Theory, Fundamental, Publication: Thomson Asia Pte. Ltd. Singapore. Vikas Publishing Home Pvt. Ltd. New Delhi.

REFERENCES

1. Mathew N. O. Sadiku, Elements of Electromagnetic, Publisher Oxford University Press.
2. Hayt & Buck, Engineering Electromagnetics , 7th Edition Tata McGraw Hill.
3. N. Narayan Rao, Elements of Engineering Electromagnetics – 6th Edition, Pearson Education.

EE-333 POWER SYSTEM ENGINEERING - I (3-1-0)

MODULE-I (14 hours)

Power Transmission by AC & DC Systems, Comparison of efficiencies of various systems.

Resistance, inductance and capacitance of single and three phase lines with symmetrical and unsymmetrical spacing, transposition, charging current, skin effect and proximity effect.

Performance of transmission Lines : Analysis of short, medium and long lines, equivalent circuit, representation of the lines and calculation of transmission parameters.

MODULE-II (13 Hours)

Corona: power loss due to corona, practical importance of corona, and inductive interference with neighbouring communication lines, use of bundled conductors in e.h.v. transmission lines and its advantages.**Overhead line Insulators:** Types of insulators, Voltage distribution in suspension type insulators, method of equalizing, economic use of insulator, arcing horns and grading ring.

Mechanical Design of Overhead Transmission Line: Sag and stress calculation, effects of ice and wind , vibration of transmission lines, dampers & spacers . **Under ground cables :** Type and construction, grading of cables, capacitance in 3 core cables and dielectric loss

MODULE-III (11 Hours)

Distribution system : Effect of System voltage on transmission efficiency. Economic choice of conductor size, Kelvin's Law, types of distributors and feeders (radial & ring), voltage drop and load calculation for concentrated and distributed loads.

Substation & Earthing : Types of substation, arrangement of bus bars and control equipments, solid earthing, resistance earthing and Peterson's coils

High Voltage Transmission : Introduction, advantages and disadvantages of EHVAC & HVDC transmission. **Symmetrical Components**: Per unit systems, Types of faults, Symmetrical components and their applications in analysis of unbalance faults.

TEXT BOOKS

1. S.N. Singh, Electric power generation, Transmission and Distribution, (PHI)
2. C.l. Wadhwa , Electric Power systems; New Age publisher
3. R.K. Rajput, Electrical Power Systems, Laxmi Publications
4. Soni, Gupta & Bhatnagar, A course in electric power,

REFERENCE BOOK

1. V.K. Meheta,S Chand, Power systems analysis and design,
2. S.L. Uppal, Electrical Power: Khanna Publication.
3. Stevenson, Electrical Power Systems, McGraw Hill Publication

EC - 321 DIGITAL SIGNAL PROCESSING (3-0-0)

MODULE-I (12 Hours)

Introduction to Discrete Time Signals & Systems: Discrete time signals, Elementary examples , Classification, Discrete Time Systems, Block diagram representation , Classification, **Analysis of discrete time LTI System:** Response of LTI systems to arbitrary inputs (convolution sum), properties of convolution and the interconnection of LTI systems, causal LTI systems, stability of LTI systems, systems with finite- duration and infinite-duration Impulse response, Recursive and non-recursive discrete time systems, LTI systems characterized by constant coefficient Difference Equations, Solution of linear constant coefficient Difference equations, **Implementation of Discrete time systems:** Structures for the realization of LTI systems (Form I, Form II, Cascade, Parallel, Lattice), Recursive and Non-recursive realizations for FIR systems. **Correlation of Discrete time signals:** Cross correlation and auto correlation sequence, Properties of the autocorrelation and cross correlation sequence. **Z transform:** The Z-transform and one sided Z-transform properties of Z transform, Inversion of the Z-transform, solution of difference equations, causality and stability of LTI systems in the Z-domain.

MODULE-II (12 Hours)

Frequency analysis of Discrete time Signals: Energy density spectrum of aperiodic signals, Relationship of the Fourier Transform to the Z-transform, The spectrum, Fourier Transform of Signals with poles on the unit circle.

LTI Systems as Frequency-selective filters:- Lowpass, highpass, bandpass filters, Digital resonators, Notch filters, Comb filters, Allpass filters

Inverse systems and Deconvolution: Minimum phase, maximum phase and mixed phase systems, system identification and deconvolution, Homomorphic deconvolution.

The Discrete Fourier Transform: DFT and IDFT, DFT as a linear transformation, relationship of DFT with Z-transform, properties of the DFT, Circular convolution, circular correlation, filtering of long data sequences: overlap-add and overlap-save method.

MODULE-II (12 Hours)

Fast Fourier Transform: Direct computation of DFT, Radix-2 FFT algorithm, DIT and DIF FFT, Applications of FFT: efficient computation of DFT of two real sequences, efficient computation of DFT of a 2 N point real sequence.

Power Spectrum Estimation : computation of the Energy Density Spectrum, the Periodogram, DFT in power spectrum estimation, Bartlett method, Welch Method, Blackmann & Tookey method

Digital Filter: Causality and its implications, characteristics of practical frequency selective filter, FIR filter design using different windows (Rectangular, Hann, Hamming, Bartlet, Kaiser), FIR filter design using frequency sampling method, Design of IIR filters: Impulse invariant method, Bilinear transformation method.

TEXT BOOKS

1. J.G. Proakis & D.G. Manolakis, Digital Signal Processing- Principles, Algorithms and Applications, Pearson.
2. Schilling & Harris, Fundamentals of Digital Signal Processing, Thomson Learning

REFERENCE BOOKS

1. J.R. Johnson, Introduction to Digital Signal Processing, PHI
2. Sanjit K. Mitra, Digital Signal Processing : A Computer Based Approach, Tata McGraw Hill

5th Sessional

EE-371 POWER ELECTRONICS LAB (0-0-3)

List of Experiments

1) Study of V-I characteristics of SCR.
2) Study of different methods of triggering of SCR.
   a) R-Triggering Method
   b) RC-Triggering Method
3) Study of different methods of triggering of SCR.
   a) UJT-Triggering method
   b) Cosine-Triggering method
4) Study of SCR Commutation Techniques
   Self Commutation (Class-A, Class-B)
5) Study of SCR Commutation Techniques
   Forced Commutation (Class-C, Class-D, Class-E)
6) Study of Single phase full wave fully controlled and semi controlled converter with R, R-L load with / without freewheeling diode.
7) Study of Three phase full wave fully controlled and semi controlled converter with R, R-L load with / without freewheeling diode.
8) Study of Single Phase AC voltage Controller Using Triac.
9) Study of DC Jones chopper with PWM controller.
10) Study of IGBT based 3-phase Voltage Source Inverter.
11) Study of Single phase Cyclo Converter.
12) Study of single phase Series Inverter.
13) Study of single phase Parallel Inverter.
14) Study of single phase Current Source Inverter.

EC 373 MICROPROCESSOR & MICROCONTROLLER LAB (0-0-3)

NOTE Total 10 (Ten) experiments have to be completed.
(2 from Gr – A , 4 from Gr – B , 2 from Gr – C, 2 from Gr – D)

A) 8085

1. Addition, Subtraction, Multiplication, Division of two 8 bit numbers resulting 8/16 bit numbers.
2. Smallest /Largest number among n numbers in a given data array
3. Binary to Gray Code / Hexadecimal to decimal conversion.

B) 8051MICROCONTROLLER

COMPULSORY

4. Initialize data to registers and memory using immediate, register , direct and indirect addressing mode

OPTIONAL (any one)

5. Addition, subtraction of 16 bit numbers.
6. Multiplication, Division of 16 bit numbers
7. Transfer a block of data to another memory location using indexing.

C) INTERFACING

COMPULSORY

8. Operation of 8255 using 8085 & 8051 microcontroller
9. Generate square waves on all lines of 8255 with different frequencies (concept of delay program)

OPTIONAL (Any Two)

10. Study of stepper Motor and its operations (Clockwise, anticlockwise, angular movement, rotate in various speeds)
11. Study of Elevator Simulator
12. Generation of Square, triangular and saw tooth wave using Digital to Analog Converter
13. Study of 8253 and its operation (Mode 0, Mode 2, Mode 3)
14. Study of Mode 0, Mode 1, BSR Mode operation of 8255.
15. Study of 8279 (keyboard & Display interface)
16. Study of 8259 Programmable Interrupt controller.
17. Study of Traffic Light controller

D) 8086

COMPULSORY

18. Addition, subtraction, Multiplication , Division of 16 bit nos + 2's complement of a 16 bit no.

OPTIONAL (Any One)

19. Marking of specific bit of a number using look-up table.
20. Largest /Smallest number of a given data array.
21. To separate the Odd and Even numbers from a given data array.
22. Sorting an array of numbers in ascending/descending order
23. Finding a particular data element in a given data array.

EE-373 ELECTRICAL MACHINE LAB – II (0-0-3)

1. To determine the voltage regulation of an alternator by zero power factor method.
2. To determine the V curve and inverted V curve of a synchronous motor.
3. Speed Control of a 3 phase induction motor by rheostatic, cascading and pole changing methods.
4. To determine (a) Positive Sequence (a) Negative Sequence (c) Zero sequence impedances of alternator.
5. Determination of power angle characteristic of an Alternator.
6. Determination of parameters of a single phase induction motor and study of
    a) Capacitor start induction motor
    b) Capacitor start capacitor run induction motor
    c) Repulsion type induction motor
7. Study of (a) Universal motor (b) Shaded pole motor
8. Measurement of direct and quadrature axis reactances of a salient pole synchronous machines.

9. Determination of parameters of 3-ϕ, 3-winding transformer.
10. Determination of transient & Sub-transient reactance of an alternator
11. Study of Magnetizing current of a Y-Y, Y-Δ transformer.
12. Loading an alternator with active and reactive loads.

EE-375 ELECTRICAL POWER APPARATUS DESIGN LAB (0-0-3)

1. Design and modeling of a DC Machine.
2. Design of 1-ϕ Transformer.
3. To study the performance of a Transmission line.
4. Study of 1-ϕ AC/DC converter for different loads.
5. Design of 3-ϕ inverter.
6. To study the transient respond of a second order system and determination of the response parameters.

EC -371 DIGITAL SIGNAL PROCESSING LAB (0-0-3)

1. Different types of Signal generation using MATLAB. (both continuous and discrete.)
2. Linear Convolution of sequences. (Without using the inbuilt function conv() available in MATLAB.)
3. Circular Convolution of two Sequences

   i) Computation of circular convolution

   ii) Computation of linear convolution using circular convolution & comparison of result with the result obtained from linear convolution.
4. Correlation between sequences

   i) Finding auto correlation of a sequence

   ii) Finding cross correlation of 2 sequences.

   iii) Finding power spectral density of a sequence.

   iv) Finding correlation using convolution

   v) Finding circular correlation between sequences
5. Finding the convolution (linear and circular) and correlation (linear & circular) of periodic sequences using DFT and IDFT.
6. Implementation of DFT (Fast Fourier Transform) and IFFT algorithms using

   i) Decimation in Time (DIT)

   ii) Decimation in Frequency (DIF)
7. Design of FIR filters (lowpass, highpass, bandpass) Using windowing technique (hamming window, hanning, window rectangular window, Kaiser window) and comparison of their frequency responses.
8. Design of IIR filter.

   i. Design of Butterworth Filter

   ii. Design of Chebyshev filter
9. Convolution of long duration sequences using overlap add & overlap save methods using DFT and IDFT
10. Working with a DSP processor. (fixed point -TMS320C-5X / Floating point) series.

    i) Implement convolution (Linear & circular convolution)

    ii) FIR & IIR filtering implementation .

7th Semester				8th Semester			
Subject Code	***Theory***	***Contact hrs L-T-P***	***Credit C***	***Subject Code***	***Theory***	***Contact hrs L-T-P***	***Credit C***
EE-431	Power System Protection	3-0-0	3	HS-402	Principles of Management	3-0-0	3
EE-413	Electric Drives	3-1-0	4	EE-412	CAD of Electrical Machines	3-1-0	4
EE-435	Power System Engg – II	3-1-0	4	EL-III	Elective – III	3-0-0	3
EL-I	Elective – I	3-0-0	3	EL-IV	Elective – IV	3-0-0	3
EL-II	Elective – II	3-0-0	3				
	Total	**17**	**17**		**Total**	**13**	**13**
Subject Code	***Practicals / Sessionals***	***Contact Hrs.***	***Credit***	***Subject Code***	***Practicals / Sessionals***	***Contact Hrs.***	***Credit***
EE-471	Power System Lab.	0-0-3	2	EE-492	Seminar	0-0-2	1
EE-491	Seminar	0-0-2	1	EE-494	Major Project	0-0-10	7
EE-493	Minor Project	0-0-5	3	EE-496	Comprehensive Viva-voce	0-0-3	2
EE-495	Summer Training		2				
	Total	**10**	**8**		Total	***15***	**10**
	Grand Total	**27**	**25**		**Grand Total**	***28***	**23**

EE- 431 POWER SYSTEM PROTECTION (3-0-0)

MODULE – I (12 Hours)

Introduction to faults, Classification – symmetrical and unsymmetrical.

Introduction to CT, PT, Linear coupler, Isolator and their arrangement in power system.

Circuit Breaker : Principle of Arc formation and Extinction, Methods of Interruption of inductive current and capacitive, current chopping, recovery, restriking voltages, RRRV, CB Ratings – Making & breaking capacities, duty Cycle, Calculation of fault MVA for symmetrical short circuits.

Types of CB : VCB, MOCB, Air blat CB, Air Breaking CB (MCB, MCCB), SF_6.

Fuse : Characteristics & Rating, Types : HRC, Cartridge, Drop Out.

MODULE – II (14 Hours)

Function and Characteristics of Protective Relaying : Primary and Backup, Introduction to various relaying schemes- over current, differential, distance, STI, Zone of protection.

Over Current Relaying : Inverse & Definite Type, directional relay and its connections. Application of IDMT, DTOC & directional relay. Coordination of relay for protection of feeders.

Differential relaying : Impedance, reactance, MHO & Offset MHO Relays. Applications and behavior under arc faults and power swing. Setting of distance relays.

Carrier Aided Distance protection. : Three stepped protection system, carrier transfer scheme, carrier acceleration scheme, carrier blocking scheme. Equipments used for carrier aided distance protection.

MODULE – III (12 Hours)

Transformer Protection : Percentage Biased Differential Protection against external and internal faults, over current protection, REF, Over fluxing, Magnetizing inrush current protection, protection for interturn and incipient faults. Development of differential connection for power transformers.

Generator Protection : Longitudinal and transverse differential protection, rotor earth fault protection, REF, Loss of Excitation, Loss of Prime Mover.

Busbar Protection : High impedance busbar differential scheme and its design, supervisory relay.

Static Relays : Amplitude, phase and hybrid comparator.

Protection against over voltage : Ground Wire, Counterpoise wires, Rod Gap, Arcing Horn, Lighting Arresters, Surge Absorber.

TEXT BOOKS

1. Y.G. Paithankar, S.R. Bhide, Fundamental of Power System Protection, (PHI)

2. Sunil S. Rao, Power System Protection, Dhanpath Publication

REFERENCE BOOKS

1. Badriram, D.N. Viswakarma, Power System Protection and Switchgear, TMH

2. Soni Gupta Bhatnagar, A Course in Electrical Power, Dhanpath Rai Publication

EE-413 ELECTRIC DRIVES (3-1-0)

MODULE – I (8 Hours)

Introduction to Electrical Drives:

Definition of Electrical Drives, Advantages, Classification and Parts of electrical drives.

Dynamics of Electrical Drives:

Fundamental Torque Equation, Different Types of Load Torque, Speed Torque convention of multiquadrant operation, equivalent systems (Loads with rotational motion, loads with translational motion), Stability consideration of Electrical Drives

MODULE – II (24 Hours)

DC Motor drives:

Characteristics of DC motors (Separately excited, shunt, series and compound), starting and breaking of dc motor, Speed Control of DC motors, phase Controlled rectifier fed DC motor drives (Single & three phase, half wave, full wave, semi converter), Dual converter, Chopper fed DC motor drives with quadrant operations.

AC Motor drives:

3-phase induction motor: Characteristic, starting, breaking and speed control. VSI fed induction motor, CSI fed induction motor, V/f control, cycloconverter fed induction motor. Rotor resistance control and slip power recovery, scheme of induction motor. four quadrant operation of induction motor.

MODULE – III

Rating and Heating of Motors:

Thermal model of motor for heating and cooling, power loss and heating of electrical motors, classes of motor duty, determination of motor duty.

Drives for specific application:

Steel rolling mills, Crain and Hoist drives, cement mill, sugar mill, paper mill, centrifugal pump.

Introduction to solar and battery power drives.

TEXT BOOKS

1. G. K. Dubey, Fundamentals of Electrical Drive, Narosa Publishing House, 2001.
2. V. Subrahmanyam, Electric Drives: Concepts and Applications, V. Subrahmanyam, Tata McGraw Hill, New Delhi, 2005.

REFERENCE BOOKS

1. R. Krishnan, Electrical Drives, Pearson Publication.

EE-435 POWER SYSTEM ENGINEERING - II (3-1-0)

MODULE-I (14 Hours)

Fundamental of power System: Concepts or real and reactive powers, Complex power, per unit representation of power system. Transmission capacity, series and shunt compensation, Load characteristics, Voltage control by on load tap changing transformer and regulating transformer, Introduction to FACT devices.

Load flow analysis: System model: The static load flow equation (SLFE), Definition of the load flow problem, Network model formulation, A load flow sample study, Gauss Siedel Method, Newton's Raphson method, Computational aspects of the load flow problem, effect of regulation transformers.

MODULE-II (10 Hours)

Power System Control: Real power balance and its effect on system frequency. Load frequency mechanism, modeling of Generator, prime mover ,load , speed governing system, Division of power system into control areas, P-F control of single control area and two area control, , PF versus QV control , Reactive power balance and its effect on system voltage reactive power and voltage control .

MODULE- (14 Hours)

Economics Operation of Power System:- Distribution of load between units within a plant, Transmission losses as function of plant generation, Calculation of loss coefficients, Distribution of loads between plants with special reference to steam plants, Automatic load dispatching,

Power System Stability: Steady state stability, transient stability, Swing equation, Equal area criterion for stability, Methods of improvement of transient stability, Stability analysis of multi-machine power systems. Introduction to voltage stability.

TEXT BOOKS

1. Hadi Saadat,Power System Analysis, TMH
2. B.R. Gupta, S. Chand, Power system analysis and design.
3. O.I. Elgerd, An introduction to electric Energy system theory, TMH

REFERENCE BOOKS

1. W.D. Stevenson, Elements of power system analysis, TMH
2. Glover, Power System Analysis and Design, CENGAGE Learning

ELECTIVE – I

EE-433 POWER SYSTEM DYNAMICS

EE-436 HIGH VOLTAGE ENGINEERING

EE-437 POWER QUALITY

EE-425 POWER ELECTRONICS APPLICATIONS TO POWER SYSTEMS

IC 325 ELECTRONICS INSTRUMENTATION & MEASUREMENT

IC-324 ADVANCED CONTROL SYSTEM ENGINEERING

CY- 201 ENGGINEERING MATERIALS

EE-433 POWER SYSTEM DYNAMICS (3-00)

MODULE-I (13 hours)

Basic concepts: Power system stability states of operation and system security, system dynamics problems system model analysis of steady State stability and transient stability, simplified representation of Excitation control.

Modeling of synchronous machine: synchronous machine park's Transformation of flux linkages, Transformation of stator voltage equations and rotor equations.

MODULE-II (10 hours)

Analysis of steady state performance, per unit quantities - Equivalent circuits of synchronous machine - determination of parameters of equivalent circuits.

Excitation system: Excitation system modeling, excitation systems block Diagram system representation by state equations.

Dynamics of a synchronous generator connected to infinite bus: system model Synchronous machine model, stator equations rotor equations, Synchronous machine model with field circuit and with field circuit and one equivalent damper winding on q axis (model 1.1), calculation of Initial conditions.

MODULE-III (12 hours)

Analysis of single machine system: small signal analysis with block diagram.

Application of power system stabilizers: basic concepts in applying PSS, Control signals, structure and tuning of PSS, washout circuit, dynamic compensator analysis of single machine infinite bus system with and without PSS.

TEXT BOOKS

1. Power system dynamics K.R. PADIYAR, B.S. Publications Hyderabad
2. Power system Stability and control by P.Kundur, Tata McGraw Hills.

REFERENCES

1. Power system control and stability P.M. Anderson and A.A. Fouad John wiley sons

EE-436 HIGH VOLTAGE ENGINEERING (3-0-0)

MODULE-I (12 hours)

Generation of High D.C. Voltages : Half wave rectifier circuit, Cockroft-Walton voltage multiplier circuit, electrostatic generator – Van de Graff Generator,

Generation of High A.C. Voltages : Series Resonant circuit, Cascaded transformers & tesla coil.

Generation of impulse voltages and currents : Definitions, Impulse Generator circuits & analysis, multi stage impulse generator circuit, construction of impulse generator, triggering and synchronization of the impulse generator, impulse current generation.

MODULE-II (10 hours)

Breakdown Mechanism of Gases, Liquid and Solid Materials : Introduction, Mechanism of breakdown of gases, Townsend's first ionization coefficient, cathode processes – secondary effects, Townsend's second ionization co-efficient, Townsend breakdown mechanism, streamer or Kanal mechanism f spark, the sparking potential-Paschen's law, penning effect, corona discharges, time-lag, breakdown in liquid dielectrics, treatment of transformer oil, testing of transformer oil, breakdown in solid dielectrics.

MODULE-III (14 hours)

Measurement of High Voltage and Currents : Introduction, sphere Gap, Uniform field spark gap, Rod gap, Electrostatic voltmeter, generating voltmeter, the chubb-fortescue method, impulse voltage measurements using voltage dividers, measurement of high DC, AC and impulse currents.

High Voltage Testing of Electrical Equipments : High voltage testing of overhead line insulators, cable, bushing, power capacitors, power transformers, circuit breakers & generators.

Transient & Insulation Co-ordination : Lightning phenomenon, line design based on lightning, switching surge test voltage characteristics, insulation co-ordination and over voltage protection.

TEXT BOOKS

1. C.L. Wadhwa, High Voltage Engineering, New Age International
2. M.S. Naidu & Kamraju, High Voltage Engineering, TMH

REFERENCES

1. Kuffel & Zaengal High Voltage Engineering

EE-437 POWER QUALITY (3-0-0)

MODULE-I (12 hours)

Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring.

MODULE-II (15 hours)

Long Interruptions : Interruptions – Definition – Difference between failure, outage, Interruptions – causes of Long Interruptions – Origin of Interruptions – Limits for the Interruption frequency – Limits for the interruption duration – costs of Interruption – Overview of Reliability evaluation to power quality, comparison of observations and reliability evaluation.

Short Interruptions : Short interruptions – definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions.

Voltage sag – characterization – Single phase: Voltage sag – definition, causes of voltage sag, voltage sag magnitude, monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, meshed systems, voltage sag duration.

Voltage sag – characterization – Three phase: Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags.

MODULE-III (13 hours)

PQ considerations in Industrial Power Systems: Voltage sag – equipment behaviour of Power electronic loads, induction motors, synchronous motors, computers, consumer electronics, adjustable speed AC drives and its operation. Mitigation of AC Drives, adjustable speed DC drives and its operation, mitigation methods of DC drives. Mitigation of Interruptions and Voltage Sags: Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault clearing time changing the power system, installingmitigation equipment, improving equipment immunity, different events andmitigation methods. System equipment interface – voltage source converter, series voltage controller, shunt controller, combined shunt and series controller.

Power Quality and EMC Standards: Introduction to standardization, IEC Electromagnetic

compatibility standards, European voltage characteristics standards, PQ surveys.

TEXT BOOKS

1. Math H J Bollen, "Understanding Power Quality Problems", IEEE Press.
2. Electrical Power Quality by R.C. Dugan.
3. Power Quality, G T. Heydt, star0in-a circle publication
4. Electrical Power Quality, J.B. Dixit, Amit Yadav, Laxmi Publication.

EE-425 POWER ELECTRONICS APPLICATION TO POWER SYSTEM (3-0-0)

MODULE-I (12 hours)

Steady state and dynamic problems in AC systems. Flexible AC transmission systems (FACTS). Principles of series and shunt compensation. Description of static var compensators (SVC), Thyristor Controlled series compensators (TCSC), Static phase shifters (SPS), Static condenser (STATCON).

MODULE-II (10 hours)

Static synchronous series compensator (SSSC) and Unified power flow controller (UPFC). Modelling and Analysis of FACTS controllers. Control strategies to improve system stability.

MODULE-III (15 hours)

Power Quality problems in distribution systems, harmonics, harmonics creating loads, modelling, harmonic propagation, Series and parallel resonances, harmonic power flow, Mitigation of harmonics, filters, passive filters, Active filters, shunt, series hybrid filters, voltage sags & swells, voltage flicker. Mitigation of power quality problems using power electronic conditioners. IEEE standards.

TEXT BOOKS

1. G.T. Heydt, Power Quality, Stars in a Circle Publications, Indian, 1991.
2. T.J.E.Miller, John Wiley & Sons,Static Reactive Power Compensation, New York, 1982.
3. Power Systems and Power Delivery Recent publications

IC 325 ELECTRONICS INSTRUMENTATION & MEASUREMENT (3-0-0)

MODULE I (15 Hours)

Measurement and Errors:-Definitions, Accuracy and precision, Significant figures, Types of error, Statistical Analysis, Probability of errors, limiting errors.

Units of Measurement:- Fundamental and derived units, systems of units, Electric and Magnetic units, International System of units, other systems of units, conversion of units.

Signals and Noise in Measurement Systems:- Introduction, Statistical Representation of random signals, effects of noise and interference on measurement circuits. Noise sources and coupling mechanism, methods of reducing effects of noise and interference.

Bridge Measurement:- Introduction, wheatstone bridge, Kelvin bridge, Guarded wheatston bridge, AC bridges and their applications, maxwells bridge, Hay bridge, Schering bridge, unbalanced condition, wein bridge, wagnor ground connection.

Electromechanical Indicating Instruments:- Permanent magnet moving coil mechanism. DC ammeter, DC voltmeter, voltmeter sensitivity, series-type Ohmmeter, shunt-type ohmmeter, Electro-dynamometers in power measurement.

MODULE II (13 Hours)

Electronic Instruments for measuring Basic parameters:- Introduction, Amplified DC meter, AC voltmeter using rectifiers, True RMS responding voltmeter, Electronic Multimeter, Considerations in

choosing an analog voltmeter, Digital voltmeter, Q-meter, RF power and voltmeter Measurement.

Cathode Ray Oscilloscope:- Cathode Ray Tube, Deflection Amplifiers, Time-based Vertical Deflection System, Delay Line, Horizontal Deflection System, Dual trace Oscilloscope, Measurement of voltage, frequency and phase, pulse measurement, Oscilloscope probes, X-Y and Z-display, Lissajous Figure.

Special oscilloscope:- Delayed- Time Base Oscilloscope, Sampling Oscilloscope, Digital storage oscilloscope, DSO application.

MODULE III (12 Hours)

Signal Generation:- Introduction, The sine wave generator, frequency synthesized signal generator, frequency divider generator, signal generator modulation, sweep frequency generator, pulse and square wave generator, function generator, Audio frequency signal generation.

Signal Analyzers:- Introduction, wave analyzer, Harmonic distortion analyzer, Spectrum analyzer.

Reliability, choice and economics and Measurement system:- Reliability of Measurement systems, choice of Measurement systems and specifications, Total lifetime measurement systems and specifications, Total lifetime operating cost.

TEXT BOOKS

1. A.D. Helfrick and W.D. Cooper , Modern Electronic and Measurement Techniques, Pearson Education.
2. John P. Bently Principles of Measurement systems, pearson education.

REFERENCE BOOKS

1. D. Bell., Electronic Instrumentation and Measurements.
2. Golding and Widdis, Electrical Measurements and Measuring Instruments

IC-324 ADVANCED CONTROL SYSTEM ENGINEERING (3-1-0)

MODULE-1 (12 Hours)

Mathematical modeling of dynamic systems in state space, state space representation of Mechanical and Electric systems, State equations and transfer functions, Characteristics equation, Eigen values and Eigenvector of state Matrix Solution of time-invariant state equation, determination of State Transition Matrix, use of Carley –Hamilton Theorem Controllability, Observability,.

MODULE-II (12 hours)

Introduction to design of control systems in state space, design of phase lead qnd phase lag controllers in time and frequency domain, pole placement design. State observers.

Sampling and Signal reconstruction: definition of Z-Transform, properties of Z-Transform, Inverse Transform, Mapping between S-plane and Z-plane, system descriptions by difference equations and solutions.

Sample data control systems: Transfer function of discrete data systems, Pulse and Z-Transform functions, transfer functions of discrete data system with cascade element, transfer function of Zero order and 1^{st} order holds, transfer function of closed loop discrete data systems.

MODULE –III (12 hours)

Non linear systems: Common physical nonlinearities, the phase plane methods, Basic concepts, Singular points, stability of nonlinear systems, Construction of phase trajectories, Construction by analytical and graphical methods. System analysis by phase plane method,

The describing function methods: Basic concepts, derivation of describing functions for common non linearity's, stability analysis by Describing function approach, Jump resonance, Lyapunov stability criterion, Popov's stability criterion.

TEXT BOOKS

1. Ogata K., "Modem Control Engineering", 2nd Edition, PHI
2. Kuo B.C., "Automatic Control System", 8th Edition, Wiley Publication
3. Gopal M., "Digital Control and State Variable Methods", Tata McGraw Hill, New Delhi, 1997.

CY-201 ENGINEERING MATERIALS (3-0-0)

MODULE – I (16 Hours)

Fuel and combustion: Classification, calorific value, Solid fuels (Analysis of coal, manufacture of metallurgical coke),Liquid fuels (Refining of crude oil: fractional distillation, cracking, reforming, knocking, octane number and cetane number), Gaseous fuel (Producer gas, water gas, Biogas, LPG), Combustion calculations.

Water treatment : Hardness of water & its determination (EDTA method), Types of hardness, Disadvantages of hard water in boiler, Softening techniques (Soda lime, Zeolite and ion-exchange processes), Purification of Drinking water.

MODULE –II (12 Hours)

Inorganic Engineering Materials:

1. Glass: Manufacture of glass, Types.
2. Ceramics: White wares, glazing, optical fibres.
3. Refractories: Classification, manufacture of silica, fire clay and carborundum bricks.
4. Abrasives: Natural and artificial (carborundum, Alundum, Norbide).

Bio &Conducting polymers:

Bio-polymers (Starch, Cellulose**),** Conducting polymers (Polyacetylene, Polyaniline) Properties and application.

MODULE – III (14 Hours)

1. **Composites :** Constituents of Composites, Types of composites fibre - Reinforced composites, (Fiberglass, Advanced composites, wood) , Aggregate composites , mechanical properties of composites. Processing of composites.
2. **Chromatography :** Thin layer chromatography, Gas-liquid chromatography, Column chromatography, High Performance Liquid Chromatography (HPLC).

TEXT BOOKS

1. Jain & Jain, Engineering chemistry, 15th Edition, Dhanpat Rai Publishing Co., 2007.
2. Shackelford & Muralidhara:Introduction to Materials Science for Engineers, Sixth Edition 2007, Pearson Education.

ELECTIVE II

EE-438 HVDC TRANSMISSION

EE-439 POWER STATION ENGINEERING

EE-427 NON CONVENTIONAL ENERGY SOURCES AND ENERGY CONVERSION

EE-417 MODELLING AND ANALYSIS OF ELECTRICAL MACHINES

EE-426 SWITCH MODE POWER CONVERSION

CS-300 DATA COMMUNICATION AND COMPUTER NETWORKING

IT-401 ESSENTIALS OF IT

EC-443 COMMUNICATION ENGINEERING

EE-438 HVDC TRANSMISSION (3-0-0)

MODULE-I (13 Hours)

H.V.D.C. Transmission : General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration.

Static Power Converters : 3-pulse, 6-pulse and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers.

Harmonics in HVDC Systems : Harmonic elimination, AC and DC filters.

MODULE-II (12 Hours)

Control of HVDC Converters and systems : constant current, constant extinction angle and constant Ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control.

Interaction between HV AC and DC systems – Voltage interaction, Harmonic instability problems and DC power modulation.

MODULE-III (15 Hours)

Multi-terminal DC links and systems; series, parallel and series parallel systems, their operation and control.

Transient over voltages in HVDC systems : Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults.

Converter faults and protection in HVDC Systems: Converter faults, over current protection - valve group, and DC line protection. Over voltage protection of converters, surge arresters.

TEXT BOOKS

1. E.W. Kimbark : Wiely Inter Science, Direct current Transmission, NewYork.
2. Peter Peregrinus ltd., H.V.D.C.Transmission, J.Arillaga : London UK 1983

EE -439 POWER STATION ENGINEERING (3-0-0)

MODULE-I (10 Hours)

Hydrology:- Catchment area of a reservoir and estimation of amount of water collected due to annual rainfall, flow curve and flow duration curve of a river and estimation of amount stored in a reservoir formed by a dam across the river, elementary idea about Earthen and Concrete dam.

Turbines: Operational principle of Kaplan., Francis turbine and pelton wheel turbine, specific speed, work done and efficiency.

Hydro plant: - Head gate, pen stock, surge tank, scroll case, draft tube and tailrace, classification of plants, turbines for different heads, plant capacity as a base load and peak load station, plant auxiliaries.

MODULE-II (14 Hours)

Thermal Power : Overall plant components in Block diagrams indicating the air cycle, coal cycle and ash cycle, water and steam cycle, cooling water cycle ; various types of steam turbines, ash and coal handling system, elementary idea about water tube boiler, super heater, reheaters, economizer, air pre-heater, dust collection, draft fans and chimney, condensers, feed water heaters, evaporator and makeup water, bleeding of steam; cooling water system; Governors.

Nuclear power : Introduction to fission & fusion, reactor construction, controlled chain reaction, operational control of reactors, Brief study of various types of reactors (Boiling water, pressurized water, sodium graphite, breeder) layout of nuclear power plant

MODULE-III (14 Hours)

Electrical System. : Different types of alternators, methods of cooling

Excitation system: Shaft mounted D.C. generator, elements of static and brush less excitation, field flashing,

AVR. - Magnetic amplifier and thyristors converter types.

Main transformer, unit transformer and station reserve transformer. Commissioning test of alternators and transformers.

Choice of size and number of generating units: - Review of the terms maximum demand, load factor, diversity factor, plant capacity and plant utilization factor, load curve & load duration curve and their effect on the generating capacity. Reserve units (hot, cold and spinning reserve) Effect of power factor on the generating capacity and economy.

Brief idea about regional grids, national grid and its operational problems.

REFERENCE BOOKS

1. M.V. Despande, Elements of electrical power system design, A.H. Wheler

2. Skrotizki & Vopat, Power Station Engg. & Economy, Tata M.H

3. Nagpal, Power Station Engg

4. S.L. Uppal, Electrical Power

EE-427 NON CONVENTIONAL ENERGY SOURCES AND ENERGY CONVERSION (3-0-0)

MODULE -I (14 Hours)

Fossil fuel based systems, Impact of fossil fuel based systems, Non conventional energy – seasonal variations and availability, Renewable energy – sources and features, Hybrid energy systems, Distributed energy systems and dispersed generation (DG)

Solar radiation spectrum, Radiation measurement, Solar Radiation at earth's surface, solar radiation data, radiation Geometry, empirical relations predicting availability of solar radiation, radiation on tilted surface.

Applications of solar thermal technologies: Heating, Cooling, Drying, Distillation, Power generation

MODULE II (10 Hours)

Other sources of solar energy utilization: Solar Photovoltaic systems, Wind energy system, Energy from Biomass, wave energy, energy from OTEC

MODULE III (10 hours)

Energy economics: Present worth, Life cycle costing (LCC), Annual Life cycle costing(ALCC), Annual savings calculations for Solar thermal system , Solar PV system, Wind system, Biomass system

TEXT BOOKS

1. SPSukhatme, Solar energy: Principles of Thermal Storage, Tata Mc Graw Hill
2. G.D.Rai , Energy Resources , Khanna Publishers

REFERENCE BOOKS

1. Non Conventional Energy Sources by B. H. Khan Tata Mc Graw Hill
2. Solar energy Utilization By G.D.Rai: Khanna Publishers

EE-417 MODELLING AND ANALYSIS OF ELECTRICAL MACHINES (3-0-0)

MODULE-I (12 Hours)

Review : Primitive machine, voltage and torque equation.Concept of transformation change of variables & m/c variables and transform variables. Application to D.C.machine for steady state and transient analysis, and equation of cross field commutator machine.

Induction Machine : Voltage, torque equation for steady state operation, Equivalent circuit, Dynamic performance during sudden changes in load torque and three phase fault at the machine terminals. Voltage & torque equation for steady state operation of 1-ö induction motor & scharge motor.

MODULE-II (15 Hours)

Synchronous Machine : Transformation equations for rotating three phase windings, Voltage and power equation for salient and non salient alternator, their phasor diagrams, Simplified equations of a synchronous machine with two damper coils. Operational Impedances and Time Constants of Synchronous Machines : Park's equations in operational form, operational impedances and G(P) for a synchronous machine with four Rotor Windings, Standard synchronous machine Reactances, time constants, Derived synchronous machine time constants, parameters from short circuit characteristics.

MODULE-III (10 Hours)

Approximate Methods for Generator & System Analysis : The problem of power system analysis, Equivalent circuit & vector diagrams for approximate calculations, Analysis of line to line short circuit, Application of approximate method to power system analysis.

TEXT BOOKS

1. Generalised theory of Electrical
2. P.S.Bhimbra, Electro Mechanical Energy Conversion - White & Woodson.

REFERENCE BOOKS

1. P.C.Krause, Analysis of Electric Machinery
2. B.Adkins, The General theory of Electrical Machines
3. B.Adkins & R.G.Harley, The General theory of AC Machines

EE-426 SWITCHED MODE POWER CONVERSION (3-0-0)

MODULE-I (12hours)

Review of Basic Power Electronics Linear power supplies, Overview of DC-DC Converters without Galvanic Isolation - DC - DC switched mode converters(CCM and DCM mode of operation): buck converters, boost converter, buck boost converter, CUK converter. dc-dc converter comparison.

MODULE -II (14 hours)

Switching dc-dc power supplies with isolation: flyback converters, double ended flyback converter, forward converters, double ended forward converter, push pull converters - half bridge converters - full bridge converters.

Introduction to resonant converters: classification of resonant converters, basic resonant circuit concepts, load resonant converter, resonant switch converter, zero voltage switching, resonant DC link inverters with zero voltage switching - high frequency link integral half cycle converter

MODULE -III (12 hours)

Introduction to modeling of switch mode power supplies - state space averaging - state space averaged models, equivalent circuits and small signal transfer functions for basic converters.

TEXT BOOKS

1. Ned Mohan et al, , Power Electronics, John Wiley ,1989
2. M.H.Rashid, Power Electronics by Prentice Hall

REFERENCE BOOKS

1. Daniel W.hart, Fundamentals of Power Electronics:
2. Robert Erickson, Springer Veralg, Fundamentals of Power Electronics:

CS-300 DATACOMMUNICATION & COMPUTER NETWORKING (3-0-0)

MODULE – I (12 Hours)

Overview of Data Communications and Networking, Physical Layer: Analog and digital, Analog Signals, Digital Signals, Analog versus Digital, Data Rate Limits, Transmission Impairments, Digital Transmissions: Line Coding Block coding, sampling, Transmission Mode. Analog Transmission: Modulation of Digital Data; Telephone modems, modulation of Analog signals. Multiplexing: FDM, WDM, TDM. Transmission Media: Guided Media, Unguided Media (Wireless) Circuit Switching and Telephone Network: Circuit Switching, Telephone Network.

MODULE – II (12 Hours)

Data Link Layer: Error Detection and Correction: Type of Errors, Detection, Error Correction. Data Link Control and Protocols: Flow and error Controls, stop-and-wait ARQ. Go-Back. N ARQ, selective Repeat ARQ, HDLC. Point-to-point Access: PPP, Point-to-point Protocol, PPP Stack, Multiple Access: Random Access, controlled Access, Channelizsation. Local Area Network: Ethernet, Traditional Ethernet, Fast Ethernet, Gigabit Ethernet, Wireless LANs: IEEE 802.11,Bluetooth virtual circuit : Frame Relay and ATM

MODULE – III (16 Hours)

Network Layer: Host to Host Delivery: Internetworking, addressing and routing Network Layer Protocols: ARP, RARP,ICMP,IPV6 and ICMPR6, Transport Layer: Process to process Delivery: UDP:TCP congestion control and quality of service. Application Layer :Client Server Model, Socket Interface Domain Name System(DNS): Electronic Mail(SMTP) and file transfer(FTP)HTTP and WWW.

TEXT BOOK

1. Behrouz A Forouzan , Data Communication and Networking , Third Edition, Tata McGraw - Hill Publishing Company Limited

REFERENCE BOOKS

1. Larry L. Peterson and Bruce S. Davie , Computer Networks: Third Edition, A system Approach, Elsevier
2. A.S. Tannenbaum, Computers Networks, PHI
3. William Stallings, Data and Computer Communication, PHI.
4. Peterson & Davice, Computer Networks, Elsevier

IT 401 ESSENTIALS OF IT (3-0-0)

MODULE-I (10 Hours)

Fundamentals of Computer Architecture-Introduction-Organization of computer, Central Processing Unit-Execution Cycle- Instruction categories- measure of CPU performance, Memory-Input/Output devices-BUS- addressing modes, System software-Assemblers-Loaders and Linkers-Compilers and

Interpreters, Operating system-Introduction- Process management scheduling-Memory management-Threads. Problem Solving with Algorithms, analysis of algorithms-Asymptotic notations

MODULE-II (12 Hours)

RDBMS-data processing-the database technology-data models, ER-modelling concepts-notations-Extended ER features, Logical database design-Normalization, SQL-DDL statements-DML statements-DCL statements, SQL tuning techniques. Objects oriented concepts-object oriented programming, UML class Diagrams-relationships-Inheritance-Abstract classes-Polymorphism, and Object Oriented Design methodology.

MODULE-III (08 Hours)

System Development Methodologies-Software Development Models, Components of Web Application-Browsers and Web servers, World Wide Web, URL-HTML-HTTP protocol-Web Applications-Application Servers-Web Security.

1. Table Creation and Queries using SQL
2. A Simple project on Database Design
3. Design the Bio- Data From using HTML
4. All the assignments will be done in the Computer lab.

TEXT BOOKS

1. Abraham Silberschatz and Peter Bear Galvin, Operating system concepts, Addison welsley.
2. David A. Patterson, John L. Hennessy, Computer Organisation & Design , Elsevier.
3. R. Elmasri, S. Navatne : 4th Edition, Fundamental of Database Systems, Pearson Education.
4. Blaha, Rumbaugh, Object-oriented Modelling & Design with UML,: PHI

REFERENCES

1. Infosys course materials.

EC - 443 COMMUNICATION ENGINEERING (3-0-0)

MODULE-I (14 Hours)

Elements of Communication System- Analogue System, Digital System, Distinguishing features. Electromagnetic Spectrum, Bandwidth.

Transformation of Base band signal from Time domain to Frequency domain and Vice-versa using Fourier Transform (FT) of few simple baseband signals.

Source of noise- External noise, Internal noise, white noise, Noise Calculation. Need for Modulation, Analogue Modulation Techniques: Amplitude Modulation (AM), Depth of Modulation, Modulated Waveform, Powers in Carrier, and Sidebands. Generation of DSBSC and SSB, Balanced Modulator, AM Demodulators. Frequency Modulation (FM)- Frequency Deviation, Frequency Modulated Waveform, Spectrum. Narrow Band FM and Wideband FM. Generation of FM; Narrow Band FM Modulator, Wideband FM Modulator, FM Discriminator. Frequency Division Multiplexing.

MODULE-II (14 Hours)

Converting an analogue signal to Digital Signal: Sampling, Nyquist Criteria. Quantization and Binary Coding of sampled values. Pulse Code Modulation. Quantization error. Companding. Line Coding: RZ, NRZ, Manchester Coding. Digital Baseband Signal Formats – T-I Carrier system. TDM. TDM of 8-bit PCM Signal. Digital Modulation Technique: Phase Shift Keying (PSK), Frequency Shift Keying (FSK) - their Basic principle, Waveform, Generation and Detection. Coding for error detection and correction. Sharon's Capacity theorem. Advantages of Digital Communication System.

MODULE-III (08 Hours) Optical Communication System: Brief description of fiber optic communication System: Block Diagram, Range of operating wavelength, Optical Fiber, Optical Sources- LED and LASER, Optical detectors. Advantages of fiber optic system.

Brief description of Satellite Communication System: Block diagram. Frequency bands of operation, uplink and downlink frequencies, Transponder, earth stations, Types of Antenna mounted on satellites. Services available through satellite.

TEXT BOOKS

1. H. Taub and D.L. Shilling. Principle of Communication System, TMH
2. Leon W. Couch, II, Digital and Analogue Communication Systems – 6th Edition, Pearson Publication.

REFERENCE BOOKS

1. Louis E. Frenzel, Communication Electronics – Principles and Applications, 3rd Edition

HS 402 PRINCIPLES OF MANAGEMENT (3-0-0)

MODULE-I [12 hours]

Introduction to Management: Science, Theory and Practice; Importance and Scope of Management; Evolution of Management Thought; Management and Environment- Environmental Impact on the Management Process; Globalisation and Business Environment; Social Responsibilities and Obligations of Business Management.

Importance of Management in Engineering and Technology - Critical Factors in Managing Technology, Management of Technology and Global Competitiveness, Formulation of a Technology Strategy; Creating the Product-Technology-Business Connection, Technology Planning, Technology as an Instrument of Competition.

MODULE-II [12 hours]

The Process of Management; Planning – Essentials of Planning and Managing by Objectives, Strategies, Policies, Planning Perishes, and Decision Making; Organising – Principles of Organization, Organization Structure, Effective Organizing and Organization Culture; Directing – Crisis Management and Corporate Governance; Staffing – Selection, Training, Development, Appraisal, Knowledge Management; Controlling – The System and Process of Controlling, Control Techniques and Information Technology.

MODULE-III [12 hours]

Functions of Management – Marketing Function of Management, Morden Concept of Marketing, Functional Classification of Marketing, Marketing Mix, Fundamental Needs of Customers, Role of Distribution Channels and Advertising; Financial Functions of Management – Concept of Financial Management, Project Appraisal, Tools of Financial Decision Making, Introduction to Short-Term and Long-Term Sources of Financing.

TEXT BOOKS

1. Essentials of Management, Harold Koontz and Heinz Weihrich, Tata McGraw Hill, 8th Edition, 2010.
2. Business Organisation and Managemnt, C. R. Basu, Tata McGraw Hill, 3rd Reprint, 2008.
3. Management of Technology, Tarek Khalil, Tata McGraw-Hill Edition, 2009.

REFERENCE BOOKS

1. Management – Theory and Practice, C. B. Gupta, 14th Edition, S. Chand & Sons, 2009.
2. Financial Management, I. M. Pandey, Vikas Publications, 9th Edition, 2009.

EE -412 CAD OF ELECTRICAL MACHINES (3-0-0)

MODULE – I (10 Hours)

Design of Solenoid : Rough sizing, Magnetic circuit, Sample design.

Transformer Design : Core volume sizing, magnetic circuit analysis, equivalent Circuit parameters, sample design.

MODULE – II (18 Hours)

DC Motor Design : Classification and standardization, volume and bore sizing,

armature design, field pole design, magnetic circuit analysis, fielding winding design, design refinement, sample design.

Induction Motor Design : Classification and standardization, volume and bore sizing,

stator design, rotor design, equivalent circuit parameters, design refinement, Sample design.

MODULE – III (10 Hours)

Synchronous Machine Design : Standards and classifications, volume bore sizing, stator design, air gap sizing, rotor design, equivalent circuit parameters, design refinement, sample design.

TEXT BOOKS

1. Simmie J. Cathey, Electric Machine Analysis and Design Applying MATLAB, Tata McGrawHill.

REFERENCE BOOKS

1. A.K. Sawhney, Electric Machine Design

ELECTIVE - III

EE-428	**POWER SYSTEM TRANSIENTS**
EE-418	**FACTS (FLEXIBLE AC. TRANSMISSION SYSTEMS)**
EE-429	**OPTIMAL CONTROL THEORY**
EC-452	**SOFT COMPUTING**
EC-425	**BIOMEDICAL INSTRUMENTATION**
CS-428	**COMPUTER SYSTEM ARCHITECTURE AND ORGANISATION**
IT-417	**MANAGEMENT INFORMATION SYSTEM**

EE-428 POWER SYSTEM TRANSIENTS (3-0-0)

MODULE-I (13 Hours)

Normal Transients: Current suppression, the circuit closing transients, the recovery transient initiated by the removal of short circuit, double frequency transients.

Abnormal transients: Abnormal switching transients, current suppressions, effect of motor, capacitance switching.

Damping: Resistance damping, load switching, transformer magnetizing inrush current, Ferro resonance, Arcing ground, insulation co-ordination, electro-magneting shielding.

MODULE-II (13 Hours)

Travelling waves on transmission line: The wave equation, reflection and refraction of travelling waves.

Behaviour of Travelling Waves at Line Termination: Short circuit, open circuit, general termination, inductive termination.

Transients in Direct current circuits and in conversion equipment: Communication transients.

MODULE-III (13 Hours)

Lightening : Lightening phenomenon, mechanism of lighting stroke, line design based on lightening.

Transients in 3-phase circuit : Importance of the type of neutral connection, switching a three phase reactor with an isolated neutral, three phase capacitance switching, the symmetrical component method for solving three phase switching transients.

TEXT BOOKS

1. C.S. Indulkar, D.P. Kothari, Power System Transient, Prentice Hall Pub.
2. Lou Van Der Sluis, Transients in Power System, Wiley Pub.
3. P. Kundur, Power System Transient,

EE – 418 FACTS (FLEXIBLE AC. TRANSMISSION SYSTEMS) (3-0-0)

MODULE-I (15 Hours)

FACTS Concepts: Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters basic types of FACTS controllers, benefits from FACTS controllers.

Voltage Source Converters: Single phase three phase full wave bridge converters transformer connections for 12 pulse 24 and 48 pulse operation. Three level voltage source converter, pulse width modulation converter, basic concept of current source Converters, comparison of current source converters with voltage source converters.

MODULE-II (15 Hours)

Static Shunt Compensation: Objectives of shunt compensation, mid point voltage regulation voltage instability prevention, improvement of transient stability, Power oscillation damping,

Methods of controllable var generation, variable impedance type static var generators switching converter type var generators hybrid var generators.

SVC and STATCOM: The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping operating point control and summary of compensator control.

MODULE-III (10 Hours)

Static Series Compensators: concept of series capacitive compensation, improvement of transient stability, power oscillation damping, Unit 8: Functional requirements. GTO thyristor controlled series capacitor(GSC) , thyristor switched series capacitor(TSSC), and thrystor controlledseries capacitor(TCSC) control schemes for GSC TSSC and TCSC.

TEXT BOOK :

1. N.G. Hingorani and L. Guygi, "Understanding FACTS Devices" IEEE Press Publications 2000.

EE-429 OPTIMAL CONTROL THEORY (3-0-0)

MODULE – I (10 Hours)

Static optimization, Linear programming, Simplex methods, Dynamic optimization, Calculus of variations, Euler's equation, Application to control problems.

MODULE – II (15 Hours)

Pontryagin's maximum principle, Control with constraints, time optimal control, Optimal tracking control problem. Bellman's dynamic programming method, continuous Kalman Filter.

MODULE – III (10 Hours)

Non-linear system optimization, Gradient optimization techniques, Steepest ascent and descent in parameter plane, Evolutionary methods, Genetic algorithms.

TEXT BOOKS

1. Digital Control & State Variable Method by M. Gopal (Tata McGraw Hill)
2. Optimal Control by Andorson & Moore (PHI)

EC- 452 SOFT COMPUTING (3-0-0)

MODULE-I

Neural networks, Introduction, Neuron Models, Supervised and Unsupervised Learning Methods, Single Neuron/ Perceptron Networks, Training Methods, Applications to Linearly separable problems, Multi layered perceptrons, Back-propagation algorithm, Introduction to Fuzzy systems, Membership function, Fuzzy relational operation, fuzzy IF THEN rules, Defuzzyffication – Sugeno and Mamdani type systems, Adaptive Neuro-Fuzzy Sytems, Training Methods.

MODULE-II

Genetic Algorithm: Basic Concepts, Search Space, Working Principle. Encoding: Binary, Octal, Hexadecimal, Permutation, Value and Tree. Decoding, Fitness Function, Selection: Roulette-wheel, Tournament, Rank and Steady-state. Elitism, Crossover: Single-Point, Two-Point, Multi-Point, Uniform, Matrix And Cross Over Rate, Mutation: Mutation, Mutation Rate.

Ant Colony Optimization: Ant Foraging Behavior, Combinatorial Optimization, Routing In Communication Network,

MODULE-III

Application: Control; Communication Engineering; System Identification And Pattern Classification, Function Optimization, Adaptive System Identification, Channel Equalization.

TEXT BOOKS

1. S. Haykin, Neural Networks, A Comprehensive Foundation, Pearson Education, India
2. Martin T. Hagan, Howard B. Demuth, Mark H. Beale; Neural Network Design; (ISBN: 0-9717321-0-8); Thomson 2002
3. Jang, Sun and Mizutani; Neuro-Fuzzy and Soft-Computing – A computational approach to learning and machine intelligence, Prentice Hall of India David E. Goldberg, Genetic Algorithms in search, Optimization and machine learning, 1989.

REFERENCE BOOKS

1. Satish Kumar, A Classroom approach, Neural Networks: Tata McGraw Hill, 2004, ISBN: 9780070482920

EC- 425 BIOMEDICAL INSTRUMENTATION (3-0-0)

MODULE-1 (12 hours)

Introduction to Biomedical Signals: The nature of biomedical signals, The action potential, objectives of biomedical signal analysis, Difficulties in biomedical signal analysis, computer aided diagnosis.

Neurological signal processing: The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics, EEG analysis, Linear prediction theory, The Autoregressive (AR) method, Recursive estimation of AR parameters, Spectral error measure, Adaptive segmentation, Transient detection and elimination- The case of epileptic patients, overall performance.

MODULE-II (12 hours)

Sleep EEG: Data acquisition and classification of sleep stages, Adaptive Interference/Noise Cancellation: The steepest-descent algorithm, the Widrow-Hoff least mean square adaptive algorithm, Adaptive noise canceller, Cancellation of 60Hz interference in ECG, Canceling Donor-heart interference in Heart-transplant electrocardiography, Cancellation of ECG signal from the electrical activity of the chest muscles, Canceling of maternal ECG in fetal ECG, Cancellation of High frequency noise in Electro-surgery.

MODULE –III (12 hours)

Cardiological Signal Processing: Basic Electrocardiography, ECG data acquisition, ECG lead system, ECG parameters and their estimation, The use of multi-scale analysis for parameter estimation of ECG waveforms.

Prony's Method: Exponential modeling, Exponential parameter estimation, The original Prony problem, Least squares prony method, The covariance method of linear prediction, Prony's method in the presence of noise, clinical application of prony's method.

TEXT BOOKS

1. Biomedical Signal Processing Principles and Techniques by - D. C. Reddy, Tata McGraw-Hill, 2005.
2. Biomedical Signal Analysis A case study approach - by Rangaraj M. Rangayyan, John Wiley, 2002.

REFERENCE BOOKS

1. Biomedical Digital Signal Processing - by Willis J. Tompkins, Prentice Hall of India publications/ Eastern Economy Edition, 2nd Print, 2000.

CS-428 COMPUTER ARCHITECTURE AND ORGANIZATION (3-0-0)

MODULE –I

Basic structures of Computers: Functional units, operational concepts, Bus structures, Software, Performance, Multiprocessors and multicomputers. **Machine Instruction and Programms**: Memory location and addresses, Memory Operations, Instructions and instruction Sequencing, Addressing modes, Assembly Language, Basic Input/Output operations, subroutine, additional Instructions.

MODULE – II

Arithmetic : Addition and subtraction of signed Numbers, Design of Fast Adders, Multiplication of positive Numbers, Signed-operand multiplication , Fast multiplication, Integer Division, Floating-point Numbers, (IEEE754 s…) and operations.

MODULE – III

Basic Processing units: Fundamental concepts, execution of complete Instructions, Multibus organization, Hardwired control, Micro programmed control

Memory System: Basic Concepts, cache Memory, performance consideration, Virtual memories, Memory Management requirement, secondary storage.

TEXT BOOKS

1. Carl Hamacher, Zvonkovranesic, Safwat Zaky, Computer Organization, Mc Graw Hill.
2. Morris M. Mano Computer system Architecture, PHI NewDelhi

REFERENCE BOOKS

1. Computer Organization and Design Hardware/ Software Interface: David A. Patterson, John L. Hennessy ELSEVIER.
2. Computer Architecture and Organisations, Design principles and Application. B. Govinda Rajalu, Tata McGraw-Hill Publishing company Ltd
3. Computer Architecture and Organization. John P. Hayes Mc Graw Hill introduction.

IT-417 MANAGEMENT INFORMATION SYSTEM (3-0-0)

MODULE-I (12 Hours)

Fundamentals of Information Systems, Systems approach to problem solving, Developing information system solutions. Information system components, Information quality, Data resource management, Database, Data models, Information Systems in marketing, manufacturing, HRM, Accounting and Finance.

MODULE-II (12 Hours)

Information analysis and design tools : Decision tools, Decision Table, Structured Analysis, Dataflow Analysis, Tools for dataflow strategy, Developing dataflow diagrams, Leveling, Data dictionary, Structured flow chart, HIPO, Warnier/ORR diagram.

MODULE-III (12 Hours)

Planning & implementation of Information Systems, Transaction Processing Systems, Executive information Systems, Decision Support Systems, Expert Systems, Knowledge Management. Computer crime, Security (Goals, risks, controls, security & recovery measures of IS, economics of information security) & ethical challenges.

TEXT BOOKS

1. James A. O'Brien, George M. Marakas, Management Information Systems, Eighth Edition, 2008, McGraw-Hill Education
2. Kenneth C. Laudon, Jane P. Laudon, Management Information Systems, Tenth Edition, Pearson Education

REFERENCE BOOKS

1. Kenneth E. Kendall, Julie E. Kendall , System Analysis and design, PHI Learning Pvt. Ltd
2. James A. Senn ,Analysis & Design of Information Systems, McGraw-Hill Education
3. Effy Oz, Management Information Systems, Sixth Edition, 2009, CENGAGE Learning India Pvt. Ltd., New Delhi.
4. Robert G. Murdick, Joel E. Ross, James R. Claggett, Information Systems for Modern Management, Third Edition, PHI Learning Pvt. Ltd., New Delhi.
5. Stephen Haag, Maeve Cummings, Amy Philips, Management Information Systems, Sixth Edition, 2007, McGraw-Hill Education (India), New Delhi.
6. Gordon B. Davis, Margarethe H. Olson, Management Information Systems, Second Edition, 1985, McGraw-Hill Education (India), New Delhi.
7. Mahadeo Jaiswal, Monika Mital, Management Information Systems, First Edition, 2004, Oxford University Press, New Delhi.

ELECTIVE – IV

EE-415	**SCADA**
EE-419	**INDUSTRIAL ELECTRONICS**
EE-416	**INDUSTRIAL AUTOMATION AND CONTROL**
EE-417	**POWER SYSTEM PLANNING**
EC-421	**DIGITAL IMAGE PROCESSING**
CS-301	**OPERATING SYSTEMS**
IT-411	**INTERNET AND WEB TECHNOLOGY**
CS-406	**MOBILE COMPUTING**

EE-415 SCADA (3-0-0)

MODULE-I (13 Hours)

Introduction to SCADA and PLC:

SCADA: Data acquisition system, evaluation of SCADA, communication technologies, monitoring and supervisory functions.PLC: Block diagram, programming languages, Ladder diagram, Functional block diagram, Applications, Interfacing of PLC with SCADA. SCADA system components: Schemes, Remote Terminal Unit, Intelligent Electronic Devices, Communication Network,

MODULE-II (12 Hours)

SCADA Architecture Various SCADA Architectures, advantages and disadvantages of each system, single unified standard architecture IEC 61850 SCADA / HMI Systems SCADA Communication Various industrial communication technologies- wired and wireless methods and fiber optics, open standard communication protocols Operation and control of interconnected power system Automatic substation control, SCADA configuration, Energy management system, system operating states,

MODULE-III (12 Hours)

System security, state estimation. SCADA applications Utility applications, transmission and distribution sector operation, monitoring analysis and improvement. Industries oil gas and water. Case studies, implementation, simulation exercises

TEXT BOOKS

1. Stuart A Boyer, SCADA supervisory control and data acquisition,
2. Gordan Clark, Deem Reynders, Practical Modem SCADA Protocols,

REFERENCE BOOKS

1. Sunil S. Rao, Switchgear and Protections, Khanna Publication

EE – 419 INDUSTRIAL ELECTRONICS (3-1-0)

MODULE - I

DC AMPLIFIERS:

Need for DC amplifiers, DC amplifiers—Drift, Causes, Darlington Emitter Follower, Cascode amplifier, Stabilization, Differential amplifiers—Chopper stabilization, Operational Amplifiers, Ideal specifications of Operational Amplifiers, Instrumentation Amplifiers.

REGULATED POWER SUPPLIES:

Block diagram, Principle of voltage regulation, Series and Shunt type Linear Voltage Regulators, Protection Techniques— Short Circuit, Over voltage and Thermal Protection.

MODULE - II

SWITCHED MODE & IC REGULATORS :

Switched Mode voltage regulator, Comparison of Linear and Switched Mode Voltage Regulators, Servo Voltage Stabilizer, monolithic voltage regulators Fixed and Adjustable IC Voltage regulators, 3-terminal Voltage regulators—Current boosting .

SCR AND THYRISTOR:

Principles of operation and characteristics of SCR, Triggering of Thyristors, Commutation Techniques of Thyristors—Classes A, B, C, D, E and F, Ratings of SCR.

MODULE - III

APPLICATIONS OF SCR IN POWER CONTROL:

Static circuit breaker, Protection of SCR, Inverters—Classification, Single Phase inverters, Converters – single phase Half wave and Full wave.

DIAC, TRIAC AND THYRISTOR APPLICATIONS:

Chopper circuits – Principle, methods and Configurations, Diac and Triac, Triacs – Triggering modes, Firing Circuits, Commutation.

MODULE - IV

INDUSTRIAL APPLICATIONS - I

Industrial timers -Classification, types, Electronic Timers – Classification, RC and Digital timers, Time base Generators. Electric Welding – Classification, types and methods of Resistance and ARC wielding, Electronic DC Motor Control.

INDUSTRIAL APPLICATIONS - II

High Frequency heating – principle, merits, applications, High frequency Source for Induction heating. Dielectric Heating – principle, material properties, Electrodes and their Coupling to RF generator, Thermal losses and Applications.Ultrasonics – Generation and Applications.

TEXTBOOKS

1. G.K. Mithal and Maneesha Gupta, Industrial and Power Electronics –, Khanna Publishers, 9th Ed., 2003.
2. J. Millman and C.C Halkias, Integrated Electronics, McGraw Hill, 1972.

REFERENCE BOOKS

1. Theodore.H.Bogart, Electronic Devices and circuits, Pearson Education,6th Edn., 2003.
2. M. Rammurthy, Thyristors and applications , East-West Press, 1977.
3. Deboo and Burroughs, Integrated Circuits and Semiconductor Devices, ISE.

EE-416 INDUSTRIAL AUTOMATION AND CONTROL (3-0-0)

MODULE-I (12 Hours)

Brief introduction about industrial processes and their automation, elements of pneumatic, hydraulic and electrical control systems, valves and actuators.

MODULE-II (13 Hours)

Stepper motors, PID controllers and their tuning, implementation of digital control, control strategies for industrial processes, programmable loci controller, real time issues on signal transmission and control, communication systems for industrial automation.

MODULE-III (13 Hours)

Data acquisition and supervisory control, control of discrete manufacturing processes, intelligent systems for monitoring, supervision and control, case studies of indusial control systems.

TEXT BOOKS

1. Job Sternerson, Hand Book of Industrial Automation,.

EE-417 POWER SYSTEM PLANNING (3-0-0)

MODULE-I (13 Hours)

Brief Outline of conventional commercial power plants : Thermal , Hydro, Nuclear , Solar, Wind etc . , Division each type of power plant in total installed capacity. Concept of adequacy and security, System Analysis. Selection of units. Load forecasting. Classification of load forecasting uncertainty. The concept of reliability , reliability indices .Component reliability hazards models conventional UP – DOWN times. Absolute and relative measures . Power system reliability . Outage definition . Construction of reliability models.

MODULE-II (12 Hours)

Generation planning : Generation system model , Loss of load indices, force outage rates , loss of energy indices . Reserve capacity evaluation , frequency and duration method . System risk indices . Generation expansion planning .

Transmission planning:- Probability arrays method of to interconnected system equivalent assisting unit approach to interconnected system . Factors affecting the emergency assistance available through interconnection . Weather effects on transmission lines, load point indicates.

MODULE-III (12 Hours)

Composite generation: - Data requirements, various configurations, application to practical system and load point indices. Transmission reliability evaluation. Distribution system reliability:- Basic concept , Customer Oriented indices in Distribution System of Planning, parallel and mesh networks Effect of transferable load economy considerations . Planning of Generation using non-conventional (renewable) Energy sources.

TEXT BOOKS

1. Billington and Allian, Reliability Evaluation o Power System.
2. J. Endrenvi, Reliability Modeling in Electrical Power System
3. Tarun Gonen, Electrical Power Distribution System

REFERENCE BOOKS

1. Tarun Gonen, Electric Transmission System Engg..
2. G.D. Rai , Non Conventional Energy Sources
3. R.S. Rao. And B.B. Parulekar, Energy Technology – Non- Conventional , Renewable and conventional

EC – 421 DIGITAL IMAGE PROCESSING (3-0-0)

MODULE-I

INTRODUCTION: Fundamental steps in Digital Image Processing, Components of an image processing system, DIGITAL IMAGE FUNDAMENTALS: Image sampling and quantization, Some basic relationships between pixels, Linear and nonlinear operations, IMAGE ENHANCEMENT IN SPATIAL DOMAIN: Some basic gray level transformations, Histogram processing, Smoothing and Sharpening spatial filters

MODULE-II

IMAGE ENHANCEMENT IN FREQUENCY DOMAIN: Smoothing and Sharpening frequency domain filters, Homomorphic filtering, IMAGE RESTORATION: Noise models, Restoration in the presence of noise only-spatial filtering, Estimating the degradation functions, Inverse filtering, COLOR IMAGE PROCESSING: Color models, Pseudo-color processing, IMAGE COMPRESSION: Image compression models, Loss-less and Lossy compression.

MODULE-III

MORPHOLOGICAL IMAGE PROCESSING: Dilation and erosion, Opening and closing, Some basic morphological algorithms, IMAGE SEGMENTATION: Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region based segmentation, RECENT DEVELOPMENTS**.**

TEXT BOOKS

1. R. C. Gonzalez and R.E. Woods, Digital Image Processing, Pearson Education, 2006
2. R. C. Gonzalez , R.E. Woods and Eddins, Digital Image Processing using MATLAB, Pearson Education

REFERENCE BOOKS

1. A.K. Jain, Fundamentals of Digital Image Processing, Pearson Education, 2007
2. B.Chanda & D. Dutta Majumdar , Digital Image Processing and Analysis, PHI, 2001.
3. Alasdair McAndrew , Introduction to Digital Image Processing with MATLAB, Cengage Learning, 2004

CS-301 OPERATING SYSTEMS (3-0-0)

MODULE-I (15 Hours)

Introduction: What is an Operating System, Evolution of operating system, Simple Batch Systems, Multiprogramming and Time Sharing systems. Personal Computer Systems, Parallel Systems, Distributed Systems and Real time Systems. **Operating system structures**: O.S. Services, system calls, operating system structure. **Process Management:** Process concept, Process Scheduling, Operation on Processes, Cooperating Processes. Inter-process communication. Threads: User and Kernel level threads. **CPU Scheduling:** Basic concepts, scheduling criteria, scheduling algorithms. **Process synchronization:** Background , Critical section problem, Hardware Primitives Semaphore, Overview of classical synchronization problems, Monitors

MODULE-II (15 Hours)

Deadlocks: System model, Deadlock Characterization Methods for Handling Deadlocks, Deadlock Prevention, Deadlock avoidance, Deadlock Detection, Recovery from Deadlock. **Memory management:** Background, address Binding, Logical versus Physical Address space, Overlays, contiguous Allocation. Paging, Segmentation. Segmentation with paging. **Virtual Memory:** Background, Demand paging, performance of Demand paging, Page Replacement Algorithms. Allocation of frames, Thrashing,

MODULE – III (10 Hours)

File-system: File concept, Access Methods, Directory structure & implementation, Allocation Method, Free space management. **I/O systems:** Overview, I/O Hardware, Application of I/O interface, Kernel I/O - subsystem Transforming I/O requests to Hardware Operations. Secondary storage Structure: Disk Structure, Disk Scheduling, Disk Management, Swap space Management, Disk Reliability. UNIX Operating System calls and interprocess communication, Case study.

TEXT BOOK

1. Abraham Silberschatz and Peter Bear Galvin, Operating System Concepts, Addison Wesley.

REFERENCE BOOKS

2. H.M Deitel, Operating System, Addison Wesley
3. Milenkovic, M , Operating Systems – concepts and Design, McGraw Hill International.
4. Andrew, S Tannenbaum, Operating System, PHI

IT-411 INTERNET AND WEB TECHNOLOGY (3-1-0)

MODULE-I (17 Hours)

Internet Basics: Basic Concepts, Communication on the Internet, Internet Domains, TCP/IP and Internet, Application Protocols, Idea of Web Server, Web Browser. **Web Design:** HTML Tags, Color and Background, text formatting tags, creating hyperlinks and anchors, Image, Image map, table, frame, Designing Forms and controls, Multimedia in Web DHTML, Style sheet. **Client Side Scripting:** Introduction to Client side Scripting, Programming Fundamentals, Java Script Document Object Model, built in object, form object and element, working with data, flow control structures, operator, custom function and object, data entry and validation using tables and forms using JavaScript, VBScript functionalities, VBScript controls. **Server Side Scripting:** Introduction to

Server side Scripting, ASP Objects and Components, Working of .asp files, CGI Basics, Why CGI is used? How it Works? Get and Post methods.

MODULE-II (15 Hours)

Introduction to Java Enterprise Edition 5: Programming for the Enterprise, Enterprise Architecture (Single tier, two tier, three tier, N tier, Enterprise) and Technologies, Introduction to Web Application. **Java Servlets:** Introduction to Web Containers, Servlet Programming, Servlet vs. Applet, Servlet API, GenericServlet Class, HttpServlet Class, Servlet Architecture, Servlet life Cycle, Working with Servlet, Working with Databases, Servlet Sessions, Cookies, Context and Collaboration. **Java Server Pages:** Basics and Architecture, Life Cycle of JSP Page, JSP Directives, Scripting Elements, Standard Action Elements of JSP, Implicit Objects and scope, Writing JSP application with standard Tag Libraries, Connecting to Databases. **XML:** Introduction, XML Document Syntax, Document Type Definition, Parsing valid XML, SAX, DOM.

MODULE-III (8 Hours)

Distributed Computing Using RMI: Basics, RMI Architecture, Locating Remote Objects, RMI Exceptions, and Developing Applications with RMI, Understanding Directory Services and JNDI. **Enterprise Java Beans:** Introduction, EJB vs. Java Beans, EJB Architecture, Features/ Benefits of EJB, Types of EJB, Working with Session Beans, Entity Beans.

TEXT BOOKS

1. Ivan Bayross, Web Technologies, Vol-I and Vol-II , BPB Publications.
2. Subrajmanyam Allamaraju and others, Professional Java Server Programming J2EE 1.3 Edn., Apress, SPD.

REFERENCE BOOKS

1. Ivan Bayross and Others, Java Server Programming for Professional covers JAVA EE 5, SPD.
2. Danny Ayers and others, Professional Java Server Programming, Wrox Press ltd, SPD.
3. Dream Tech Press , Java Server Programming (J2EE 1.4) Black Book" Bruce W. Perry, "Java Servlet & JSP", Cookbook SPD-O'Reilly
4. SL-134 Web Component with Servlets & JSP Technologies, Sun Solaris.
5. FJ-310-EE5 Developing Applications for the Java EE Platform, Sun Solaris.
6. SL-285-SE6 Developing Applications with the Java SE Platform, Sun Solaris.

CS-406 MOBILE COMPUTING (3-0-0)

MODULE-I (10 Hours)

Introduction to Personal Communications Services (PCS): PCS Architecture, mobility management, Networks signaling, Global System for Mobile Communication (GSM) System overview : GSM Architecture, Mobility management, Network signaling**. General Packet Radio Services (GPRS)**: GPRS Architecture, GPRS Network Nodes, Mobile Data Communication ; WLANs (Wireless LANs) IEEE 802.II standard, Mobile IP.

MODULE-II (15 Hours)

Wireless Application Protocol (WAP): The Mobile Internet standard, WAP Gateway and Protocols, wireless mark up Languages (WML), **Wireless Local Loop (WLL):** Introduction to WLL Architecture, wireless Local Loop Technologies. Third Generation (3G) **Mobile Services**:

Introduction to International Mobile Telecommunications 2000 (IMT 2000) Vision, Wideband Code Division Multiple Access (W-CDMA), and CDMA 2000, Quality of services in 3G.

MODULE-III (15 Hours)

Global Mobile Satellite Systems; case studies of the IRIDIUM and GLOBALSTAR systems. **Wireless Enterprise Networks**: Introduction to Virtual Networks, Blue tooth technology, Blue tooth Protocols. Server-side programming in Java, Pervasive web application architecture, Device independent example application.

TEXT BOOKS

1. Burkhardt, Pervasive Computing, Pearson
2. J. Schiller, Mobile CommunicationPearson
3. Sandeep Singhal, The Wireless Application Protocol, Pearson
4. Raj Pandya, Mobile and Personal Communication Systems and Services, Prentice Hall of India, 2001.

REFERENCE BOOKS

1. Mark Ciampa, Thomson learning, Guide to Designing and Implementing Wireless LANs, Vikas, 2001.
2. Ray Rischpater, Wireless Web Development, Springer.
3. Sandeep Singhal, The Wireless Application Protocol, Pearson.
4. P. Stavronlakis, Third Generation Mobile Telecommunication Systems, Springer.

7th Semester Sessional

EE-471 POWER SYSTEM LAB (0-0-3)

1. Performance of Short transmission lines
2. Performance of medium transmission line and calculation of ABCD parameters
3. Floating star point in a three phase distribution system
4. Voltage distribution over a string of suspension insulator
5. Study of characteristic of miniature circuit breaker[MCB]
6. Plotting the characteristic of HRC fuse
7. study of Electromagnetic Relay
8. Plotting of IDMT characteristic of Over current relay
9. study of Induction Cup relay, Directional relay, Directional over current relay
10. Study of Biased or percentage differential protection of Transformer
11. Study over voltage, under voltage relay