Vision Buldhana Educational & Welfare Society's

PANKAJ LADDHAD INSTITUTE OF TECHNOLOGY & MANAGEMENT STUDIES, YELGAON,

BULDHANA

(Recognized by AICTE, New Delhi & affiliated to SantGadge Baba Amravati University)

Accredited by NAAC

Department of Electrical (E&P) Engineering

Syllabus (3rd Semester to 8th Semester)

Semester 3rd

3EE 01/ 3 EP01 /3EX01 ENGINEERING MATHEMATICS – III

Course Outcomes:

After successfully completing the course, the students will be able to:

1. Demonstrate the knowledge of differential equations and partial differential equations, applied to electrical engineering systems.
2. Apply Laplace transform to solve differential equations.
3. Demonstrate the use of Fourier Transform to connect the time domain and frequency domain.
4. Apply Z Transform to solve of various Linear Difference equations with constant coefficients.
5. Apply the knowledge of vector calculus to solve physical problems.
6. Demonstrate the basic concepts of probability and statistics.

SECTION-A

UNIT-I:

Ordinary Differential Equations: - Complete solution, Operator D, Rules for finding complementary function, the inverse operator, Rules for finding the particular integral, Method of variations of parameters, Cauchy's and Legendre's linear differential equations. Applications to electrical circuits. (7)

UNIT-II:

Laplace Transforms: definition, standard forms, properties of Laplace transform, inverse Laplace transform, Laplace transform of some basic functions, initial and final value theorem, convolution theorem, Laplace transform of Periodic Function, Impulse Function, Unit Step Function. Solution of linear differential equation using Laplace transform. (7)

UNIT-III:

a) Partial differential equation of first order and first degree of following type-

(i) f (p, q) = 0; (ii) f (p, q, z)=0; (iii) f (p, q, x, y) = 0; (iv) Pp + Qq =R (Lagrange's Form);

(v) Clairaut form Z = px + qy + f(p, q) **b)** Fourier transforms- Definition, standard forms, inverse

Fourier transform Fourier sine and Fourier cosine transforms and integrals. (7)

SECTION-B

UNIT-IV:

a) Difference Equation:- solution of difference equations of first order, solution of difference equations of higher order with constant coefficient.

b) Z-transform: Definition, standard forms, Z-transform of impulse function, Unit step functions, Properties of Z- transforms (Linearity, shifting, multiplication by k, change of scale), initial and final values, inverse Ztransforms (by direct division and partial fraction), Solution of difference equation by Z-transforms. (7)

UNIT-V:

Vector Calculus: - Scalar and Vector point functions, Differentiation of vectors, Curves in space, Gradient of a scalar point function, Directional derivatives, Divergence and curl of a vector point function and their physical meaning, expansion formulae (without proof), Irrotational and Solenoidal vector fields, Line Integral, Stokes and Divergence Theorem. (7)

UNIT-VI:

Statistics & Probability: Axioms, conditional probability, Bay's theorem, mathematical expectations, probability distributions: Binomial, Poisson and Normal. (7)

Books Recommended:

1. Elements of Applied Mathematics by P. N. Wartikar and J. N. Wartikar
2. Advancing Engineering Mathematics by E. K. Kreyzig.
3. Advance Engineering Mathematics by B. S. Grewal
4. Integral Transforms by Goyal & Gupta.
5. Statistical Methods by S.G. Gupta

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3EE02/3 EP02/3EX02 ELECTRICAL CIRCUIT ANALYSIS

Course Outcomes:

After completing this course studentwill be able to:

1. Analyze electric and magnetic circuits using basic circuital laws
2. Analyze the circuit using Network simplification theorems.
3. Solve circuit problems using concepts of electric network topology.
4. Evaluate transient response of different circuits using Laplace transform
5. Evaluate two-port network parameters and network functions

Unit I:

a] Terminal Element Relationships: V-I relationship for Dependent &Independent , Voltage and Current Sources., Source Transformations. Source Functions: unit impulse, unit step, unit ramp and interrelationship, sinusoidal input, generalized exponential input.

Magnetic Circuits: concept of self and mutual inductance, dot convention, coefficient of coupling, composite magnetic circuit, Analysis of series and parallel magnetic circuits. b] Basic Nodal and mesh Analysis: Introduction, Nodal analysis, super node analysis, mesh analysis, super mesh analysis.

Unit II:

Network Theorems: Superposition theorem, Thevenin'stheorem, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem, Millman's theorem, Substitution theorem, Compensation theorem, Tellegen's theorem

Unit III :

Graph Theory and Network Equation:-Graph of a network, Trees and loops, Tie-set and cut set matrix of a network, Network equilibrium equations, duality-network transformation.

Unit IV:

a] **Transformation of a Circuit into s-domain:** LaplaceTransformed equivalent of inductance, capacitance and mutual inductance, Impedance and admittance in the transform domain, Node Analysis and Mesh Analysis of the transformed circuit. Complete Solution ofLinear Differential Equations for Series RC, Parallel RC, Series RL, Parallel RL, Series RLC, Parallel RLC and Coupled Circuits-for step Inputs. Natural Response, Transient Response, Determination of initial conditions.

Unit V :

Two Port Networks: Two port networks: Open circuit impedance parameters, Short circuit admittance parameters, Transmission parameters, Hybrid parameters, Condition for reciprocity and symmetry of a two port network, Interrelationship between parameters, Interconnection of two port networks , Input impedance in terms of two port network parameters, Output impedance, Image impedance.

Unit VI :

Network functions: Ports and terminal pairs, Network functions, poles and zeros, Necessary conditions for driving point function, Necessary conditions for transfer function. Applications of network analysis in driving network functions, positive real functions, driving point and transfer impedance function.

Text Book: Network Analysis, M.E. Van Valkenburg, PHI, 2005.

Reference Books:

1. Circuits & Networks – Analysis, Design & Synthesis by M.S.Sukhija, T.K.Nagasarkar, OxfordUniversity Press, 2010.

2. Circuit and Network Analysis, SudhakarShyammohan, Tata Mc Graw Hill, 2005.

3. Network Analysis, P. Ramesh babu, SciTech Publications, Chennai, 2009

3EE03/3 EP03/3EX03 ELECTRICAL MACHINE - I

Course Outcomes:

After Completing this course, students will be able to:

1. Explain the construction and working of DC Machines.
2. Illustrate the different Characteristics, types, their applications and parallel Operation of D.C. Generators.
3. Demonstrate the various characteristics, starting, speed control and braking operation on DC motors
4. Analyze the performance of DC machines by conducting the various tests on it.
5. Determine the parameters of equivalent circuits, performance parameters of single phase transformer and

merits & demerits of autotransformer

6. Explain the construction, working, different connections, applications and testing of three phase transformer.

D.C. Machines: Construction, Principle of Operation, EMF Equation, Torque Equation. Armature winding – Lap,wave, single layer, double layer. Armature Reaction and commutation, method of improving commutation.

Unit II :

D.C. Generators: Types, Characteristics and Applications of D. C. Generators, Parallel Operation of D.C.Generators, Introduction to testing of D. C. Generators as per Indian standard.

Unit III :

D.C. Motors: Types, Characteristics & Modified Characteristics, Applications of D.C. Motors. Starting, Electric Braking, Speed Control of DC Motors. Losses, efficiency and testing of DC Motors.

Unit IV :

Single phase Transformer: Working Operation, EMF Equation, and separation of core losses in to its component. Equivalent Circuit, Parallel Operation. Open Circuit, Short Circuit & Sumpner's test on transformer as per Indian standard. Single phase Autotransformer: - construction, working, merits, demerits and its application.

Unit V :

Three Phase Transformer: Construction, Working, Types, connections, vector group connections, open delta Connection, OC, SC, Heat run test, load test, magnetic balance, vector group test on three phase transformer.

Unit VI :

Three Phase Transformer: Three-winding transformer, On load & Off load tap changers, Scott Connection, Power transformer and Distribution transformer. Waveforms of no load current & inrush current phenomenon.

Reference Books:

1) C. Dawes: Electrical Engineering, Vol.I: Direct current (IV Edition), (McGraw Hill Book Company)

2) H. Cotton: Advance Electrical Technology, (Wheeler publication)

3) Indian Standard Guide for testing DC Machine. IS: 9320-1979, (Indian Standards Institution, New Delhi.)

4) Indian Standard Specification for safety transformer. IS: 1416-1972, (Indian Standards Institution, New Delhi.)

3EE04/3 EP04 – ENERGY RESOURCES AND GENERATION

Course Outcomes:

A student, on completion of this course, will be able to:

1. Explain the operation of Thermal, Hydro, Nuclear and Diesel power plants.
2. Summarize solar energy conversion, solar radiation measuring instruments, wind energy conversion and
their applications.
3. Outline the principle and operation of fuel cells, ocean & tidal energy conversion, and other nonconventional
energy resources.
4. Determine the various factorsand curves related to electrical load & generating plant.

Unit I:

Conventional and non conventional energy sources, Indian Energy Scenario.

Thermal and hydro power plant: Layout of Thermal power plant, Selection of site, working of various parts: Economizer, air preheater, condenser, cooling tower, ash &coal handling plant, advantages & disadvantages Layout of Hydro power plant, classification of hydro power plant according to available head, nature of load, functions of different components and their working, mini and micro hydro-electric power generation, advantages & disadvantages.

Unit II :

Nuclear and Diesel power plant: nuclear fission and fusion, Layout of Nuclear power plant, Selection of site, Functions of different components of nuclear plant, types of nuclear reactors , advantages & disadvantages of different nuclear reactors, nuclear waste disposal., safety measures.

Layout of Diesel power plant, functions of different components of diesel plant, advantages & disadvantages.

Unit III :

Solar Energy and its measurement: Solar cell, array & module, Solar constants, solar radiation at earth's surface, Solar radiation geometry, solar radiation measurement, estimation of average solar radiation, solar radiation on tilted surface, principle of solar energy conversion in to heat, types of solar collectors, energy balance equation and collector efficiency.

Unit IV:

a]Fuel cells: Chemistry applied to fuel cells, principle and operation ,classification and types of fuel cells, performance characteristics of fuel cells, classification of fuel cell system. b]Wind energy :Basic principle of wind energy conversion, wind data and energy estimation, selection of site ,basic components of wind energy conversion system ,classification of WEC systems ,generating system, applications of wind energy.

Unit V :

Ocean, Tidal & Other non-conventional energy resources: Ocean energy resources, ocean energy routes, ocean thermal energy conversion, basic principle of tidal power, components of tidal power plants, operation methods of utilization of tidal energy, estimation of power and energy in single and double basin tidal system,. Operating principles of energy from biomass, energy from biogas, geothermal energy, MHD power generation, energy from urban and rural waste.

Unit VI :

Load-Generation factors: connected load, maximum demand, demand factor, load factor, diversity factors, plant capacity and utilization factor, types of loads, load curve, chronological load curve, load duration curve, energy load curve, energy duration curve, load survey, base load and peak load station.

Text Book: Generation of electrical energy by B.R.Gupta, Eurasia Publishing House, New Delhi.

Reference Books:

1. Non conventional energy resources. By G.D.Rai, Khanna Publishers New Delhi
2. Solar energy by S.P.Sukhatme Tata McGraw Hill Publication
3. Principles of Power System by V.K.Mehta, S.Chand publication.
4. Conventional energy technology by S.B.Pandya, Tata McGraw Hill Publication

3EE05/3 EP05ELECTRONIC DEVICES AND CIRCUITS

Course Outcomes:

After successfully completing the course, the students will be able to :

1. Demonstrate the knowledge of semiconductor physics and PN Junction Diode
2. Analyze the rectifier and regulator circuits.
3. Analyze the operational parameters of BJT
4. Analyze various multistage amplifier circuits
5. Demonstrate the knowledge of JFET, MOSFET, UJT and their operational parameters

UNIT-I:

P-N Junction diode theory, Energy bands in intrinsic and extrinsic silicon, carrier transport, diffusion current , drift current, mobility and resistivity, generation and recombination of carriers, PN junction diode , zener diode, zener diode as voltage regulator, Numericals based on voltage regulator (line and load regulation, Numericals based on resistivity, conductivity, mass action law)

UNIT-II:

Half wave, full wave center tapped full wave and bridge rectifier. Filters-C, LC and their analysis, clipping and clamping, Numericals based on clipping and clamping

UNIT-III:

Theory and Analysis of Bipolar Junction transistor, 'H' Parameter, methods of biasing, their needs, 'Q' and stability factors, compensation techniques.

UNIT-IV

Study of typical transistor amplifier circuits i) Emitter follower, ii) Darlington emitter follower. iii) Bootstrap emitter follower, iv) RC coupled amplifier, v) Transformer coupled amplifier, vi) Cascaded amplifier, vii) Direct coupled amplifier, viii) Cascade stage.

UNIT-V :

FETs (JFET & MOSFET): Types, Characteristics and parameters (u, gm &Rds), Applications of FET amplifiers, UJT: Characteristics, working, UJT as relaxation oscillator.

UNIT-VI :

Theory, construction and applications of Schottky diode, Tunnel diode, Varactor diode, Selenium diode, LED, Photo diode, PIN diode, photo-transistor.

Text Book: Millman's Electronic Devices & Circuits by J.Millman, C.Halkias, Satyabrata Jit TMH 3rd ed, 2nd reprint 2011.

Reference Books:

1. Electronic Devices and Circuits 5/e – David Bell Oxford University Press

2. Microelectronic Circuits 5/3 – Sedranad Smith Oxford University Press

3. Boylestad R. and "Electronics Devices & Circuits", Prentice Hall of India Private Limited, New Delhi (Fifth

Edition), 1993..

3EE06/3 EP06/3EX06 ELECTRICAL CIRCUIT ANALYSIS LAB

Minimum eight experiments based on the syllabus content of 3EP02 Electrical Circuit Analysis. The intensive list of experiment is given below.

1. Verification of output response of series R-C circuit for step input

2. Study of dot convention and determination of

A) Mutual inductance

B) Coupling coefficient of b transformer

3. Verification of Mesh and Node analysis.

4. Verification of Superposition theorem.

5. Verification of Thevenin's theorem.

6. Verification of Maximum Power Transfer theorem.

7. Verification of reciprocity theorem.

8. Study of Milliman's theorem& verification.

9. Verification of Norton's theorem.

10. Determination of ABCD parametersT-network &Π-network.

11. Study of Tie set and Cut set schedule for a given network.

12. MATLAB simulation for o/p verification of any theorem.

13. Determination of Z and Y parameter.

14. Determination of hybrid parameter.

3EE07/3 EP07/3EX07 ELECTRICAL MACHINES - I LAB.

Minimum eight experiments based on the syllabus content of 3EP03Electrical Machines – I.

The indicative list of experiments is given below.

1. Plot the OCC of DC generator and find its critical resistance and critical speed.

2. To study the build-up of DC shunt generator, calculate critical resistance at different speeds.

3. Plot/Compare: External, Internal Characteristics of DC Shunt/series/compound generator.

4. Calculate the efficiency and voltage regulation of DC generator by the direct load test.

5. Speed Control of DC Shunt motor by armature control & Field Control method.

6. Perform the direct load test on DC series/shunt/compound motor to plot its performance characteristics, and determine its efficiency and speed regulation.

7. Conduct the Swinburn's test on DC machine to estimate its performance at any desired load condition.

8. Conduct the Hopkinson's test on DC Machine to analyze its performance.

9. Perform Electric Braking Operation on DC shunt Motor.

10. Conduct the Polarity test and Ratio test on transformer

11. Calculate the Equivalent circuit parameters of single-phase transformer by performing OC & SC test on it and determine its efficiency and voltage regulation

12. Perform the direct load test on single phase/three phase transformer and determine its efficiency and voltage regulation.

13. Conduct back to back test (Sumpner's test)on two single phase transformers and determine the temperature rise.

14. Conduct the magnetic balance test on three phase transformer.

15. Conduct the vector group test on three phase transformer.

16. Conversion of three phase to two phase supply system using Scott Connection

17. Capture the waveform of inrush current of single phase/three phase transformer using DSO.

Reference:

S.G.Tarnekar, P.K.Kharbanda, S.B.Bodkhe, S.D.Naik and D.J.Dahigaonkar"Laboratory Courses in Electrical Engineering", S. Chand & Co. New Delhi, 2013.

3EE08/3 EP08/3EX08 ELECTRONIC DEVICES & CIRCUITS LAB

Minimum eight experiments based on the syllabus content of 3EP05Electronic Devices & Circuits. The intensive list

of experiment is given below.

1. To study and verify V-I characteristics of semiconductor diode
2. To study and verify V-I characteristics of Zener diode.
3. To verify the performance of half wave rectifier circuit with and without filter.
4. To verify the performance of full wave bridge rectifier circuit and determination of load regulation.
5. To verify the performance of Zener voltage regulator.
6. To verify characteristics of bipolar junction transistor
7. To study and perform C-E amplifier gain with variation of load resistance.
8. To study and verify the characteristics of FET
9. To study UJT as a relaxation oscillator
10. To study phase shift oscillator & determine frequency of oscillation
11. To study characteristics of MOSFT
12. To study clipper circuits using diodes
13. To study clamper circuits using diodes
14. To study and verify operation of cascade amplifiers

3EE09/3 EP09/3EX09 ELECTRICAL TECHNOLOGY - LAB

Perform minimum Eight practicals / demonstration from the following list and prepare the report as a term work for this laboratory.

1. Introduction to standard symbols used in wiring diagrams
2. Introduction to different wiring accessories.
3. Demonstration of different types of wirings eg. Domestic wiring, commercial wiring, Industrial wiring.
4. Connection of Staircase wiring, Godown wiring, fluorescent lamp. Ceiling fan, air cooler etc
5. Domestic wiring diagrams
6. Connections of switch board, MCB and energy meter
7. Testing and electrical Maintenance of domestic appliances like lamps, electric iron, heater, geyser, air cooler, fan, microwave-oven, induction heater, etc.
8. Insulation resistance and earth resistance measurement
9. Conduct the load survey for domestic/commercial /Industrial consumers
10. Illumination system Design (selection of type and number of lamps required for any location)
11. Calculation of Energy bill for LT & HT consumers.

12. Safety precautions while working with electrical system

13. Demonstration of first aid treatment after getting electric shock.

14. Study of various components of solar power plant.

15. Design calculation of small capacity roof top solar power plant

SEMESTER – IV

4EE01/4EP01/4EX01 ELECTROMAGNETIC FIELDS

Course outcomes :

At the end of the course the student should be able to:

1. Demonstrate the basic mathematical concepts related to electromagnetic vector fields.

2. Apply the principles of electrostatics to the solutions of problems relating to electric field and electric

potential, boundary conditions and electric energy density.

3. Apply the principles of magneto statics to the solutions of problems relating to magnetic field.

4. Apply Maxwell's equation in different forms (differential and integral) to diverse engineering problems.

Unit I :

Review of Vector Analysis: Cartesian, cylindrical and spherical co-ordinate systems, vector algebra and vector calculus. Line integral and multiple integrals. Gauss theorem.

Unit II :

Electrostatics: Coulomb's law, electric field, Gauss flux theorem in integral and differential form. Electrostatics potential, Poison and Laplace equations.

Unit III :

Electrostatics fields in dielectrics: electric dipole, polarization. P and D vectors, boundary conditions. Capacitance and electrical energy.

Unit IV :

Magnetic fields: Biot-Savart law, Ampere's law in integral and differential form. Continuity equation, time of relaxation. Vector and Scalar magnetic potential, electric current, J vector..

Unit V

Magnetic fields in materials: magnetic dipole equivalent volume and plane section curve. H vector, magnetization vector M, boundary conditions between magnetic materials, inductance, Electromagnetic Energy.

Unit VI :

Maxwell equations and wave equations: Displacement current, time varying fields and Maxwell's equations, plane uniform magnetic waves. Depth of penetration Poynting vector

Text Book: "Engineering Electromagnetics", by Hayt W.H. Tata Mc-Graw Hill publication

Reference Books:

1. Electromagnetic fields by TVS Arun Murthy S Chand & Co
2. Principles and applications of Electromagnetic fields by Plansycollin , Mc-Graw Hill Books Co.
3. Foundations of electromagnetic theory by John Reitz, Addison Wesley Pub Co.
4. Basic electromagnetic field by Herbert Neelf, Harber International education
5. Introduction to electromagnetic, Derucy and Johnson, Mc-Graw Hill Books Co.

4EE02/4EP02/4EX02 ELECTRICAL MEASUREMENTS & INSTRUMENTATION

Course Outcomes:

A student completing this course, should be able to:

1. Classify the various measuring instruments like PMMC, MI, Electrodynamometer, and Induction type instruments for measurement of current, voltage, power, and energy.
2. Demonstrate the construction & working of Instrument Transformers and special purpose meters.
3. Analyze various methods for measurement of resistance, inductance, and capacitance using AC/DC bridges.
4. Explain the working of various Digital measuring instruments.
5. Explain the generalized Instrumentation system & working of different transducers.

Unit-I: Analog Instruments - Classification of measuring instrument, Different torques in measuring instrument, Analog Ammeter, Voltmeter, Electrodynamic type Construction, ,theory of operation, torque equation, errors, merits and demerits of each type

Unit II : Wattmeter and Energy meter-Construction, theory of operation, torque equation, errors, merits and demerits of each type. Analysis of three phase balanced load:- Blondell's theorem, Measurement of active and reactive power in single phase and three phase circuits.

Unit III : Instrument transformers- C.T.and P.T., Importance, theory and construction, phasor diagram, causes of errors, testing, and applications. Special Instruments- Frequency meter, Power factor meter, Phase sequence indicator, Synchroscope and Stroboscope.

Unit IV: Measurement of circuit parameters- Different methods of measurement of low, medium, high value of resistance, sensitivity and accuracy of different methods. AC and DC bridges, Wheat - stone, Kelvin, Maxwell ,Wein , Hay , De-Sauty ,Schering , Owen , Anderson's bridge.

Unit V:

Digital methods of measurements, Introduction to A/D, D/A techniques , F/V and V/F conversion techniques , Digital voltmeter (DVM), ammeter, wattmeter, multi-meter and Electronic energy meter, Sources of error, Inherent error in digital meters.

Unit VI:

Generalized Instrumentation system- characteristics of measurement and Instrumentation system. Transducers: Definition, classification, Specification, selection, loading effect, Displacement, velocity transducers, Force and torque transducers, Resistive, inductive, Capacitive, strain gauge

transducers, Piezoelectric, current and voltage transducers. Elastic-members (Bellows, Bourdon tube, Diaphragm)

Text Book: A.K. Sawhney, 'Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai& Co (P) L

Reference Books:

1. E.W.Golding&F.C.Widdis, 'Electrical Measurements & Measuring Instruments', A.H.Wheeler& Co.

2. Albert D. Helfrick& William D. Cooper, 'Modern Electronic Instrumentation & Measurement Techniques',

Prentice Hall of India, .

3. Joseph. J. Carr, 'Elements of Electronic Instrumentation & Measurements', III edition, Pearson Education.

4. Bouwens, A.J., "Digital Instrumentation", McGraw Hill.

4EP03 CONTROL SYSTEMS

Course Outcomes:

After completing this course, student will be able to:

1. Demonstrate the fundamental concepts of automatic Control and mathematical modeling of the Systems.
2. Determine the transfer function of control system components.
3. Analyze the time response of various systems and performance of controllers.
4. Evaluate the stability of linear systems using various methods.

Unit I : Introduction to automatic control

Open loop and closed loop system, servo-mechanisms, mathematical modeling of physical systems, transfer functions, block diagrams and signal flow graphs. Effect of feedback on sensitivity to parameter variation and reduction of the noise.

Unit II : Control System Components

Electrical / Electro-mechanical components such as A.C./D.C. servomotors, stepper motors, synchros, potentiometers, tacho-generators, encoders, their functional analysis and operating characteristics and their application.

Unit III: Time response analysis:

Time response of first and second order systems to standard inputs. Time response specifications, types of system, error analysis, error coefficients, steady state errors, dynamic error series. Approximate methods for higher order system, proportional, derivative and integral control.

Unit IV: Stability

Stability of control systems, characteristics equation, impulse response, Routh-Hurwitz stability criterion, relative stability. Root Locus: construction of root locus, determination of roots from root locus conditions on variable parameter for stability, effect of addition of poles and zeros.

Unit V: Frequency response methods

Frequency response of linear system, specification, Logarithmic frequency response (Bode) plots from transfer function for various systems. Polar plots for various systems. Estimation of approximate transfer functions from the frequency response.

Unit VI: Stability analysis from frequency response : Gain margin and Phase margin; Stability analysis from Bode plots. Nyquist criterion, Nyquist plots and stability analysis.

Books Recommended:

Text Book: Nagrath I.J., Gopal M.: Control System Engineering, Wiley Eastern.

Reference Books:

1. Control Engineering, D.Ganesh Rao, k. Chennavenkatesh, 2010, PEARSON
2. Ogata K.: Modern Control Systems, Prentice Hall of India.
3. Control Systems by K.R.Varmah TMH edition 2010
4. Linear Control Systems, Ashfaq Hussain, Haroon Ashfaq, Dhanpat Rai & co.

4EP04 NUMERICAL METHODS & OPTIMIZATION TECHNIQUES

Course Outcome:

After completing this course students will be able to

1. Solve linear and Simultaneous Equations with the help of Numerical Methods.
2. Apply various Numerical methods to fit the curve.
3. Solve Numerical differentiation, integration, and Differential Equations.
4. Solve linear, non linear and dynamic optimization problem by various methods.
5. Determine the optimum scheduling by using CPM and PERT.

Unit I:

(a)Absolute, relative and percentage errors and analysis, Solution of Algebraic and Transcendental equations: Bisection Method, False Position method, Newton Raphson methods, Successive approximation method

(b) **Solution of Simultaneous Algebraic Equations**: matrix inverse method, Gauss elimination method,Iterative method-Jacobi's Method, Gauss Seidel Method; Eigen values of a matrix.

Unit II:

(a) Curve fitting by Least Square Method, Correlations and Regression.

(b) Newton's forward and backward interpolation method, Newton's Divided Difference Method, Lagrange's Interpolation method, Interpolation with Cubic Splines.

Unit III:

Numerical differentiation by Taylor series method, Maximum and minimum values, Numerical Integration by rapezoidal, Simpsons one third and three eight rules, Numerical solution to differential equations by Taylor Series, Euler's method, RungeKutta second and fourth order methods

Unit IV:

Basics of Optimization Techniques, Linear programming - standard form, definitions and theorems, graphical method, simplex method, two phase simplex method, balanced and unbalanced transportation problems.

Unit V:

Non linear programming: unimodal function, Fibonancci search method and golden section method, Steepest descent method, conjugate gradient method, unconstraint optimization, direct search method.

Unit VI:

Dynamic programming: multistage decision processes, principle of optimality, sub optimization, calculus and tabular method of solution, conversion of final value problem into initial value problem.

CPM and PERT: introduction, Network representation of project, critical path, Probability of completion of project, optimum scheduling by CPM, crashing of project.

Books Recommended:

Text Books:

1. Introductory Methods of Numerical Analysis; S. S. Sastry (PHI)
2. Engineering Optimization – Theory & Practice; S. S. Rao (New Age International Pvt. Ltd.)

Reference Books:

1. Mathematical Statistics by J. N. Kapoor, Tata McGraw Hill Pub. Co. Ltd
2. Numerical Methods in Engineering and Science; B. S. Grewal (Khanna Publishers)
3. PERT and CPM- Principles & Application; L. S. Srinath (Affiliated East-West press pvt. Ltd)
4. Optimization for Engineering Design - Algorithms and Examples byKalyan Moy Deb, PHI Pub.

4EE04/ 4EP05 /4EX04 ANALOG AND DIGITAL CIRCUITS

Course Outcomes:

After completing the course, students will be able to

1. Explain the principles of operational amplifiers, parameters of op-amp
2. Illustrate the linear and nonlinear applications of op-amp
3. Demonstrate the knowledge of Voltage regulator and Timer ICs
4. Describe the working of Logic families andtheir applications.
5. Demonstrate the knowledge of combinational and sequential circuits and its application

Unit I:

Introduction to IC’s: Operation amplifier; Block schematic internal circuits, Level shifting, overload protection, study of IC 741 op-amp, Measurement of op-amp parameter.

Unit II:

Linear and Non-linear Application of Op-amp: Inverting and non inverting amplifiers, voltage follower, integrator, differentiator differential amplifier, op amp as adder subtractor, op amp as a log and antilog amplifier

Sinusoidal RC-phase shift and Wein bridge oscillators, clipping, clamping and comparator circuits using op-amps.

Unit III:

Other linear IC's : Block schematic of regulator IC 723, and its applications, study of 78XX, 79XX and its applications, SMPS, Block schematic of timer IC 555 and its applications as a timer, a stable, mono stable, bistable multivibrator and other applications, Operation of phase lock loop system and IC 565 PLL, its application.

Unit IV: Basic Logic Circuits : Logic gate characteristics, NMOS inverter, propagation delay, NMOS logic gate, CMOS inverter, CMOS logic gates, BJT inverter, TTL, NAND gate, TTL output, state TTL logic families, ECL circuits, composition logic families.

Unit V:

Combinational Digital Circuits: Standard gate assemblies, Binary adder, Arithmetic functions, Digital comparator,Parity check generator, Decoder / demultiplexer, Data selector / multiplexer, Encoder

Unit VI:

Sequential Circuits and Systems: Bistable Latch, Flip-Flop clocked SR,J-K, T, D type shift Registers, counter. Design using filp-flops, Ripple and synchronous types, application of counters

Books Recommended:-

Text Book: Millman, Microelectronics, 2nd Ed., McGraw Hill.

Reference Books:

1. Gayakwad, Op-Amp & LLG, 2nd Ed.
2. Malvino& Leach, Digital Principles & Applications, 4th Ed., McGraw Hill.
3. K.B.Botkar, Integrated Electronics (Khanna Publishers.)

4EE07/ 4EP06 /4EX06 ELECTRICAL MEASUREMENTS & INSTRUMENTATION- LAB

Minimum eight experiments based on the syllabus content of 4EP02 Electrical Measurements & Instrumentation.

The intensive list of experiment is given below.

1. Measurements of Low resistance by using Kelvin double Bridge.
2. Measurements of Medium resistance by Ammeter Voltmeter method/Wheatstone Bridge
3. Measurement of High resistance by Loss of Charge method.
4. Measurement of Insulation resistance by using Megger
5. Measurement of unknown Inductance using Maxwell Bridge/Hay Bridge/Anderson Bridge
6. Measurement of Unknown Capacitance by Desauty Bridge/Schering Bridge
7. Measurement of frequency using Wien Bridge
8. Extension of range of ammeter using shunt/CT.
9. Extension of range of voltmeter using multiplier/PT.
10. Calibration of Wattmeter by Phantom loading

11. Calibration of energy meter to detect the error in it.

12. Measurement of active & reactive power measurement in 1 phase / 3 phase circuit.

13. Measurement of rotational speed using stroboscope

14. Conversion of non electrical quantity into its equivalent electrical quantity using proper transducer.

15. Compare the accuracy, preciseness, sensitivity of Analog & Digital Measuring Instruments

4EP07 CONTROL SYSTEM LAB

Minimum eight experiments based on the syllabus content of 4EP03Control System. The intensive list of experiment is given below.

1. Study of Potentiometer

2. Study of A.C. Synchro and its characteristics

3. Determination of Transfer Function of D.C. Generator

4. Determination Of Transfer Function of D.C.Servomotor and Its Characteristics

5. Performance Characteristics of a D.C. Motor Angular Position Control System

6. Determination Of Frequency Response of Given R-C Network

7. Determination Of Transfer Function of A.C. Tacho-Generator

8. Experimental Study Of The Operating Characteristics of a Small Stepper Motor and Its Controller

9. Study Closed Loop PI Controller System and Its Time Response to Different Input.

10. Experimental Study of Position Control of DC Motor using Ardiuno

11. Experimental Study of Time Domain Analysis of Second Order Control System

12. Study AC Position Control System

4EE09/ 4EP08 /4EX08 ANALOG AND DIGITAL CIRCUIT LAB

Minimum eight experiments based on the syllabus content of 4EP05Analog & Digital Circuit. The intensive list of experiment is given below.

1. To Plot Frequency Response Of Non-Inverting Mode Of Op-Amp Using IC741 and Determine the Bandwidth & Maximum Gain

2. To Plot Frequency Response Of Inverting Mode Of Op-Amp Using IC741 and Determine the Bandwidth &

Maximum Gain

3. To Perform Op-Amp as Differentiator Using IC741 .

4. Design The Circuit for Supplying 5V,25mA As A Low Voltage Regulator Using IC 723

5. Verification Of Truth Table Of Various Logic Gates Using ICs

6. To Study and Verify The Operation Of SR and MS ,JK Flip Flop

7. To Verify The Operation Of Multiplexer Using IC74153.

8. To Design And Verify Function Of Decade Counterusing IC 7490

9. To Verify The Truth Table Of 4 Bit Comparator

10. To Perform Op-Amp As Integrator Using IC741

11. A stable Multi-vibrator Using IC 555timer

12. To Study And Verify The Operation Of Half-Adder And Full-Adder

4EE10/ 4EP09 /4EX09 ELECTRONIC TECHNOLOGY LAB

Perform Minimum Eight experiments / demonstration based on the following contentand prepare the report as a term work for this laboratory.

 Study of electronic Components: Identification of components, name, types, symbol, size, rating and application.

 Handling Electronic Components: Finding values and testing (using DMM), test working condition, fault detection.

 Working with breadboards: understanding the breadboards for component mounting, working with small circuits on breadboard

Soldering: Soldering skill tips- use of proper soldering Iron, Metal, Flux**,** Cleaning, Tinning etc., mounting components on zero PCB, testing of small circuits mounted on zero PCB. De-soldering of components

 PCB Layout and design: Understanding different PCBs, Working on PCB Layout (Software), PCB etching, drilling on PCB, Mounting components on PCB, Working with small circuits on PCB and their testing

 Electronic circuit Simulation: Familiarizing with the simulation software, simulation and result validation of simple circuit with software.

SYLLABUS BE SEM. V ELECTRICAL ENGG. (ELECTRONICS & POWER)

5EP01 POWER SYSTEM- I

Course Outcomes:

After completing this course, the students will be able to:

1. Determine the parameters of transmission lines.
2. Evaluate the performance of transmission line
3. Describe transmission lines voltage control and power factor improvement methods.
4. Explain representation of power system, Ferranti effect and corona phenomenon.
5. Demonstrate various Insulators , its string efficiency & underground cables.

Syllabus:

Unit I: Transmission line parameters: calculation of resistance, inductance and capacitance of single phase andthree phase transmission lines, skin effect and proximity effect, transposition, G.M.D. & G.M.R. methods, double circuit lines, bundled conductors, effect of earth on inductance and capacitance, interference with communication lines.

Unit II: Electrical characteristics of transmission line: V-I characteristics of short, medium and long lines, A, B, C, D constants, nominal T and equivalent π representations

Unit III: Voltage control and power factor improvement: methods of voltage control and power factor improvement, use of static VAR generators and synchronous condenser, automatic voltage control. Receiving end and Sending end power circle diagrams.

Unit IV: Representation of power systems: single line diagrams, per unit system and one-line impedance and reactance diagrams. Ferranti effect, corona phenomenon, Introduction to Travelling waves.

Unit V: Insulators: materials used, types, comparison of pin type and suspension type insulators, voltage distribution and string efficiency, methods of increasing string efficiency, grading rings and arcing horns. Introduction to insulator testing, line supports for LV, HV, EHV and UHV.

Unit VI: Underground cables: material used for conductor & insulation, different types of cables and their construction, parameters of underground cable, grading of cable, losses, break down and rating, selection of cables.

Text Books:

1. Modern Power System Analysis by D. P. Kothari, I. J. Nagrath TMH Publishing

2. Elements of power system analysis by William D. Stevenson, Jr, McGraw-Hill International edition

Reference Books:

1. Power System Engineering by D. P. Kothari, I. J. Nagrath TMH company ltd., New Delhi

2. Narain G. Hingorani and Lazlo Gyugyi "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems.

3. Principles of power system by V. K. Mehta, S. Chand & company ltd., New Delhi.

4. Electrical Power Systems by C. L. Wadhwa, New Age International Publishers, New Delhi

5. Electrical Power Systems by Ashfaq Husain, CBS Publishers & Distributors Pvt. Ltd., New Delhi.

6. Electrical Power system design by M. V. Deshpande, TATA McGraw-Hill Publishing Company Limited, New Delhi.

5 EP02 MICROPROCESSORS & MICROCONTROLLER

Course Outcomes:

After completing the course the students will be able to

1. Recite Fundamentals and Architecture of Microprocessor 8085, Microcontroller 8051
2. Interpret Assembly Language Programming of Microprocessor 8085, Microcontroller 8051
3. Illustrate interfacing with Microprocessor 8085, Microcontroller 8051
4. Apply knowledge of Microprocessor 8085 for measurement of Electrical quantities
5. Discusss Fundamentals and Architecture of Microprocessor 8086
6. Explain Fundamentals and Architecture of Microprocessor 8051

Unit I: 8085-architecture and Pin Diagram, Microprocessor Operations (Initiated, Internal and External) BUS
organization and register structure, instruction set of 8085, addressing modes, Machine Cycles & Bus Timings

Unit II: Assembly Language Programming of 8085, counters and time delays, stack and subroutines, Memory mapped I/O and I/O mapped I/O, address decoding techniques. Interrupt system of 8085 (software and hardware interrupts), Data transfer schemes, serial data transfer through SOD and SID line.

Unit III: Programmable Interfacing devices: Internal architecture, programming and interfacing of Programmable Peripheral Interface PPI (8255), Programmable Interrupt Controller PIC (8259), and Universal Synchronous Asynchronous Receiver Transmitter USART (8251) and Programmable Interval Timer PIT (8253)

Unit IV: Introduction to microcontroller: 8051 pin configuration and architecture, 8051 Internal resources, pin diagram, I/O pins, ports and their internal logic circuits, counters, serial ports, interrupt structure, SFRs and their addressing, watch-dog timer, internal code memory, data memory, stack pointer, flags, bit addressable memory.

Unit V: Instruction set of 8051.Addressing modes. Various groups of instructions: data transfer. Arithmetic-logical
group. Interrupt, timer counter related instructions. Interfacing of 8051with external memories. Programming 8051 with interfacing examples.

Unit VI: 8085 Microprocessors / 8051 Microcontroller Applications: hardware & software developments: signal conditioning & data acquisition system components. Measurement of Pulse width and Magnitude using 8085. Measurement of fundamental quantities -voltage, current, frequency, speed using 8051 Microcontroller.

Text Book: Microprocessor Architecture, Programming, and Applications with the 8085, Romesh Gaonkar PHI Publication - 2006

Reference Books:

1. An Introduction to Microcomputers Volume 1 Basic Concepts, Adam Osborne Osborne-McGraw Hill, Berkely California, 1980
2. Introduction to Microprocessor L. Gibson, Prentice-Hall, 2003
3. Advance Microprocessor and Peripherals, K. M. Bhurchandi & A. K. Ray, 2nd Edition, Tata McGraw Hill, 2006.
4. Microprocessor 8086 ,Sunil Mathur PHI 2010
5. The 8051 Family of Microcontrollers Richard Barnett Prentice-Hall, Inc -2000
6. The 8051 Microcontroller and Embedded Systems: Using Assembly and C,M A Mazidi,J.GMazidi and Mckinlay, 2nd Edition, Pearson.

5EP03 ELECTRICAL MACHINES – II

Course Outcomes:

After completing this course students will be able to

1. Describe the construction, working operation & performance characteristics of three phase Induction Motor
2. Analyze the starting, braking and speed control of three phase induction motors by various methods.
3. Describe the construction, working operation & performance characteristics of single-phaseInduction Motor
4. Demonstrate the construction, working operation & performance characteristics of synchronous machine.
5. Explain the construction & working of special motors like Universal, Reluctance, PMSM & BLDC Motor

Unit I: Three phase induction motor – I:

Construction, Types (squirrel cage and slip-ring), Rotating Magnetic Fields, principles of operation, Working, Torque Slip Characteristics, Starting and Maximum Torque. Effect of parameter variation on torque slip characteristics (variation of rotor and stator resistances, stator voltage, frequency).Equivalent circuit. Phasor Diagram, Performance evaluation by direct & indirect testing, circle diagram.

Unit II: Three phase induction motor – II :

Starters for squirrel cage &slip-ring type IM, Methods of speed control, electric braking, High Torque IM, single phasing, cogging and crawling, Generator operation Self-excitation, Doubly-Fed Induction Machines.

Unit III: Single phase Induction Motor : Double revolving field theory, Constructional features, equivalent circuit, working, Split-phase starting methods and applications of single-phase Induction motors.

Unit IV: Synchronous Generator:

Constructional details, working principle, operation, armature reaction, circuit model, determinations of parameters of the circuit model and phasor diagram, methods of determining the regulations and efficiency, Parallel operation of alternators - synchronization and load division.

Unit V: Synchronous Motor:

Construction, principle of operation, working, starting methods, torque equation - V-curve, Inverted V curve & power angle characteristics, hunting & damping, applications. Transient, sub transient & steady state reactance of synchronous machines.

Unit VI: Special Motors:

Construction, working principle, operation, characteristics and applications of Universal motor, Reluctance Motor, Permanent Magnet Synchronous Motor & BLDC Motor.

Text Books:

1. D.P.Kothari & I.J. Nagrath, "Electrical Machines"- 5thEdition, TMH Publication.

2. S. Langsdorf, "Alternating Current Machines", McGraw Hill Publication

Reference Books:

1. Stephen D. Umans, "Fitzgerald and Kingsley's Electric Machinery", 7th Edition, McGraw Hill Publication,

2020.

2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.

3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.

4. C L Dawes, "A Course in Electrical Engineering (Volume -2)", McGraw Hill Publication.

5EP04 Professional Elective-I SIGNALS AND SYSTEMS

Course Outcomes :

After completing this course student will be able to

1. Demonstrate knowledge of continuous-time and discrete-time signals and systems.
2. Analyze the continuous-time systems using continuous Time Fourier transform.
3. Explain the concept of sampling, Sampling Theorem, aliasing and the Nyquist rate.
4. Analyze DT systems & their realization using Z-transforms.
5. Analyze the discrete time systems using DTFT and DFT

Unit I: Introduction to Signals and Systems: Classification of Signals Classification of Systems, Systems Modeling Some Ideal Signals, Energy and Power Signals Frequency Response, Discrimination of Continuous-Time Signals Topological Models, Analysis of Continuous-Time Systems Properties of Elementary Signals Linear Convolution Integral, Response of Continuous-Time Systems

Unit II: Fourier Transform Properties of Fourier Transform, Tables of Fourier Transform Pairs Fourier Transform of Periodic Signals, Ideal Low-Pass Filter Frequency-Domain Analysis of Systems Fourier analysis of Sampled Signals

Unit III: Analysis of LTI Discrete-Time Systems: Time Domain and Frequency Domain, Properties of Discrete- Time Sequences Linear Convolution, Discrete-Time System Response.

Unit IV: Sampling: Representation of continuous time signals by its samples, reconstruction of a signal from its samples, aliasing, discrete time processing of continuous time signals, sampling of discrete time signals

Unit V: Z- Transform: Z- transform, the region of convergence for the z-transform, Inverse z-transform, properties of Z transform, analysis and characterization of LTI systems using z transforms, System function algebra and block diagram representations, the unilateral z –transform.

Unit VI: Discrete Fourier Transform and Fast Fourier Transform Representation of Discrete-Time aperiodic signals and the Discrete-Time Fourier Transform; Fourier Transform for Periodic

Signals; Properties of the Discrete-Time Fourier Transform; Discrete-Time LTI Systems and Discrete-Time Fourier Transform. Fast Fourier Transform (FFT)

Text Books:

1. Alan Oppenheim &Alan Willsky ,"Signals and Systems" Prentice Hall India Learning Private Limited; 2nd edition

2. P. Ramesh Babu R. Ananda Natarajan "Signals and Systems**."** Scitech Publications

Reference Books:

1. Fred Taylor,Principles of Signals and Systems "Tata McGraw-Hill, 1998, New Delhi

2. Nagrath, Sharan, Ranjan Rakesh and Kumar Sukhbinder" Signals and Systems" Tata McGraw-Hill, 1998, New Delhi.

3. S Haykin and B Van Veen, "Signals and Systems "John wiley & sons

5EP04 Professional Elective - I

2. NETWORK ANALYSIS AND SYNTHESIS

Course Outcomes :

After completing this course student will be able to

1. Analyze the transient response of series and parallel A.C. circuits
2. Demonstrate the properties of network functions.
3. Demonstrate the properties of positive Real Functions
4. Synthesize driving point functions of RL, RC and RLC
5. Synthesize two port network functions
6. Design passive filters to meet desired specifications

Unit I: Transient Analysis:

Transient response of RC, RL and RLC circuit to various excitation signals such as step, ramp, impulse and sinusoidal signals. Network solution with Laplace transformation, initial and final value theorem and convolution integral.

Unit II: **Network Functions:**

Network Functionsfor one port & two-port networks, poles and zeroes of network functions. Restrictions on poles and zeroes locations for driving point functions and transfer functions. Time domain behavior of electrical network from the pole- zeroes plot.

Unit III: Positive Real function: Driving point function, Brune's positive real function, properties of positive real function, testing of driving point function. An application of Maximum Modulus Theorem, properties of Hurwitz polynomial, computation of residue, even and odd functions

Unit IV: Synthesis of One Port Networks

Properties of LC, RC and RL driving point functions and their synthesis in canonical (Foster and Cauer) forms. Synthesis of RLC driving point functions which can be synthesized by partial fraction or continued fractions

Unit V: **Synthesis of Transfer Functions**

Properties of transfer functions, Zeros of Transmissions (ZOTs), synthesis of Y21 and Z21 with 1ohm termination. Synthesis of transfer functions using constant resistance single and double terminated lattice and bridge T networks. Synthesis of open circuit transfer function

Unit VI: Filter fundamentals

Classification of filters, Analysis of prototype filter section, Analysis of a prototype Low Pass Filter, High Pass Filter, Band Pass Filter, Band Stop Filter, M-Derived Filter, Low Pass Filter with RC and RL Circuits, High Pass Filter with RC and RL Circuits, Low Pass Filter with RLC Circuit. Introduction of Different Types of Active Filters

Text Books :

1. Van Valkenberg, "Network Analysis",, Prentice Hall of India (PHI)

2. Sudhakar and Shyammohan,"Circuits and Networks: Analysis and Synthesis ,McGraw-Hill Education

Reference Books:

1. Van Valkenburg "Introduction to Network Synthesis", Prentice Hall of India (PHI)

2. Kelkar, Pandit, "Linear Network Theory", Pratibha Publication.

3. Franklin Kuo, "Network Analysis and Synthesis", Wiley international.

4. A.Chakrabarti, "Circuit Theory" Dhanpat Rai & Co.

5. C.L Wadhwa, "Network Analysis and Synthesis" New Age International Publishers, 2007.

5EP04 Professional Elective – I

3. ELECTRONIC COMMUNICATION THEORY

Course Outcomes:

After successfully completing the course, the students will be able to

1. Explain various types of signal & elements of communication system.
2. Analyze the signal using Fourier Transform
3. Apply Amplitude modulation & Frequency modulation on the communication signal
4. Compare Pulse communication & Digital communication
5. Describe microwave communication system.

Unit I: Introduction to Electronics Communication Systems:

Signals: Analog & digital, Deterministic & Non-deterministic, Periodic & non periodic,Elements of Communication Systems, Transmitter, Receiver, Need for Modulation, bandwidth requirements, Noise, External, internal noise, noise calculation, noise figure.

Unit II: Signal Analysis:

Fourier Series, Exponential Fourier Series, Fourier Transform, Properties of Fourier Transform, Dirac Delta Function, Fourier Transform of Periodic functions, Fundamental of Power Spectral Density & Energy Spectral Density.

Unit III: Amplitude Modulation:

Amplitude Modulation Theory, Generation of Amplitude Modulation, Single Side band Communication, suppression of carrier, suppression of unwanted sideband, AM receiver.

Unit IV: Frequency Modulation:

Theory of Frequency Modulation, characteristics of FM, Generation of FM, pre-emphasis, De-emphasis, wide &Narrowband FM Transmission, FM receiver.

Unit V: A. Pulse Communication:

Information Theory, Classification of pulse modulation, Sampling process, pulse amplitude modulation, PWM and PPM modulation pulse code modulation.

B. Digital Communication:

Fundamentals of data communication systems, data sets and interconnection requirements.

Unit VI: Microwave communication system

Analog microwave communication: LOS, OTH microwave system Satellite communication: Satellite orbits, frequencies, attitude, transmission path.

Text Book: Electronic Communication System by Kennedy, Davis, TMH

Reference Books:

1. Electronics Communication by K.Shoenbcle PHI, India.
2. Electronics Communication techniques, Paul Young, Willey Eastern Pub.
3. Principle of C.E TMIL Taub Schilling.
4. Electronics Communication - Robert Shrader McGraw Hill.

5FEEP05 Open Elective – I

1. ELECTRICAL DRIVES

Course Outcomes:

After completing this course, Students will be able to:

1. Explain the basic Concept of electrical drives
2. Describe Power Electronics devices & their Applications
3. Demonstrate various starting, braking and speed control methods of D.C. Motors
4. Demonstrate various starting, braking and speed control methods of three phase Induction Motor.

5. Describe the construction, working principle and applications of single phase Induction Motor& special motors.

Unit I: Concept of electric drives, classification and comparison of electrical drive system, Cooling and heating of electric motors. Types of duties: continuous, intermittent and short time. Selection of an electric drive for particular applications.

Unit II: Theory, principle, Characteristics of Power Transistor, SCR, Power MOSFET and IGBT. Introduction to single phase & three phase fully controlled bridge convertors.

Unit III: D.C. Motors: Types, characteristics, Torque equation, Starting and braking, Speed controland Applications.

Unit IV: Three phase Induction Motors: Types, construction, principle of working, characteristics and applications. Starting and braking. Speed control methods: Thyristorized stator voltage control of three phase induction motor.

Unit V: Single phase Induction Motors: Double revolving field theory, Cross field theory,types, construction, principle of working, starting methods and applications.

Unit VI: Special Motors: Construction, Principle of working, and applications of D.C. servo motors, stepper motors, Brushless D.C. motors and Universal motor.

Text Books :

1. S.K.Pillai : A First Course on Electrical Drives by New Age International Publishing Co. Ltd
2. I.J.Nagrath & D.P.Kothari : Electric Machines by Tata Mc Graw Hill Publishing Co Ltd

Reference Books :

1. VedamSubrahmanyam: Electric Drives : Concepts & Applications by Tata Mc Graw Hill Publishing Co Ltd.
2. Ion Boldea, Nasar. S A : Electric Drives by CRC Press India
3. Ashfaq Husain: Electric Machines by Dhanpat Rai & Co. Ltd
4. M.D.Singh &K.B.Khanchandani : Power Electronics by Tata Mc Graw Hill Publishing Co Ltd
5. V.K.Mehta: Principles of Electronics by S.Chand and Co Ltd ,New Delhi

5FEEP05 Open Elective-I:

2. POWER SUPPLY SYSTEM

Course Outcomes:

After completing this course student will be able to

· Describe the Structure of Power system

· Explain construction and working of various generation plants

· Describe layout and working of Substations

· Compare various power distribution system

· Explain Electrical wiring required for various Installations

Unit I: Structure of Power System :

Generation, transmission and distribution. Power generating stations – different types. Steam power stations: Main parts and working, Water tube boiler, Fire tube boiler and their characteristics. Main flow circuits of steam power station. Power station auxiliaries,

Unit II: Gas-turbine power stations:

Main parts, plant layout and Bryton cycle operation. Combined cycle generation & Cogeneration. Nuclear power stations- Layout of nuclear power station, types of power reactors, main parts and control of reactors, nuclear waste disposal, radioactivity and hazards.

Unit III: Hydro-electric stations:

Site selection, constituents and schematic arrangement of hydroelectric stations, principles of working, types of turbines, Layout and working of Pumped storage plant.

Unit IV: Substation:

Classification of substations, Major equipment, Selection & location of site for substation, Main Electrical connections, Symbols for various apparatus & circuit elements in substation, 66/11kV and 11kV/400V substation Key diagram, Busbar layouts. Auxillary supply, substation earthing

Unit V: Power distribution system:

Primary and secondary distribution, types of conductors in Distribution system. Connection Scheme: radial, parallel, ring main, comparison of distribution systems

Unit VI: Electrical wiring and installation:

Domestic, commercial and industrial wiring, main, sub-main and sub-circuit wiring.Types and need of Earthing.Fuse and disconnecting devices. Electrical Safety precautions.

Text Books :

1] Principles of Power System, by V K Metha and RohitMetha, S Chand Publication

2] Generation of Electrical Energy, by B R Gupta, S Chand Publication

Reference Books :

1] A Course in Power System J B Gupta, S Chand Publication

2] Elements of Electrical Power Station Design, by M. V. Deshpande, Wheeler publications

3] Electrical Installation Estimating & Costing by J. B. Gupta

4] Transmission & Distribution by H. Cotton.

5FEEP05 Open Elective – I

3. POWER PLANT ENGINEERING

Course Outcomes: -

1) Describe different Sources of Energy Generation

2) Explain the Working and layout of steam power plant & hydro power plant.

3) Discuss the working principle and basic component of Nuclear, Diesel & gas power plant

4) Illustrate various terms related to power plant economics & tariff.

Unit-I: Introduction:

Energy resources and their availability, types of power plants, selection of the plants, Introduction to basic thermodynamic cycles used in power plants, Conventional and non-conventional energy sources, Indian Energy Scenario.

Unit-II: Hydro Electric Power Plant:

Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, Layout of Hydro power plant, operation of different components of hydro-electric power plant , classification of hydro Electric power plant, Pump Storage Plant, site selection, advantages & disadvantages

Unit-III: Steam Power Plants:

Flow sheet and working of modern-thermal power plants, super critical pressure steam stations, Layout of Thermal power plant , Site selection, coal storage, coal handling systems, ash handling

systems, working of various parts: Economizer, air preheater, condenser, cooling tower, Electrostatic Precipitator, advantages & disadvantages

Unit-IV: Nuclear Power Plants:

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium-Uranium reactor (CANDU) fast breeder reactor, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

Unit-V: Diesel & Gas power plant:

Layout of Diesel power plant, functions of different components of diesel plant, advantages & disadvantages, Principle of Operation of Gas Turbine Plants, Open cycle gas turbine plant, closed cycle gas power plant, Combined gas and steam cycle.

Unit-VI: Power Plant Economics:

Load curve, energy load curve, energy duration curve, connected load, maximum demand, demand factor, load factor, diversity factors, plant capacity and utilization factor, types of loads, operating cost, annual plant cost, Generation cost, Depreciation, Objectives of Tariff, Types of Tariff.

Text Books:

1. Generation of electrical energy by B.R.Gupta, Eurasia Publishing House, New Delhi.
2. Power Plant Engineeirng; R. K. Rajput ; Laxmi Publications.

Reference Books:

1. Non conventional energy resources. By G.D.Rai, Khanna Publishers New Delhi
2. Principles of Power System by V.K.Mehta, S.Chand publication.
3. Conventional energy technology by S.B.Pandya, Tata McGraw Hill Publication.
4. Power Plant Engineeirng. P. K. Nag.

5EP06 POWER SYSTEM – I LAB

Student should perform minimum eight practicals based on the syllabus

List of Experiments:

1. To study the performance of a transmission line using a nominal T model.
2. To study the performance of a transmission line using a nominal π model.
3. To calculate A,B,C,D parameters for a transmission line by using nominal T model
4. To calculate A,B,C,D parameters for a transmission line by using nominal π model.
5. To study skin effect, proximity effect and Ferranti effect in transmission line.
6. To study Corona phenomenon and corona loss and its control in transmission line.
7. To study conversion of single line diagram to impedance diagram and reactance diagram for a typical power system.
8. To draw the circle diagram for a typical power system.
9. Study of a tap changing transformer (ON load and OFF load tap changing).

10. Study of static VAR generator and synchronous condenser.

11. To study different types of insulators used in power system & their comparison.

12. To conduct a dry and wet test on a pin type insulator.

13. To conduct a flashover test on an insulator.

14. To study a horn gap.

15. To study different types of power cables.

16. To study testing of cables.

17. To draw different Tower structures

Note: Above experiments may be conducted by using models, simulation, numerical, drawing sheets or experimentation.

5EP07 MICROPROCESSOR & MICROCONTROLLER- LAB

List of Experiments:

Student should perform minimum eight practicals based on the syllabus

1. Write an Assembly Language Program for the Addition of two 8-bit/16-bit numbers
2. Writean Assembly Language Program for the Subtraction of two 8-bit numbers
3. Write a Program for Finding the larger and smaller one among the two 8- bit numbers
4. Write a Program for Finding the largest/smallest number in array of 8-bit numbers
5. Write a Program for Masking and setting of nibbles
6. Write a Program for Block data transfer in same and reverse order
7. Write a Program for Sorting of even and odd numbers from an array of 8-bit numbers
8. Write a Program for Multiplication of two 8-bit numbers
9. Write a Program for Square wave generation using 8255 PPI
10. Write a Program for Stepper motor control using 8255 PPI
11. Write a Program for Interfacing ADC with 8085/8051using 8255 PPI
12. Write a Program for Interfacing DAC with 8085/8051 using 8255 PPI
13. Write a Program for Lamp load control using 8255 PPI
14. Write a Program for measurement of DC Voltage /Current using ADC, 8255 PPI
15. Study of Architectural Differences: Microprocessor 8085, and Microcontroller 8051

5EP08 ELECTRICAL MACHINES-II LAB

Student should perform minimum eight practicals based on the syllabus**.**

List of Experiments:

1. Perform the load test on three phase IM & plot its performance characteristics.
2. Perform the No load test on three phase IM to separate out its no load losses.
3. Estimate the performance parameters of three phase IM from its circle diagram.
4. Plot the equivalent circuit of three phase Induction motor.
5. Study of different types of starters used for three phase IM

6. Speed control of three phase squirrel cage Induction motor by various methods like stator voltage control method, frequency control method, changing number of poles.

7. Speed control of three phase Induction motor.

8. Perform the electric braking of three phase Induction motor.

9. Perform the load test on single phase IM & plot its performance characteristics.

10. Load test on three phase alternator to determine its performance parameters.

11. Synchronize the three-phase alternator with infinite bus-bar

12. Perform the OC & SC test on synchronous generator to estimate its regulation by EMF & MMF methods

13. Estimate the regulation of three phase alternator using ZPF method.

14. Perform the load test on three phase Synchronous motor.

15. Plot the V & inverted V curves of synchronous motor.

5EP09 INFORMATION & COMMUNICATION TECHNOLOGY - LAB

Student needs to complete minimum eight assignments based on the following:

Word Processing with MS-Word:

· Basic operations- Editing and Formatting text, paragraphs and pages, printing the documents.

· Working with tables, figures, images.

· Mail merge. Working with Charts, Equations, symbols.

Working with workbooks /work sheets.

· Data Entry techniques & Defining data set as a Table.

· Setting, Previewing, and Printing under MS-Excel.

· Performing Calculations, using Excel Formulas, Functions and Charts.

· Sorting/ Filtering data in excel sheet.

Working with MS Power Point.

· Presentation Basics. Adding more components to the slides, Printing the slides.

· Formatting Presentations, backgrounds and layout. Applying Themes. Using Slide Master.

· Working with Graphics, Images and Clips.

· Working with Multimedia. Inserting Sound and Narration.

· Delivering Presentations. Animating Objects. Adding Action effects.

· Live Presentation. Using Custom Shows.

· Saving/Protecting the Presentation.

Working with Latex:

· Basic operations- Editing and Formatting text, paragraphs and pages, printing the documents.

· Working with tables, figure & images.

Web Page Development:

· Introduction to HTML, CSS, JAVA Coding.

· Development of Web page

Semester VI

6EP01 POWER ELECTRONICS

Course Outcomes:

After completing this course student will be able to

1. Explain the concepts and techniques used in power electronics
2. Apply the knowledge of series and parallel connection of SCRs in power control applications
3. Analyze various single phase and three phase power converter circuits
4. Analyze the single phase and three phase Inverter circuits
5. Explain the operation of DC/DC and AC/AC converter circuits
6. Demonstrate the applications of power electronic circuits.

Unit I: SCR, Triac, Diac – Construction and Applications, two Transistor Analogy of SCR, SCR turn ON mechanism, different methods for turning ON SCR, turn OFF mechanism, Thyristor firing circuits, introduction tomPower MOSFET and IGBT their construction and characteristics.

Unit II: Series-Parallel operation of SCRs, firing circuits for series and parallel operations, static and dynamic equalizing circuit, equalization of current in parallel connected SCRs ,string efficiency, de-rating factors, protections of SCRs against di/dt, dv/dt, over-voltage and over-current protection, Gate protections, Electro Magnetic Interference(EMI) and Shielding.

Unit III: Principle of phase control, half wavecontrolled rectifier, half controlled bridge and fully controlled bridge rectifier for R, RL and RLE load, derivation for output voltage and current, effect of freewheeling diode, effect of source inductance. Three phase half controlled bridge and fully controlled bridge rectifier.

Unit IV: Classification of circuit for forced commutation, series inverter, improved series inverter, parallel inverter, single phase PWM inverters, principle of operation of three phase bridge inverter in 1200 and 1800mode,single phase transistorized bridge inverter.

Unit V: Basic principle of Chopper, Time ratio control and current limit controlled technique, Voltage commutated Chopper circuit, Jones Chopper, Step up Chopper, Step down Chopper and AC Chopper.

Unit VI: Basic principle of cycloconverter, single phase to single phase cycloconverter, Introduction, principle of operation of single-phase voltage controllers for R and R-L load Speed control of DC series motor using chopper, Speed control of DC shunt motor using phase controlled rectifier.

Speed control of three phase Induction motor by stator voltage control method, V/f control.

Text Books:

1. M.D. Singh & K.B. Khanchandani, “Power Electronics “Tata Mc-Graw Hill, New Delhi

2. Rashid Muhammad, H., “Power Electronics: Circuits, Devices and Applications”, 2nd Edition. Prentice- Hall, 1998

Reference Books:

1. Mohan Ned, Undeland Tore, M. and Robbins William, P., “Power Electronics: Converter, Applications and Design”, John Wiley & Sons, 1994.
2. LandevCyrill, W., “Power Electronics”, McGraw Hills, London, 1981.
3. Dewan, S.B. and Satrughan A., “Power Semiconductor Circuits”, John Wiley & Sons,
4. Dubey, G.K., Doradlla, S.R., “Thyristerised Power Controllers”, Wiley Eastern, 1987.

6EP02 ELECTRICAL ENERGY DISTRIBUTION & UTILISATION

Course Outcomes:

After completing this course, Students will be able to:

1. Demonstrate the knowledge of distribution substation
2. Compare different power distribution systems
3. Describe elements of distribution Automation system
4. Select proper electrical drive for industrial applications
5. Explain the workingof electric traction system
6. Describe an illumination system & electric heating

Unit I: Substation: Selection & location of site, classification, major equipment ,graphical symbols for various apparatus & circuit elements ,key diagram for 33/11kV substation along with selection & specification of substation equipment, types of bus-bar arrangements, substation earthing. Introduction to Gas Insulated Substation (GIS).

Unit II: Power distribution system -I: Primary and secondary distribution, types of conductors in Distribution system, comparison of distribution systems radial, parallel and ring main, economics of feeder design.

Unit III: Power distribution system - II: Methods for reduction of line losses in distribution system. Introduction to High Voltage Distribution System (HVDS). Distribution Automation: Need for distribution automation, feeder automation, and communication requirements for Distribution automation, Remote terminal unit (RTU). Introduction to SCADA systems.

Unit IV: Electrical Drives: Concept, types, selection criterion for electrical drive. Types of duties, rating calculations for these duties. Heating and cooling. Industrial applications: Textile mill, Cement mill, Sugar mill.

Unit V: Traction System: Requirement, speed- time curves. General features, types, Quadrantal diagram of speed torque characteristics of traction motors. Control of traction motors: Series-Parallel control. Different accessories for track electrification –overhead wires, conductor rail system, current collector-pantograph

Unit VI: Illumination : Street lighting**:** Principle, illumination level, mounting height of lamps, spacing, types of lamps. Flood lighting: Flood lighting calculations, waste light factor, Depreciation factor, Utilization factor. LED: Working principle, advantages & applications.

b) **Electric Heating**:Resistance& Induction heating & its applications.

Text Books:

1. S.K.Pillai, “A First Course on Electrical Drives”, New Age International Publication
2. J.B.Gupta, “A Course in Power System”, S.Chand Publication

Reference Books:

1. M.V.Deshpande, “Electrical Power System Design”, TMH Publishing Company Ltd
2. S.Sivanagaraju&S.Satyanarayana, “Electric Power Transmission & Distribution” Pearson Publication
3. P. S. Satnam&P.V.Gupta, “Substation design & Equipment” Dhanpat Rai Publication.
4. J.Upadhyay&S.N.Mahendra : Electric Traction by Allied Publishers Ltd
5. J.B.Gupta :Utilization of Electric Power & Electric Traction by S.K.Kataria& Sons, New Delhi.
6. H.Pratap :Art & Science of Utilization of Electrical Energy by Dhanpat Rai & Company Ltd.
7. H Pratap, “Modern Electric Traction” Dhanpat Rai & Sons Ltd
8. Dr.M.K.Khedkar&Dr.G.M.Dhole : A Textbook of Electrical Power Distribution Automation by University Science Press
9. S.L.Uppal: Electrical Wiring, Estimating and Costing by Khanna Publishers.

6EP03 COMPUTER AIDED ELECTRICAL MACHINE DESIGN

Course Outcomes:

After completing this course, student will be able to

1. Explain the Basics of Computer aided machine design & material selection.
2. Derive the design parameters of single & three phase transformer core.
3. Calculate the winding& cooling system parameters of the transformer
4. Develop the armature winding diagram for three phase Induction Motor
5. Determine the stator core dimensions of three phase Induction motor
6. Design the squirrel cage & wound type rotor for three phase Induction motor

Unit I: Introduction :

Review of transformer & Induction motor constructional features, Major considerations in electrical machine design, optimization, electrical engineering materials: Conducting, Insulating & Magnetic Materials,Limitations of traditional design, need for CAD, analysis, synthesis and hybrid methods of CAD, Introduction to FEM based machine design.

Unit II: Transformer Design –I:

Transformer Core Design - Material selection, type of construction, Specific magnetic & electric loadings, output equation, core and yoke cross sections, window dimensions, overall core dimensions calculations, core loss estimation from design data. Optimum core design for Minimum cost, Minimum losses, Minimum weight & Minimum volume.

Unit III:Transformer Design – II:

Transformer Winding - types, and design calculation, Layout, no-load current calculation, primary and secondary winding resistance and leakage reactance from design data, mechanical forces – types

& causes.Estimation of efficiency & regulation from design data. Cooling methods for a transformer, design of transformer tank. Calculation of cooling tubes.

Unit IV: AC winding Design :

Concentrated & distributed winding, Integral slot & fractional slot winding, Full pitch & short pitch windings, Single layer& double layer winding, distribution factor, coil pitch factor and winding factor, EMF equation, Development of winding diagrams.

Unit V: Induction motor stator design:

Specific electric and magnetic loadings selection, output equation, main dimensions (D&L) calculation, stator slotnumbers, shape and dimensions, stator teeth dimension, stator core dimensions.Air gap length calculation.

Unit VI: Induction motor rotor design:

Squirrel cage rotor design –selecting number of rotor slots, design of rotor bars & slots, design of end rings.

Wound type rotor design - rotor winding design, rotor slots design, and rotor core design. Bearings, shaft design.estimation of no-load current, stator and rotor winding resistances from design data, dispersion coefficient & its effect on performance of IM.

Text Books:

1. A. K. Sawhney, "A Course in Electrical Machine Design" Dhanpat Rai & Co Ltd, 2016

2. R.K.Agrawal, "Principles of Electrical Machine Design", S.K.Kataria and Sons, Delhi

Reference Books:

1. M.G.Say,"The Performance and Design of Alternating Current Machines", C.B.S. Pub., Delhi.

2. K.G.Upadhyay,"Design of Electrical Machines", New Age international Publishers,1st Edition 2008

3. S.K.Sen,"Principles of Electrical Machine Design with Computer Programs", Oxford and I.B.H. Company Pvt. Ltd., New Delhi

4. IndrajitDasgupta, "Design of Transformers", TMH 1st Edition 2002

5. Indian Standards for Transformer & Three phase IM design from BIS websites

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6EP04 Professional Elective - II

1. ADVANCED CONTROL SYSTEMS

Course Outcome

After completing this course students will be able to

1. Design compensator using time domain and frequency domain specifications
2. Represent system using state space model
3. Analyze controllability and observability for systems and design full state feedback controller.
4. Analyze digital systems using Z Transform
5. Develop the describing function for the nonlinearity to assess the stability of the system.

6. Analyzethe Nonlinear system using Phase plane Analysis

Unit I: Compensation Techniques:

Introduction, preliminary consideration of classical design. Lead compensator, Lag Compensator, Lead-Lag compensator, Feedback compensation in frequency domain.

Unit II: State Space Technique I:

State, state space and state variables ,SISO /MIMO linear systems state Variable models- differential equations, transfer functions, block diagrams And state diagrams. Transfer function decomposition – Phase variable Forms,canonical forms and Jordan canonical forms, STM computation, L.T, Canonical transformation, and Cayley Hamilton theorem. Time Response –SISO systems.

Unit III: State Space Technique II:

Concept-controllability and observability , SISO/ MIMO linear Systems Gilbert's method and Kalman's test; SISO controllable Systems design –state feedback.

Unit IV: Sampled Data Control Systems:

Representation, Z transform, Sampler and hold, ZOH, Open loop and closed loop SDCS,

Z transfer Function, difference equation, solution, Pulse transfer function, Stability Analysis, S and Z domain relationship, Jury's test, and bilinear Transformation. Root locus method.

Unit V: Non-Linear System Analysis I:

Non linear system behaviour, types and characteristics, Describing function Stability analysis limit cycles, Limitation of Describing function.

Unit VI: **Non-Linear System Analysis II**:

Linearization, Singular points, Classification and nature, Phase plane method, non linear system analysis, Phase trajectories, construction –analytical and graphical method by isoclines, stability analysis, limit cycles, limitations – phase plane method.

Text Books:

1. Nagrath and Gopal, "Control system Engineering" Wiley Eastern Ltd , New Delhi

2. K.Ogata," Modern Control Theory "Prentice Hall Of India Pvt Ltd , New Delhi.

Reference Books:

1. Naresh Sinha. "Control system Engineering" Wiley Eastern Pvt. Ltd., New Delhi.

2. B.C. Kuo. "Automatic Control system" Prentice Hall Of India Pvt Ltd Delhi

3. D Roy Choudhury, "Modern Control Engineering"Publisher: PHI Learning.

6EP04 Professional Elective – II:

2. PROCESS CONTROL SYSTEMS

Course Outcomes:

After Completing this course student will be able to

1. Explain the various Electronic Instruments for measurement of electrical parameters.
2. Analyse the different signals
3. Demonstrate the signal counting, recording and working of digital readout devices.

4. Demonstrate the Various techniques of A/D and D/A conversions.

5. Apply various signal processing tools as per requirement

6. Develop ladder diagrams &programmes for PLC

Unit I : Electronics Instruments for Measurement of Electrical Parameters Advantages of Electronic Instruments, Electronic Voltmeters Electronic Multi-meter, differential volt meter, Digital voltmeter, Q meter, vector impedance meter, vector voltmeter.

Unit II: Signal Generation and Analysis Signal generators, Function generators. Wave analyzer Harmonic Distortion Analysers, Spectrum Analysis.

Unit III: Signal Counting and Recording Decade counting Assembly, Binary counter, Decimal counter, Decade counter with digital display, universal counter, Digital readout devices, storage type CRO, Servo type X-Y recorder.

Unit IV: Signal conditioning and Conversions. Frequency characteristics of various types of signals, active filters bandpass, low pass and high pass filters using opAmps. Various techniques of A/D and D/A conversions. Modulation and demodulation PCM techniques, phase locked loop.

Unit V: Signal Processing Pulse times, triggered delayed sweeps, discrete pulse delay circuits, pulse sequencing, analog multiplexers and de-multiplexers, digital multiplexing sample and hold circuits, serial and parallel digital data conversion. Signal transmission, Analog and digital telemetry techniques, MODEM and UART, keyboard and character generators, tape recorder,

Unit VI : Introduction to Processor and Processor based Techniques. Introduction to PLC, PLC architecture, programming; ladder diagram and examples, micro controller based instrumentation

Text Books:

1. H.S. Kalsi – Electronic Instrumentation, - Tata Mc-Graw Hill Publishing Company, New Delhi.

2. Cooper, Helfrick – Electronic Instrumentation and Measurement Techniques, A Prentice Hall of India. New Delhi.

Reference Books: -

1. B.R. Gupta-Electronics and Instrumentation – Wheeler Publishing.

2. Rangan, Sharma & Mani – “Instrumentation – devices & Systems.” Tata Mc-Graw Hill Publishing Company, New Delhi.

3. R.P. Jain-Digital Electronics, Tata Mc-Graw Hill Publishing Company, New Delhi.

4. Microprocessors and Digital Systems, by:D.V.Hall,TMH Publishing Company, New Delhi.

5. Shoen Beck- Electronic Communication, Prentice Hall of India. Pvt. Ltd. New Delhi.

6. B. Ram- fundamental of Microprocessors, Dhanpat Rai & Sons, New Delhi.

7. A.K. Sawhney – A Course in Electrical & Electronics Instrumentation, Dhanpat Rai & Sons, New Delhi

6EP04 Professional Elective – II

3. INDUSTRIAL ELECTRICAL SYSTEM

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the electrical wiring systems for residential, commercial and industrial consumers.
2. representing the systems with standard symbols and drawings, SLD.
3. Understand various components of industrial electrical systems.
4. Analyze and select the proper size of various electrical system components

Unit I: Electrical System Components :

LT system wiring components, selection of cables, wires, switches, distribution box, meteringsystem, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse currentcharacteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator,Relays, MPCB, Electric shock and Electrical safety practices

Unit II: Residential and Commercial Electrical Systems:

Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

Unit III: Illumination Systems:

Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

Unit IV: Industrial Electrical Systems – I:

HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC,MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

Unit V: Industrial Electrical Systems – II:

DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing theDG, UPS and Battery Banks, Selection of UPS and Battery Banks.

Unit VI: Industrial Electrical System Automation:

Study of basic PLC, Role of in automation, advantages of process automation, PLC basedcontrol system design, Panel Metering and Introduction to SCADA system for distribution automation.

Text Book: S. L. Uppal and G. C. Garg, “Electrical Wiring, Estimating & Costing”, Khanna publishers, 2008.

Reference Books:

1. K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2007.
2. S. Singh and R. D. Singh, “Electrical estimating and costing”, Dhanpat Rai and Co.,
3. Web site for IS Standards.
4. H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2008.

6FEEP05 Open Elective – II

(1) ENERGY AUDIT AND MANAGEMENT

Course Outcomes:

After completing this course student will be able to:

1. Discuss energy scenario and its management.
2. Conduct the energy audit of different systems.
3. Determine the economics of energy conservation
4. Discuss various energy Conservation methods & their case studies
5. Explain fundamentals of Harmonics.

Unit I : Energy Scenario & Management:

Indian energy scenario, Energy needs of growing economy, Energy pricing in India Energy sector reforms, various forms of energy, Primary and secondary energy, commercial and non-commercial energy, Global primary energy reserves, Energy and environment, Necessity of conserving energy, Energy strategy for the future, Electrical energy management, Concept of supply side management and demand side management, Methods of implementing Demand side management and advantages to consumer, utility and society.

Unit II: Energy Audit:

Definition, Need of energy audit, Preliminary and detailed energy audit. Procedure for carrying out energy audit Instruments used for energy audit, Data Analysis-Energy— production relationship, specific energy consumption, Sankey diagram, CUSUM Technique, Bench marking energy performance, Recommendations for energy conservation, Action plan, Executive Summary.

Unit III: Economics of energy conservation:

Cost factors, Budgeting, Standard costing and Sources of capital, Cash flow diagram and activity chart, Simple Payback period analysis, Time value of money, Net present value method, internal rate of return method, Profitability index for benefit cost ratio

Unit IV: Energy Conservation:

Energy conservation in motive power, Illumination, Heating & cooling systems, Pumping systems, thermal power stations and Transmission & Distribution Sector. Cogeneration &Waste heat recovery systems.

Unit V: Energy Audit Case Studies:

Energy Intensive Industries, Commercial, Industrial, Municipal and Agriculture Sector, IT industries, Hospitals

Unit VI: Fundamentals of Harmonics:

Harmonic distortion, voltage versus current distortion, Power systems quantities under non sinusoidal conditionsactive reactive and apparent power, displacement and true power factor, harmonic phase sequences, triplen harmonics, harmonic indices- Total harmonic distortion (THD), Total demand distortion (TDD) , Harmonic sources

from commercial and industrial load.

Text Book: Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, Book-2, Book-3, Book-4 (available online BEE website)

Reference Books:

1. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.
2. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)
3. Energy Conservation and Audit ByThumman, Fairmont Press
4. Energy Audit and Conservation TERI

6FEEP05 Open Elective – II

(2) ELECTRICAL ESTIMATING & COSTING

Course Outcomes:

After completion of the course students will be able to

1. Understand methods of installation and estimation of service connection
2. Decide type of wiring, its estimation and costing for residential building
3. Carry out electrification of commercial complex, factory unit installations
4. Design & estimate for feeders & distributors
5. Understand contract, tendering and work execution process.

Unit I: Electrical Installation:

Classification of Electrical Installation, General requirement of Electrical Installation. Important definitions related to Installation. Service Connection: Concept of service connection, Types of service connection & their features. Methods of Installation of service connection. Estimation of service connection.

Unit II : Residential Building Electrification :

Procedures for designing the circuits and deciding the number of circuits. Selection of type of wiring and rating of wires & cables. Earthing of Residential Installation. Estimate and cost Preparation of Residential Installation.

Unit III: Electrification of commercial Installation:

Concept of commercial Installation. Differentiate between electrification of Residential and commercial Installation Deciding the size of cables, busbar and busbar chambers. Earthing of the electrical Installation Selection of type wire, wiring system.Preparation of detailed estimate and costing of commercial Installation.

Unit IV: Electrification of factory unit Installation:

Concept of Industrial load. concept of Motor wiring circuit.Important guidelines about power wiring and Motor wiring.Selection and rating of wire, cable size. Sequence to be followed to prepare estimate. Preparations of detaile estimate and costing of small factory unit/ workshop.

Unit V: Design & estimate for feeders &distributors:

Different schemes for feeders & distributors, estimates for different feeders & distributors, Distribution transformer, Deciding Size & location, Estimate for outdoor & indoor type distribution substation.

Unit VI: Contracts, Tenders and Execution:

Tender and tender notices. Procedure for submission and opening tenders. Comparative statements, criteria for selecting contractors, General conditions in order form. Principles of Execution of works administrative approval, technical sanctions. Billing of executed work.

Text & Reference Books:

1. Electrical Design; Estimating and costing by K.B. Raina, S.K.Bhattacharya New Age International (p) Limited, New Delhi.

2. Electrical Estimating and costing by Surjit Singh Dhanpat Rai and company, New Delhi

3. Electrical Estimating and costing by N. Alagappan S. Ekambaram, Tata Mc Graw Hill Publication New Delhi

6FEEP05 Open Elective - II

3. ELECTRICAL MATERIALS

Course outcomes:

After completing this course students will be able to

1. understand importance of electrical engineering materials
2. understand how electric conduction takes place in conductors
3. understand importance of semiconductors and magnetic materials in electrical engineering.
4. understand importance of dielectric materials in electrical engineering.
5. Identify the need of special materials in electrical engineering

Unit-I Introduction to Electrical Engineering Materials:

Importance of materials, Classification of electrical materials, Scope of electrical materials, Requirement of Engineering materials.Types of engineering materials, Levels of material structure.

Unit-II Conducting Materials:

Review of metallic conduction on the basis of free electron theory. variation of conductivity with temperature and composition, materials for electric resistors- General Electric properties; material for brushes of electrical machines, lamp filaments,fuses and solder.

Unit-III Semiconductors:

Semiconductors: Mechanism of conduction in semiconductors, types of semiconductors. Hall effect, compound semiconductors, basic ideas of amorphous and organic semiconductors.

Unit-IV Magnetic Materials:

Classification of magnetic materials- origin of permanent magnetic dipoles, magneto materials used in electrical machines, instruments and relays. Magnetic Circuit terminology, Relation between relative permeability and magnetic susceptibility. Classification of

magnetic materials, Diamagnetic, Paramagnetic, Ferromagnetic, Antiferromagnetic. Magnetization curve, Initial and maximum permeability. Hysteresis loop and loss, Eddy current loss.

Unit-V Dielectrics & Insulating Materials:

Dielectrics, Factors influencing dielectric strength. Capacitor materials. Insulating materials, Insulating Materials: Inorganic materials (mica, glass, porcelain, asbestos), organic materials (paper, rubber, cotton silk fiber, wood, plastics and bakelite), resins and varnishes, liquid insulators(transformer oil) gaseous insulators (air, SF6 and nitrogen) and ageing of insulators.

Unit-VI Materials for Special Applications:

Materials for solar cells, fuel cells and battery. Materials for coatings for enhanced solar thermal energy collection and solar selective coatings, Cold mirror coatings, heat mirror coatings, antireflection coatings, sintered alloys for breaker and switch contacts.

Text & Reference Books:

1. Electrical Engineering Materials by Dekker A.J (PHI)

2. Electrical Engineering Materials by S.P.Seth (Dhanpatrai and Sons)

3. An Introduction to Electrical Engineering Materials by Dr. C. S Indulkar & Dr. S. Thiruvelgadam (S Chand

Publication)

6EP06 POWER ELECTRONICS LAB

Perform minimum eight experiments:

List of Experiments:

1. To verify the V-I characteristics of SCR
2. To verify forward and reverse characteristics of DIAC
3. To verify forward and reverse characteristics of TRIAC
4. To study UJT as relaxation oscillator
5. AC voltage control using triac - diac combination
6. To verify the operation of half and full controlled converter
7. To verify the operation of SCR commutation circuits
8. To design & simulate dc-dc buck converter
9. To design & simulate dc-dc boost converter
10. Construct and test the dc chopper control circuit using thyristor
11. Study of PWM based step down dc chopper using MOSFET/IGBT
12. To verify the operation of Single phase single pulse / sinusoidal PWM inverter using MOSFET/IGBT
13. To verify the operation of Single phase parallel inverter using MOSFET/IGBT

14. To verify the operation of Single phase to single phase cycloconverter

15. To verify the operation of Single phase dual converter With R - RL loads

16. To verify the operation of Single phase ac voltage controller

6EP07 ELECTRICAL ENERGY DISTRIBUTION & UTILIZATION LAB

Perform minimum eight experiments

List of Experiments:

1) Study of Distribution substation equipments.

2) Study of various types of busbar arrangements.

3) Study of Power distribution system.

4) Study of Distribution Automation system.

5) Prepare a report on visit to distribution substation.

6) Simulation of various types of Electrical Distribution System (Radial, Parallel, Ring main)

7) Development of single line diagram of of 33/11 kV substation in AutoCAD Electrical

8) Determination of Efficiency by Performing Load Test on Three-Phase Induction Motor.

9) Determination of Efficiency by Performing Load Test on DC Shunt Motor.

10) Electric Braking of DC.Shunt Motor.

11) Electric Braking of Three-Phase Induction Motor.

12) Speed Control of Three-Phase Slip-Ring Induction Motor.

13) Determination of Efficiency by Performing Load Test on Single-Phase Induction Motor.

14) Study of Electric Heating.

15) Design Scheme of Illumination System.

16) Study of Electric Traction System .

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6EP08 COMPUTER AIDED ELECTRICAL MACHINE DESIGN LAB

Develop Minimum Eight Computer Programme:

List of Computer Programme:

1. Develop a computer programme for core design of a single-phase core type transformer

2. Develop a computer programme for core design of a single-phase shell type transformer

3. Develop a computer programme for core design of a three-phase core type transformer

4. Develop a computer programme for optimum core design of a three-phase core type transformer for minimum cost or maximum efficiency.

5. Develop a computer programme for Estimation of Iron losses in a three-phase core type transformer.

6. Develop a computer programme for windings design of a single-phase transformer

7. Develop a computer programme for windings design of a three-phase transformer

8. Develop a computer programme for calculating the No load current of a single-phase transformer.

9. Develop a computer programme for calculating the No load current of a three-phase transformer.

10. Develop a computer programme for tank design and calculating the number of cooling tubes required for three phase core type transformer.

11. Develop a computer programme to calculate Main dimensions (D & L) of a three phase Induction motor.

12. Develop a computer programme for stator core design of three phase induction motor.

13. Develop a computer programme for squirrel cage rotor design of three phase induction motor.

14. Develop a computer programme for wound type rotor design of three phase induction motor.

15. Develop a computer programme for estimating magnetizing current of a squirrel cage type three phase induction motor.

6EP09 COMPUTER TECHNOLOGY- LAB

Student needs to complete minimum eight assignments based on the following:

· Computer Network: Basic hardware and terminology in networks, Classifications, The Internet, The Intranet and Extranet.

· Installation of operating systems, application software in Personnel Computer or laptop.

· Develop the simulation models for various tasks in electrical engineering using simulation software.

· Develop the computer programme for various tasks in electrical engineering using software.

· Study of PLCs used for Industrial automation & develop the ladder diagram for given task in automation using PLC.

· Basics of IoT, IoT based Monitoring & Controlling of various Electrical Equipments.

Syllabus of VII & VIII Semester B.E Electrical (Electronics & Power) (C.B.C.S.)

SEVENTH SEMESTER

7EP01 POWER SYSTEM-II

Course Outcomes:

After successful completion of this course, student will be able to:

1. Explain the basic Concept of Fault Analysis in Electrical systems.
2. Analyze the different types of symmetrical and Unsymmetrical Faults in Electric Power System.
3. Explain the concept of Power System Stability and synchronous machine parameter determination.
4. Analyze the steady state stability of system.
5. Assess transient state stability of two machine system.

Unit I: Basic Concepts: Symmetrical components Definition and choice, Alpha operator, transformation matrices, sequence components, power invariance, line and phase sequence quantities relations, three phase delta/star

transformer bank- sequence voltages and currents relationship; power system elements – sequence impedance and sequence networks; Various three phase transformer connections – zero sequence rules;

Unit II: Symmetrical Fault Analysis: Symmetrical Fault Analysis Transmission line transients, three phase symmetrical short circuit at alternator terminals, Power system fault calculations, short circuit MVA, Current limiting reactors, ring system and tie bar system, Circuit breaker rating calculation.

Unit III: Unsymmetrical Fault Analysis: Unsymmetrical Fault Analysis L-G, L-L-G and L-L faults at unloaded generator terminals, Equivalent sequence network diagram, Fault impedance, Unsymmetrical faults through impedance, Power system faults loaded and unloaded conditions.

Unit IV: Fundamentals of Stability: Meaning of stability, Steady state, Transient and Dynamic stability limits; Three Phase Synchronous Machine-circuit representation, voltage equation and Park's Transformation; Reactance and Time Constants determination.

Unit V: Steady State Stability: Steady state stability limit-short transmission line, two machines system, Clarke's diagrams for system with and without loss, Conservative criterion, Synchronizing coefficients and Multi machine system. Short circuit ratio and automatic voltage regulator effects.

Unit VI: Transient State Stability: Transient state stability and equal area criterion, Swing equation and its pointby- point solution, Critical clearing angle and time. Type of faults, Grounding and high-speed re-closing effects, Stability improvement methods, and role of Digital Computers in stability studies

BOOKS RECOMMENDED:

Text Books:

1. D. P. Kothari, I. J. Nagrath, "Power System Engineering", TMH 3rd edition, 26th April 2019.
2. E W Kimbark, "Power System Stability", Vol.1 and 3, Dover Publications Inc., NewYork.
3. Prabha Kundur, "Power System Stability & Control", TMH, 11th reprint 2011.

Reference Books:

1. L.P. Singh, "Computer Aided Power System Operation and Dynamics", Wiley Eastern Ltd. New Delhi.
2. J.Nagrath and D.P.Kothari, "Modern Power System Analysis", Tata Mc-Graw Hill Publishing Company, New Delhi.
3. N. V. Ramana, "Power System Analysis", PEARSON education, 2010.
4. Arthur R. Bergen, Vijay Vittal, "Power System Analysis", 2nd Edition, 2009, PEARSON Education.

7EP02 DIGITAL SIGNAL PROCESSING

Course Outcomes: After successful completion of this course, students will be able to:

1. Analyze the discrete time signals in time domain.
2. Analyze the discrete time systems using DTFT and DFT.
3. Apply the concept of Band pass sampling.
4. Design the structures of different types of digital filters.
5. Analyze the frequency response of various digital filters.
6. Apply the knowledge of multi-rate signal processing.

Unit I: Introduction to DSP, Frequency domain description of signals &systems, Discrete time sequences systems, Linearity unit sample response, Convolution, Time invariant system, Stability criteria for discrete time systems, Solutions of linear difference equations.

Unit II: Fourier Transform**:** Introduction to Fourier transform of Discrete Time Signal and its properties, Inverse Fourier transform, DFT and its properties, Circular convolution, Linear convolution from DFT, FFT, decimation in time and frequency algorithm.

Unit III: Sampling of Band pass signals, Representation of Band pass signals, sampling of Band pass signals, discrete time processing of continuous time signal; Analog to digital conversion-sample and hold, quantization and coding, analysis of quantization errors, oversampling of A/D converter; Digital to Analog conversion sample and hold, first order hold, linear interpolation with delay, oversampling of D/A converter.

Unit IV: Filter categories, Direct form I, Direct form II, Cascade and parallel structure for IIR and FIR Filter, Frequency sampling structures for F.I.R. filter, Steps in Filter Design, Design by Pole Zero Placements, FIR filter design by Windowing Method, Rectangular, Triangular and Blackman window

Unit V: Analog filter types, Butter worth, Elliptic filter, Specification and formulae to Decide to filter order, Methods to convert analog filter into IIR digital, Mapping of differential, Impulse Invariant, Bilinear, Matched Z transformation.

Unit VI: Multirate DSP and Introduction to DSP Processor, Decimation by a factor D, interpolation by a factor I, sampling rate conversion by a rational factor I/D, Filter Design & Implementation for sampling rate conversion, Multi stage Implementation of sampling rate conversion. General Architecture of DSP, Case Study of TMS320C67XX.

BOOKS RECOMMENDED:

Text Books:

1. J. G. Proakis and D. G. Manolakis, “Digital Signal Processing: Principles, Algorithm and Applications”, (4th Edition), Prentice Hall, 2007

2. N. J. Fliege, “Multirate Digital Signal Processing: Multirate Systems - Filter Banks – Wavelets”, (1st Edition), John Wiley and Sons Ltd, 1999.

Reference Books:

1. S. K. Mitra, “Digital Signal Processing”, 3rdEdition, TMH Edition.

2. Ifaeachor E.C, Jervis B. W., “Digital Signal Processing: A Practical Approach”, Pearson Publication

3. S. K. Mitra, “Digital Signal Processing: A Computer Based Approach”, McGraw Hill, 2011.

7EP03 ENTREPRENEURSHIP AND PROJECT MANAGEMENT

Course Outcomes: After successful completion of this course, students will be able to:

1. Understand the concept of entrepreneurship and its role in economic development.
2. Compare the various business model and select the most suitable.
3. Identify & formulate the project report and Source of finance for a project.
4. Estimate the cost, time & resources for the project work.

Unit I: Entrepreneurship: Introduction to Entrepreneurship, Meaning and concept of entrepreneurship, Need o Entrepreneurship, Types of Entrepreneurships-Social, For Profit, Not for Profit, the Evolution history of entrepreneurship development, role of entrepreneurship in economic development, Institutions/agencies for entrepreneurship development, future Scope of entrepreneurship, Entrepreneurial Ecosystem.

Unit II: Entrepreneur: Entrepreneur: Who? Why? How? the Attributes, skills/traits required to be an entrepreneur; Creative and Design Thinking, types of entrepreneurs. Myths and Realities about entrepreneurs, the entrepreneurial decision process, skill gap analysis, and Entrepreneurial models, entrepreneurial success stories, Pitching for Startups, Marketplace, Market space.

Unit III: Business Model & Business Organization: Types of Business Models; its importance, Business Plan: Importance, Guidelines and Contents, Specimen of a B-Plan and Feasibility Studies, pre- requisites from the perspective of investor. The importance and diversity of business model, components of an effective business model Canvas, Various form of business organization-sole proprietorship, partnership, corporations, Limited Liability Company.

Unit IV: Project Management: Basic concepts & Planning: Life Cycle of a Project. The Steps in managing a Project. International Standards (PMI, IPMA). Different types of projects: industrial, research and more. The role of the Project Manager. Terms of the Project Contract. Project Planning. Goals and Objectives of the Project. Owners and Stakeholder. The Work Breakdown Structure (WBS) to plan a project.

Unit V: Project identification & Evaluation: Selection - project formulation – contents of a project report - planning commission, guidelines for formulating a project - specimen of a project report. Source of finance for a project - Institutional finance supporting projects, project evaluation - objectives - types - methods.

Unit VI: Time and Cost Management: Estimation of Time, Costs and Resources. Scheduling Project Work. Critical Path Method (CPM). Resource balancing. Defining Project Risks. Process to establish the project risk plan. Contingency Reserves. Risk Matrix Analysis. Project Control and Evaluation.

BOOKS RECOMMENDED:

Text Books:

1. S. S. Khanka, "Entrepreneurial Development", S. Chand and Company Limited, New Delhi, 2001.

2. Dr. C. B. Gupta, Dr. N.P. Srinivasan, "Entrepreneurial Development", Sultan Chand & Sons.

Reference Books:

1. S. Choudhury, "Project Management", Tata McGraw Hill Education Private Limited, 2009.

2. Denis Lock, "Project Management", Gower Publishing Company, USA.

7EP04 PROFESSIONAL ELECTIVE III

(i) WIND AND SOLAR SYSTEMS

Course Outcomes: After successful completion of this course, students will be able to:

1. Understand the energy scenario and the consequent growth of the power generation fromrenewable energy sources.
2. Understand the basic physics of wind and solar power generation.
3. Understand the power electronic interfaces for wind and solar generation.
4. Understand the issues related to the grid-integration of solar and wind energy systems.

Unit I: Physics of Wind Power: History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and powercumulative distribution functions.

Unit II: Wind Generator Topologies: Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent-Magnet Synchronous Generators, Power electronics converters. Generator- Converter configurations, Converter Control.

Unit III: The Solar Resource: Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun

angles, solar day length, Estimation of solar energy availability.

Unit IV: Solar Photovoltaic: Technologies-Amorphous, mono-crystalline, polycrystalline, V-I characteristics of a PV cell, PV model, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control

Unit V: Network Integration Issues: Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behaviour during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

Unit VI: Solar Thermal Power Generation:

Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, Elementary analysis.

BOOKS RECOMMENDED:

Text Books:

1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.

2. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.

References Books:

1. G. M. Masters, "Renewable and Efficient Electric Power Systems"**,** John Wiley and Sons, 2004.

2. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems", John Wileyand Sons Ltd., 2006.

3. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.

4. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.

7EP04 PROFESSIONAL ELECTIVE – III

(ii) ELECTRICAL ESTIMATING & COSTING

Course Outcomes: After successful completion of this course, students will be able to:

1. Understand methods of installation and estimation of service connection.
2. Decide type of wiring, its estimation and costing for residential building.
3. Carry out electrification of commercial complex, factory unit installations.
4. Design & estimate for feeders & distributors.
5. Understand contract, tendering and work execution process.

Unit I: Electrical Installation: Classification of Electrical Installation, General requirement of Electrical Installation, Important definitions related to Installation, Service Connection: Concept of service connection, Types of service connection & their features, Methods of Installation of service connection, Estimation of service connection.

Unit II: Residential Building Electrification: Procedures for designing the circuits and deciding the number of circuits, Selection of type of wiring and rating of wires & cables, Earthing of Residential Installation, Estimate and cost Preparation of Residential Installation.

Unit III: Electrification of Commercial Installation: Concept of commercial Installation, differentiate between electrification of Residential and commercial Installation Deciding the size of cables, busbar and busbar chambers, earthing of the electrical Installation Selection of type wire, wiring system, preparation of detailed estimate and costing of commercial Installation.

Unit IV: Electrification of Factory Unit Installation: Concept of Industrial load, Concept of Motor wiring circuit, Important guidelines about power wiring and Motor wiring, Selection and rating of

wire, cable size, Sequence to be followed to prepare estimate, preparations of detailed estimate and costing of small factory unit/workshop.

Unit V: Design &Estimate for Feeders & Distributors: Different schemes for feeders & distributors, estimates for different feeders & distributors, Distribution transformer, Deciding Size & location, Estimate for outdoor & indoor type distribution substation.

Unit VI: Contracts, Tenders and Execution: Tender and tender notices, Procedure for submission and opening tenders, Comparative statements, criteria for selecting contractors, General conditions in order form, Principles of Execution of works administrative approval, technical sanctions, Billing of executed work.

BOOKS RECOMMENDED:

Text Book: N. Alagappan S. Ekambaram, "Electrical Estimating and Costing", Tata Mc Graw Hill Publication, New Delhi.

Reference Books:

1. K. B. Raina, S. K. Bhattacharya, "Electrical Design; Estimating and Costing", New Age International (p) Limited, New Delhi

2. Surjit Singh, "Electrical Estimating and Costing", Dhanpat Rai and Company, New Delhi

7EP04 PROFESSIONAL ELECTIVE – III

(III) POWER SYSTEM OPERATION AND CONTROL

Course Outcomes: After successful completion of this course, students will be able to:

1. Summarise the knowledge of preliminaries on power system operation and control.
2. Determine the optimal scheduling of generation for a two-plant system with and without losses for the economic operation of the power system.
3. Develop the mathematical model of the Automatic Load-Frequency Control (ALFC) loop and the Automatic Voltage Regulator (AVR) loop.
4. Build the block diagram of two area system.
5. Explain the role of the power system stabilizer in damping the steady-state oscillations set up in the power system.

Unit I: Preliminaries on Power System Operation and Control: Power sector scenario in India: an overview, Players in the Indian power sector, Concept of grid: necessity and types of grids, Need of voltage and frequency control, Energy control centers (Load dispatch centers): Operation and functions, Levels of power system operation and control, SCADA: components and functions, Operating states of power system: normal state, alert state, emergency state, in extremis state and restorative state, State transition diagram showing various state transitions and control strategies.

Unit II: Economic Operation – Part I: Meaning of optimum scheduling, definition of unit, plant load and system

load, UCP and LSP, Input – Output characteristics, Heat rate characteristic, Incremental fuel rate, Incremental fuel cost, Reserve requirements: Installed reserves, spinning reserves, Cold reserves, Hot reserves, Methods of obtaining incremental fuel costs, Conditions for incremental loading, Optimum scheduling of generation between different units (Only two plant system without transmission loss).

A. Economic Operation – Part II: Transmission loss as a function of plant generation, Calculation of loss coefficient (two plant system), Incremental transmission loss, Optimum scheduling of generation between different plants including transmission loss, Concept and significance of penalty factor.

Unit III: Generator Control Loops: Concept of real and reactive power, Effect of real and reactive power on system parameters, Philosophy of real and reactive power control, Basic generator control loops.

1. Automatic Voltage Regulator (AVR): Functions of AVR, Types of Exciters, Brushless AVR loop: Exciter modeling, Generator modeling, Transfer function block diagram representation, Static performance, dynamic response, Stability compensation, Effect of generator loading.

Unit IV: Automatic Load Frequency Control: Automatic generation control (AGC), Speed governing system, Transfer function modeling: Governor, Hydraulic valve actuator, Turbine, Generator, Load, Transfer function representation of an isolated generator, Static performance of speed governor, Closing of ALFC loop.

Unit V: Control Area: Meaning, Primary ALFC Loop: Static response, Dynamic response, physical interpretation of results, Secondary ALFC loop, Integral Control, Pool operation, Tie-line Modeling, Two area system – Dynamic response, Tie-line bias control.

Unit VI: Steady-State Instabilities: Natural torsional oscillatory modes in power system, Natural mode of a single generator operating onto infinite bus, Effect of damper winding, Effect of changing excitation, Power system stabilizer, Introduction to modern control application, Introduction to power system security.

BOOKS RECOMMENDED:

Text Books:

1. O. L. Elgerd, “Electric Energy Systems Theory: An Introduction”, Second edition, McGraw-HillBook Comp. N. Y. 1987.

2. J. Nagrath, D. P. Kothari, “Modern Power System Analysis”, Second edition, Tata Mc-Graw Hill Publishing Company, New Delhi.

Reference Books:

1. L. K. Kirchmayor, “Economic Operation of Power System”, Wiley Eastern Pvt. Ltd., New Delhi.

2. B. R. Gupta, “Generation of Electrical Energy”, S. Chand & Company Ltd.

3. P. S. R. Murty, “Power System Operation and Control”, Tata Mc-Graw Hill Publishing Company, New Delhi.

4.Wood and Wallenberg, “Power Generation, Operation and Control”, Willey Inter Science Publication.

5. Abhijit Chakrabarti, Sunita Halder, “Power System Analysis Operation and Control”, PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010

7EP05 PROFESSIONAL ELECTIVE – IV

(i)ARTIFICIAL INTELLIGENCE

Course Outcomes: After successful completion of this course, students will be able to:

1. To understand and communicate fundamentals of Artificial Neural Networks and Systems.
2. To understand and present various learning methods and architectures of neural network.
3. To understand and describe fuzzy logic and genetic algorithm fundamentals and be able to solve problems.
4. To apply AI techniques to solve electrical engineering problems along with inter disciplinary problems.

Unit I: Introduction: Biological Neurons and their artificial models, introduction to neural computing Components of neuron, input and output weight, threshold, weight factors, transfer Functions, concepts of supervised and unsupervised learning.

Unit II: Supervised Learning: Single Layer network, perceptron, Linear Separability, Training algorithm and limitations Multilayer Network: Architecture of feed forward network, learning rule, generalized Delta rule, learning function. Back propagation algorithm.

Unit III: Unsupervised Learning: Introduction, Counter propagation networks, Korhonen’s self-organizing maps, Hopfield’s networks.

Unit IV: Introduction to Fuzzy: Uncertainty in information, basic concepts of Fuzzy sets, operations on fuzzy sets, properties. Fuzzy relations: operations, properties, value assignments.

Unit V: Membership Functions: Features, fuzzification, membership value assignments, Fuzzy Rule based Systems, Graphical technique of inference. De-fuzzification: Lambda-cuts for Fuzzy sets and Fuzzy relations, Defuzzification methods.

Unit VI: Genetic Algorithm (GA): Introduction to genetic algorithm, working principle, coding of variables, Fitness function. GA operators, similarities & differences between Gas and Traditional methods; Unconstrained and constrained optimization using Genetic Algorithm, real coded GA, Advanced GA, global optimization using GA.

BOOKS RECOMMENDED:

Text Books:

1. J.M. Zurada, “Introduction to Artificial Neural Network”, Jaico Publishing House.

2. T J Ross, “Fuzzy Logic with Engineering Application”, Wiley Publication.

Reference Books:

1. G.J. Khir and T.A. Folger, “Fuzzy sets, Uncertainty and Information”, PHI Publication.

2. KoskaBart, “Neural Network & Fuzzy systems”, Prentice Hall of India Pvt Ltd, NewDelhi.

3. MeherotraKishan, Mohan C.K., Ranka Sanjay, “Elements of Artificial Neural Networks”, Penram International Publishing (India) Pvt. Ltd.

4. D.E. Goldberg,“Genetic Algorithm in Search Optimization and Machine Learning”, Addison-Wesley Longman Publishing Co., US.

5. Kalyanmoy Deb, “Optimization for Engineering Design Algorithms and Examples”, Prentice Hall of India, New Delhi.

7EP05 PROFESSIONAL ELECTIVE – IV
(ii) ELECTRICAL DRIVES& CONTROL

Course Outcomes: After successful completion of this course, students will be able to:

1. Explain the basic Concept of electrical drives
2. Demonstrate various modern speed, torque control techniques of DC drives
3. Demonstrate various modern speed, torque control techniques of AC drives

Unit I: Introduction to Electrical Drives: Overview of electrical drive, comparison of DC & AC drive, components of load torque. Stability of an electrical drive. Introduction to frame of references (synchronous and rotating), Park and Clark transformation.

Unit II: DC Drive Control: Introduction to Four quadrant operation of dc drive, reviewof principle of operation of the chopper, four quadrant chopper circuit operation. Steady state analysis of chopper-controlled DC motor drive: continuous and discontinuous current conduction. Closed loop speed controlled separately excited dc motor drive.

Unit III: AC Drive Control: Review of basic principle of operation, speed control of induction motor: Impact of rotor resistance of the induction motor torque--speed curve. Review of slip energy recovery scheme. Closed loop control of slip energy recovery-controlled induction motor drive. Power electronic based rotor side control of slip ring Induction motor.

Unit IV: Scalar Control of Induction Motor: overview of three-phase voltage source inverter, generation of threephase PWM signals, sinusoidal modulation, space vector theory, conventional space vector modulation, voltage fed inverter control: open loop v/f control, close loop speed control with v/f control and slip regulation. of vector control, direct or feedback vector control, flux vector estimation, indirect or feed forward vector control, vector control of line side PWM rectifier, stator flux-oriented vector control, vector control of current Fed inverter drive.

Unit VI: Direct Torque & Flux Control (DTC): Torque expression with stator & rotor fluxes, control strategy of DTC, Adaptive control: self-tuning control, Model Referencing adaptive control (MRAC), sliding mode control: Control Principle, sliding trajectory control of vector drive.

BOOKS RECOMMENDED:

Text Books:

1. Bimal K. Bose, “Modern Power Electronics and AC Drive”,Pearson Education.

2. Vedam Subrahmanyam, “Electric Drives: Concepts & Applications”, Tata Mc Graw Hill Publishing Co

Ltd.

3. Austin Hughes and Bill Drury,"Electric Motor and Drives: Fundamentals, Types and Applications", Newnes, Oxford.

Reference Books:

1. S.K.Pillai, "A First Course on Electrical Drives", New Age International Publishing Co. Ltd.

2. Gopal. K. Dubey, "Fundamentals of Electrical Drives", CRC Press

3. R.Krishnan, "Electric Motor Drives: Modeling, Analysis & Control", Prentice Hall of India Pvt. Ltd.

4. M.D. Singh & K.B. Khanchandani, "Power Electronics", Tata Mc Graw Hill Publishing Co Ltd.

5. G. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall.

6. Dr. P. S. Bimbhra, "Generalized theory of Electrical Machine", Khanna Publishers.

7EP05 PROFESSIONAL ELECTIVE – IV

(iii) DISTRIBUTION AUTOMATION

Course Outcomes: After successful completion of this course, students will be able to:

1. Summarize distribution system planning and automation.
2. Select appropriate communication technology for SCADA applied to distribution automation.
3. Demonstrate the knowledge of substation automation.
4. Improve the voltage profile of distribution feeder using distribution automation.
5. Explain the concept of remote metering.
6. Choose the appropriate type of energy management.

Unit I: Distribution System Planning and Automation: Power Sector Reforms, Basic Distribution Systems, Short-Term Load Forecasting, Long-Term Energy Forecasting, Technological Forecasting, Problems with existing Distribution System, Need for Distribution Automation, Characteristics of Distribution System, Distribution Automation (Objectives, Functions, Benefits), Basic architecture of Distribution automation system, Feeder Automation, Communication Requirements for DA, Remote Terminal Unit (RTU), Communication Technologies for DA.

Unit II: SCADA-Control and Communication: Introduction, Block Diagram, Components of SCADA, Functions of SCADA, SCADA applied to Distribution Automation, Advantages of DA through SCADA, Requirements and Feasibility, DA Integration Mechanisms, Communication Protocols in SCADA Systems.

Unit III: Substation Automation: Introduction, Definition of Substation Automation, Benefits of SubstationAutomation, Functions of Substation Automation System, State and Trends of Substation Automation, Intelligent Affordable Substation Monitoring and Control, Advantages of an EEM (Enterprise Energy Management) Substation Automation Solution.

Unit IV: Feeder Automation: Losses in Distribution Systems, System Losses and Loss Reduction, Network

Reconfiguration, Improvement in Voltage Profile, Capacitor Placement in Distribution System for Reactive Power Compensation, Algorithm for location of capacitor.

Unit V: Remote Metering: Background of Remote Metering, Components of AMR Systems, Communications Methods used for Meter Reading, AMR System, Services and Functions, Financial Analysis, Planning for AMR Implementation.

Unit VI: Energy Management: Energy Management, Need Based Energy Management (NBEM), Demand Side Management (DSM), Maintenance of Automated Distribution Systems, Difficulties in Implementing Distribution Automation in Actual Practice, Urban/Rural Distribution.

BOOKS RECOMMENDED:

Text Book:

Dr. M. K. Khedkar and Dr. G. M. Dhole, "A Textbook of Electric Power Distribution Automation", University Science Press (Laxmi Publications Pvt. Ltd.), 2011.

Reference Books:

1. Bassett, K. Clinard, J. Grainger, S. Purucker, and D. Ward, "Tutorial Course: Distribution Automation", IEEE Tutorial Publication 88EH0280-8-PWR, 1988.

1. James Northcote-Green, Robert Wilson, "Control and Automation of Electrical Power Distribution Systems" CRC Press, Taylor and Francis Group, 2007

2. James A. Momoh, "Electric Power Distribution, Automation, Protection, and Control", CRC Press, Taylor and Francis Group, 2007

3. S. Sivanagaraju, V. Sankar, "Electrical Power Distribution and Automation", Dhanpat Rai and Co, 2006.

7EP06 POWER SYSTEM II – LAB.

Student should perform minimum eight (8) practicals based on syllabus**.**

List of Experiments:

1. Determination of Xd and Xq by slip test.
2. Determination of Xd' and Xd'' by sudden symmetrical short circuit test.
3. Determination of Xd'' and Xq'' by conducting static test.
4. Determination of X1, X2 and Xo by conducting direct test.
5. Determination of X1, X2 and Xo by conducting In-direct test.
6. Symmetrical Component Analysis of Unbalanced Three Phase Vector.
7. Symmetrical and Unsymmetrical Fault Analysis
8. Improvement transient stability using Facts Devices.
9. Power System Stability improvement using STATCOM.
10. Solution of swing equation using Point by Point Method.
11. Solution of swing equation using by Runge-Kutta method.
12. To Study Equal Area Criteria for transient stability.
13. To Study abc to dq0 (Parks) Transformation.

14. Transient stability analysis of a multi-machine power system.

7 EP07 DIGITAL SIGNAL PROCESSING – LAB.

Student will carry out minimum eight (8) assignments based on syllabus. List of experiments is given below for reference.

List of Experiments:

1. To generate various continuous and discrete signals.
2. To verify sampling theorem.
3. To find linear convolution of given sequences.
4. To compute auto-correlation between two sequences.
5. To find impulse response of given system.
6. To find DFT and IDFT of given sequence.
7. To find FFT of a given sequence.
8. To determine power spectrum of a given signal.
9. To find frequency response of a given system.
10. To design and implement FIR filter for given specifications.
11. To implement LP FIR filter for a given sequence.
12. To implement HP FIR filter for a given sequence.
13. To implement LP IIR filter for a given sequence.
14. To implement HP IIR filter for a given sequence.
15. To generate a sinusoidal signal through filtering.
16. To plot magnitude and phase response of digital butter worth low pass and high pass filter.
17. To perform implementation of I/D sampling rate converter.

7EP08 ENTREPRENEURSHIP & PROJECT MANAGEMENT –LAB.

Student will carry out minimum eight (8) assignments based on syllabus. List of assignments is given below for reference.

List of Assignments:

1. Undertake SWOT analysis to arrive at your business idea (Product / services).
2. Undertake self-assessment test to discover your Entrepreneurial traits.
3. Undertake the market survey to identify the need of market.
4. Identify Business opportunity for you.
5. Carry out the survey of industries of your stream and prepare the report.
6. Arrange the Visit to industries/firms of your product/service stream to study their business model.
7. Visit the banks and other financial Institutions to enquire about various funding scheme for set up the new business.
8. Compile the information of government agencies and financial agencies which provide loan/financial support to establish the business.
9. Prepare a report of technological and financial feasibility of chosen product/service.

10. Prepare a marketing strategy for chosen product/service.
11. Prepare a short term &long-term goal of your business.
12. Prepare a business plan for your chosen product/services.
13. Arrange a discussion session with successful entrepreneur to discuss on your business plan.
14. Study the stories of successful entrepreneur.
15. Prepare a DPR (Detail Project Report) of chosen product /services.

7EP09 PROJECT & SEMINAR

Seminar:

Each one of the students will be assigned a Seminar Topic in the current and frontier areas. The student has to conduct a detailed study/survey on the assigned topic and prepare a report. The student will make an oral presentation followed by a brief question and answer session. The Seminar (presentation and report) will be evaluated by an internal assessment committee for 50 marks.

Project:

The objective of the project is to enable the students to work in groups of not more than six members in each group on a project involving analytical, experimental, design or combination of these in the area of Electrical Engineering. Each project shall have a guide. The student is required to do literature survey, formulate the problem and form a methodology of arriving at the solution of the problem. On completion of the work, a project report should be prepared and submitted to the department. The evaluation is based on continuous internal assessment by an internal assessment committee for 75 marks. The university examination, which carries a total of 75 marks, will be a Viva Voce examination at the end of VIII Semester, conducted by a committee of one external examiner appointed by the University and one internal examiner/Guide.

SEMESTER EIGHTH

8EP01 POWER SYSTEM PROTECTION

Course Outcomes: After successful completion of this course, the students will be able to:

1. Explain the need, desirable features & main components of protection system.
2. Design the various protection scheme for transmission line
3. Develop the protection scheme for Alternator, Transformer, Motors & Busbar
4. Demonstrate the knowledge of static relays & Numerical relays
5. Select the proper type & rating of circuit breaker and fuses for various application.

Unit I: Fundamentals of Power System Protection: Importance & need of protection system, faults statistics,Desirable features, CT's and PT's for protection circuit, Relay classification. Basic terminology, Construction,operation, characteristics and application of Over-current relay, Directional relay, Distance relay and Differential relays.

Unit II: Protection of Transmission Line: Protection of radial feeder, parallel feeder, and ring main distribution system using over current relay, Combine OC & EF protection system, Distance protection of transmission line, three stepped protection, differential protection using pilot wire, translay system, carrier current protection for EHV line. Power swing, Auto-reclosure.

Unit III: Protection of Power System Equipment's: Alternator Protection: Protection system against failure of prime mover, failure of excitation system, over-speed, overvoltage, unbalanced loading, overloading, stator winding faults & rotor earth fault.

Transformer Protection: Over current protection, Merz Price Protection, Buchholz relay, restricted earth fault protection, Protection against Over-fluxing.

Motor Protection: Faults on Motor, Protection against single phasing, overloading, stator winding faults, locked rotor, bearing failure, phase reversal.

Bus-bar Protection: types of bus-bar arrangement, differential protection, Frame leakage protection.

Unit IV: Static & Numerical relays: Static Relay: General block diagram of static relay, merits & demerits of static relay over electromechanical relay, static over-current, directional, differential and distance relay.

Numerical relay: Numerical relaying fundamentals, block diagram, merits & demerits of numerical relay. Digital Protection scheme for alternator, transformer & Motor.

Unit V: Fuses: Construction, operation & application of HRC fuses, Basic terminology, HV fuses.

Circuit breaker: Basic principle of operation, arc phenomenon, arc interruption methods, arc voltage and current waveform in AC circuit breaking, re-striking and recovery voltage, Inductive and Capacitive current interruptions, current chopping, ratings of circuit breakers.

Unit VI: Circuit Breakers: Construction, operation and important features of oil CB, minimum oil CB, air blast CB, vacuum CB and SF6 CB, Testing, Installation & Maintenance of CB., auto high-speed re-closing. Construction, working and application of MCB, MCCB, ELCB & RCCB.

BOOKS RECOMMENDED:

Text Books:

1. Badri Ram and B. N. Vishwkarma, "Power System Protection and Switchgear", Tata Mc-Graw Hill Publishing Company Limited, New Delhi.

2. Y. G. Paithankar& S. R. Bhide, "Fundamentals of Power System Protection", PHI Publication, Delhi.

Reference Books:

1. Sunil S. Rao, "Switchgear and Protection", Khanna Publications, New Delhi

2. S R Bhide, "Digital Power System Protection", PHI Publication, New Delhi.

3. C. R. Mason, "The Art and Science of Protective Relaying", **4Th Edition by Blackburn J L, Taylor &**

Francis Exclusive (Cbs)

4. R. Van and C. Warringtan, "Protective Relaying", Vol 1 and 2, Chapman Hall, London.

5. B. Ravindranath and M. Chander, “Power System Protection and Switchgear”, Wiley Eastern Ltd, New Delhi.
6. A G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, Research Studies Press Ltd., England John Wiley & sons Inc., New York.
7. R. T. Lythall, “Switchgear Handbook”, J and P Newness Butterworth, London

8EP02 COMPUTER METHODS IN POWER SYSTEM ANALYSIS

Course Outcomes: After successful completion of this course, the students will be able to:

1. Develop mathematical model to represent the power system components for computerized analysis.
2. Demonstrate the topology of electrical power system.
3. Formulate Zbus& Ybus by algorithm.
4. Analyze short circuit studies of electrical power system.
5. Analyze load flow studies of electrical power system.
6. Examine stability studies of electrical power system.

Unit I: Representation of Power system for Computerized Analysis: Mathematical model of synchronous generator for steady state and transient analysis. Representation of Induction motor, Fixed tap setting transformer, Phase shifting transformer, On Load Tap Changer, transmission line & loads.

Unit II: Topology of Electrical Power System: Introduction to frame of references (bus, branch and loop), graph theoretic approach: Incidence Matrices: element node, bus incidence, branch path, basic cut set, augmented cut set, basic loop, augmented loop. Representation of Primitive network in impedance & admittance form, formation of network matrices by singular & non-singular transformation.

Unit III: Formation of Zbus & Ybus by Algorithm: Development of Zbus&Ybus by step-by-step algorithm on account for changes in network (addition of branch and link). Derivation of Zloop matrix. Transformation matrix- incidence & network matrices for three phase networks. Three phase balanced network elements: Balanced & unbalanced excitation. Clark component transformation. Algorithm for formulation of three phase bus impedance (Zbus) matrix.

Unit IV: Short Circuit Studies: Need, assumptions for short circuit analysis, three phase networks representation, symmetrical components, Thevenin’s theorem and short circuit analysis using Zbus matrix, Algorithm for calculation of System conditions, short circuit calculations for balanced three phase networks using Zbus matrix: Transforming to symmetrical components.

Unit V: Load Flow Studies: Network performance equation, line flow equation and bus loading equation. Classification of buses. Formation of load flow problem by using Gauss- Seidel and

Newton-Raphson method (Polar & Rectangular), decoupled load flow and Fast Decoupled methods of power flow, sparse Matrices.

Unit VI: Stability Studies of Power system: Development of mathematical model for multi-machine system stability analysis-Formation of equations and methods of solutions. Transient stability analysis including synchronous machines, system networks and loads. Solution of state equation by modified Euler method and Runge Kutta forth order approximation method.

BOOKS RECOMMENDED:

Text Books:

1. G.W.Stagg &Ahmed H. Ei–Abaid, "Computer Methods in Power System Analysis", Mc Graw Hill Book Co. Ltd.

2. M.A.Pai, "Computer Techniques in Power System Analysis", Tata Mc Graw Hill Publishing Co. Ltd.

Reference Books:

1. L.P.Singh, "Advanced Power System analysis and Dynamics", New Academic Science

2. R.N.Dhar, "Computer Aided Power System Operation and Analysis of Power System", Mc Graw Hill Co. Ltd.

3. I.J.Nagrath and D.P.Kothari, "Modern Power System Analysis", Tata Mc Graw Hill Publishing Co. Ltd

8EP03 PROFESSIONAL ELECTIVE-V

(i) HIGH VOLTAGE ENGINEERING

Course Outcomes: After successful completion of this course, students will be able to:

1. Explain the breakdown mechanism in solid, liquid, and gaseous dielectrics.
2. Select an appropriate protective device to protect the power system against overvoltage's caused by internal and external causes.
3. Utilize different circuits used for the generation of high AC, DC, and impulse voltages.
4. Measure high AC, DC, and impulse voltages.
5. Test the insulation of various high voltage apparatus used in the power system.

Unit I :

Breakdown in Gases: Breakdown in Gases, Insulating materials Classification, Gases as insulating media, Ionization and decay process, Breakdown in gases, Townsend's law, Streamer mechanism of spark, Paschen's law, Corona discharge, Electronegative gases.

Unit II:

Breakdown in Liquid & Solid Dielectrics: Breakdown in Liquid and Solid Dielectrics, Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, High voltage bushings, Guarding, Shielding, Field plotting.

Unit III:

Over Voltages in Electrical Power System: Lightning and Switching Over Voltage and Protection, Lightning strokes to lines and towers, Mechanism, Characteristics and protection of transmission lines from lightning, Lightning arrestors, Metal oxide arrestor, Insulation coordination of HV and EHV power system and substation.

Unit IV:

Generation of High Voltages & Impulse Voltages: High Voltage and Current Generation, Generation of high DC, AC and impulse voltages, Standard impulse wave shapes, Switching surges, and High impulse generator.

Unit V:

Measurement of High Voltages & Impulse Voltages: High Voltage and Current Measurement Peak voltage, Impulse voltage and High direct measurement methods, Non-destructive measurement, High voltage dielectrics loss and capacitance measurement, Radio frequency and Partial discharge measurement.

Unit VI:

High Voltage Testing: Basic terminology, High voltage testing of electrical power apparatus as per International and Indian standards - Insulators, Bushings, Cables, Transformers, Surge diverters and Isolators, Electric shock and threshold current, Capacitance of long objects, Electromagnetic interference.

BOOKS RECOMMENDED:

Text Book: M. S. Naidu and V. Kamraju, "High Voltage Engineering", Tata McGraw Hill Publishing, Company, New Delhi.

Reference Books:

1. E. Kuffel and W. S. Zaenglo, "High Voltage Engineering", Pergamon Press.

2. Rokosh Das Begamudre, "EHV AC. Transmission Engineering", Wiley Easter Ltd. New Delhi.

3. E. Kuffel and M. Abdullaha, "High Voltage Engineering", Pergamon Press.

4. M. S. Naidu and V. N. Maller, "SF6 and Vacuum Insulation for High Voltage Application", Khanna Publications, Delhi.

5. Subir Ray, "An Introduction to High Voltage Engineering", Prentice –Hall & India, Private Limited, New Delhi.C.L. Wadhawa, "High Voltage Engineering", New Age international (P) Ltd. Publications.

8EP03 : PROFESSIONAL ELECTIVE- V

(ii) HVDC and FACTS

Course Outcomes: After successful completion of this course, students will be able to:

1. Discuss different components of HVDC transmission system.
2. Explain the operation and control of HVDC converters.
3. Identify the suitable reactive power compensation technique and filter for HVDC system.

4. Choose proper FACTS controller for the specific application based on system requirements.

5. Analyze the circuits of static shunt and static series compensators used for the prevention of voltage instability and improvement of transient stability and power damping oscillations.

6. Demonstrate the knowledge of Unified power flow controller (UPFC)

Unit I:

Introduction to HVDC:HVDC Transmission Basic principle, Need for HVDC, Comparison of AC and D transmission systems, Advantages and Disadvantages of HVDC Systems, Application of HVDC transmission,Types of HVDC links, Layout of HVDC converter station and various equipment's, Planning for HVDC transmission, Modern trends in HVDC transmission.

Unit II:

HVDC Converters: Choice of converter configuration, types of converters, 6 - pulse and 12- pulse converters, Analysis of Graetz circuit with and without overlap, Principles of DC Link Control, Converters Control Characteristics, System control hierarchy, firing angle control, Constant current (CC) and Constant extinction angle (CEA) control, Starting and stopping of DC link, DC smoothing reactors.

Unit III:

Reactive Power Compensation, Harmonics and Filters : Reactive Power Requirements in steady state, sources of reactive power, Synchronous condensors, Generation of harmonics, AC and DC filters, Introduction to multiterminal DC systems.

Unit IV:

Introduction to FACTS: Transmission Inter connections, Opportunities for FACTS, Flow of power in an AC system, Power flow in parallel paths, Power flow in meshed systems, loading capability limits, Control of Power Flow in AC Transmission Line, Reactive power compensation, Basic types of FACTS controllers, Brief description and definitions of FACTS controllers, Shunt connected controllers, Series connected controllers, Combined Shunt and Series Connected Controllers, Benefits of using FACTS technology.

Unit V:

Static Shunt Compensators: Objectives of Shunt Compensation - Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, Improvement of Transient Stability, Improvement of Power Damping Oscillations, Methods of Controllable Var Generation - Thyristor controlled Reactor (TCR) and Thyristor Switched Reactor (TSR), Thyristor Switched Capacitor (TSC), Fixed Capacitor - Thyristor Controlled Reactor (FC-TCR), Static VAR Compensator (SVC) and Static Synchronous Compensator (STATCOM), Comparison between SVC and STATCOM, V-I and V-Q Characteristics of SVC and STATCOM.

Static Series Compensators: Concept of Series Capacitive Compensation, Objectives of Series Compensation, Voltage Stability, Improvement of Transient Stability, Power Oscillations Damping, Sub-synchronous Oscillation Damping,Variable Impedance Type Series Compensators -Thyristor

Controlled Series Capacitor (TCSC), Switching Converter Type Series Compensators -Static Synchronous Series Compensator (SSSC).

Unit VI:

Power Flow Controllers: Unified power flow controller (UPFC) – Introduction, operating principle, independent real and reactive power flow controller and control structure. Comparison between UPSC and Controlled Series Compensator, Interline power flow controller (IPFC).

BOOKS RECOMMENDED:

Text Books:

1. K.R. Padiyar, "HVDC Power Transmission Systems: Technology and system Interactions", New Age Publishers, Third *Edition,* 2017.

2. Narain G. Hingorani&LaszloGyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", Wiley India Pvt Ltd,2011.

Reference Books:

1. S. Kamakshaiah, V. Kamaraju, "HVDC Transmission", McGraw Hill Education, 2017.

2. Kimbark, E.W., "Direct current transmission", Vol.1, Wiley Interscience, New York, 1971.

3. Arrilaga, J., "High Voltage Direct current transmission", Peter Peregrinus Ltd., London, UK.,1983.

4. Vijay K. Sood, "HVDC and FACTS Controllers Applications of Static Converters in Power Systems", Kluwer Academic Publishers, 2004.

5. Enrique Acha, "FACTS: Modeling and Simulation in Power Networks", Wiley India Pvt. Ltd., 2012.

6. R. Mohan Mathur, Rajiv K. Varma, "Thyristor Based FACTS Controllers for Electrical Transmission Systems", Wiley Inter-science, 1st Edition, 2002.

8EP03 PROFESSIONAL ELECTIVE- V

(iii) SMART GRID SYSTEM

Course Outcomes: After successful completion of the course, students will be able to:

1. Explain the features, necessity and architecture of Smart Grid.
2. Relate the role of Automation in Transmission and Distribution.
3. Decide different measuring methods and sensors used in Smart Grid.
4. Interpret the role of batteries and energy storages in Smart Grid.
5. Discuss Power Quality issues in Smart Grid.
6. Elaborate the role of communication and networking in Smart Grid.

UNIT I: Introduction to Smart Grid: Evolution of Electric Grid, Smart Grid Concept - Definitions and Need for Smart Grid – Functions – Opportunities - Benefits and challenges, Difference between conventional & Smart Grid.

UNIT II: Smart Grid Architecture and Automation: Components and Architecture of Smart Grid, Fundamental components of Smart Grid designs, Transmission Automation, Distribution Automation, Renewable Integration

UNIT III: Sensors and Measurement: Sensors for Smart Grid, Monitoring and Measurement Technologies, Phase Measurement Unit (PMU), Smart meters, Smart Appliances, Multi Agent Systems (MAS) Technology, Micro grid and Smart grid comparison, Wide Area Measurement

UNIT IV: Smart Substation and Energy Storage: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System (GIS), Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smart storage like Battery, Superconducting Magnetic Energy Storage, Super Capacitors, Flywheel, Pumped Hydro Storage, Compressed Air Energy Storage.

UNIT V: Power Quality Management in Smart Grid: Power Quality & Electromagnetic Compatibility (EMC) in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT VI: Communication Technologies and Smart Grid: Elements of communication and networking – architectures, standards, PLC, Zigbee, GSM, Local Area Network (LAN) - House Area Network (HAN) – Wide Area Network (WAN) - Broadband over Power line (BPL) - IP based Protocols - Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid

BOOKS RECOMMENDED:

Text Books:

1. Stuart Borlase, "Smart Grid: Infrastructure, Technology and Solutions", CRC Press 2012

2. A.G. Phadke and J.S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer Edition, 2010.

Reference Books:

1. Stephen F. Bush, "Communication-Enabled Intelligence for the Electric Power Grid", Wiley-IEEE.

2. James Momoh, "Smart Grid: Fundamentals of design and analysis", John Wiley & sons Inc, IEEE Press, 2012.

8EP04 PROFESSIONAL ELECTIVE - VI

(i) POWER QUALITY

Course Outcomes: After successful completion of this course, students will be able to:

1. Illustrate the concept, need, and standards of Power Quality.
2. Classify Power quality characteristics.
3. Select power conditioning device for mitigation of power quality problem.
4. Make use of measurement tools for power quality survey.

Unit I: Introduction: Power Quality Definition. Need for Power Quality, Sensitive Loads, Nonlinear Loads, Interconnected Power System, Deregulation and its Effect, Stakeholders of Power Quality and their Role.

Unit II: Power Quality Characteristics: Power Quality Theory, Types of power Quality Problems, Voltage Swells, Long-Duration Over voltages, Under voltages, Interruptions, Transients, Voltage Unbalance, Voltage Fluctuations, Harmonics, Electrical Noise, Sources and Effects of Power Quality Problems, Power Quality Problem-Solving Procedures.

Unit III: Power Quality Standards: Power Quality Standards' Organizations, Institute of Electrical & Electronics Engineers (IEEE), American National Standards institute (ANSI), International Electro technical Commission (IEC) Other International Standards Organizations, Purpose of Power Quality Standards, 'Types of Power Quality Standards, Voltage Sag (Dip) Standards, Transients, Voltage Unbalance, Voltage Fluctuation or Flicker Standards, Harmonics Standards, Transformer Overheating Standards, Natural Conductor Loading Standards, Static Electricity, Telephone Power Quality Standards, Grounding and Wiring Standards, Sensitive Electronics Equipment Standards,

Trends in Power Quality Standards Eliminate Transfer Medium, Install Power Conditioning Equipment, Surge Suppressors, Noise Filters, Isolation Transformers, Line-Voltage Regulators, Motor-Generator Sets, Magnetic Synthesizers Uninterruptible Power

Supply (UPS), Solid-State Switches, Harmonics Solutions, Construction and Working Principle of Shunt Active Power Filter, Series Active Power Filter and Unified Power Quality Conditioner, Selection of Appropriate Power Conditioning Equipment.

Unit V: Wiring and Grounding: Wiring and Grounding Principles, Utility Power System Grounding, Telecommunication System Grounding, End-User Power System Grounding, Wiring and Grounding Problems, Ground Loops, Electromagnetic Interference (EMI) Noise, Loose Connections, Grounding for Lightning and Static Electricity, Wiring Solutions: Separation, Selection of Wire and Cables, Shielding Grounding Solutions: Ground Rods, Ground Ring, Ground and Reference Signal Grids, Other Grounding Systems, Isolated Grounds, Multipoint Grounding, Separately Derived Source Grounding.

Unit VI: Power Quality Measurement Tools & Power Quality Surveys: Factors considered for selection of measurement tools, Kilowatt-Hour Meter, Multimeters, Average-responding versus True RMS Meters, Current Probes, Oscilloscope, Disturbance Analyzer, Harmonics Analyzer, Power Quality Analyzer Purpose of a Power Quality Surveys, planning a power Quality Survey.

BOOKS RECOMMENDED:

Text Book: Roger C Dugan, Santoso & McGranahan, "Electrical Power Systems Quality", McGraw Hill.

Reference Books:

1. G.T. Heydt, "Electric Power Quality", Stars in a circle Publication, Indiana, 1991.

2. Barry W. Kennedy, "Power Quality Primer", McGraw-Hill.

3. Alexander Kusko, "Power Quality in Electrical Systems", McGraw-Hill.

4. Bhim Singh,Ambrish Chandra,Kamal Al-Hadad, "Power Quality Problems and Mitigation Techniques", Wiley Publication.

8EP04 PROFESSIONAL ELECTIVE – VI

(ii) ELECTRICAL ENERGY CONSERVATION AND AUDITING

Course Outcomes: After successful completion of this course, students will be able to:

1. Summarize Indian and global energy scenario.
2. Explain types of energy Audit and its procedure.
3. Discuss economics of energy conservation
4. Elaborate the concepts of energy conservation and management.
5. Choose Appropriate energy efficient techniques for energy conservation
6. Apply the understanding of energy conservation and management for industrial applications.

Unit I: Energy Scenario: Various forms of energy: Primary and secondary energy, commercial and noncommercial energy, renewable and non-renewable. Indian and global energy scenario, energy needs of growing economy, energy pricing, electricity billing and tariff. Energy sector reforms: In coal, oil, natural gas and electricity. Functions and Responsibilities of CERC & SERC. Energy Conservation Act-2001, Indian electricity Act 2003 and its features. Electricity (Amendment) Bill, 2020 – Key Highlights. Energy and environmental Impacts.

Unit II: Energy Audit: Definition, energy audit, need, types of energy audit: Preliminary and detailed energy audit. Energy audit instruments. Procedure for carrying out energy audit. Data Analysis-Energy production relationship, specific energy consumption, Sankey (energy flow) diagram, CUSUM Technique, Bench marking, energy performance.

Unit III: Economics of Energy conservation: Cost factors, Budgeting, Standard costing and Sources of capital, Cash flow diagram and activity chart, Simple Payback period analysis, Time value of money, Net present value method, and internal rate of return method. Profitability index for benefit cost ratio.

Unit IV: Energy Conservation & Management: Definition and necessity of energy conservation. Review of electric motors, types, losses, motor efficiency, factors affecting motor Performance, transformer types & its losses. Rewinding and motor replacement issues. Definition and Objective of Energy Management, concept of Supply Side Management (SSM) and Demand Side Management (DSM), methods of implementing demand side management and advantages to consumer, utility and society. Energy strategy for the future.

Unit V: Energy Efficient Techniques in Electrical Systems: Review of power factor improvement and its benefit, selection and location of capacitors. Power factor penalties and incentives in tariff for demand control. Recommendations for energy conservation: Maximum demand controllers, automatic power factor controllers, Variable Speed Drives, Energy efficient transformers. Soft starting of motors.

Unit VI: Energy Conservation in Industrial Applications: Energy conservation opportunities in motive power (Motors and drive system)- Energy efficient motors, Heating Ventilation and Air Conditioning(HVAC), Illumination system, Pumps and Pumping systems, thermal power stations,

Utility Industries: Transmission & Distribution Sector. Cogeneration &Waste heat recovery systems. Energy Audit Case Study of energy intensive industry.

BOOKS RECOMMENDED:

Text Books:

1. "Energy Audit and Conservation", TERI.
2. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", Mc.Graw Hill, 1991.

Reference Books:

1. "Success stories of Energy Conservation", BEE, New Delhi. (www.beeindia.gov.in)
2. Thumman, "Energy Conservation and Audit", Fairmont Press.
3. SonalDesai, "Handbook of Energy Audit", Mc. Graw Hill.
4. Guide books for National Certification Examination for Energy Manager/Energy.
5. Auditors Books, General Aspects (available online).

8EP04 PROFESSIONAL ELECTIVE – VI

(iii) ELECTRIC AND HYBRID VEHICLES

Course Outcomes: After successful completion of this course, students will be able to:

1. Understand the models to describe hybrid vehicles and their performance.
2. Understand the different possible ways of energy storage.
3. Understand the different strategies related to energy storage systems.

Unit I: Introduction: Conventional Vehicles: Basics of vehicle performance, vehicle power source Characterization, transmission characteristics, mathematical models to describe vehicle performance.

Unit II: Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Unit III: **Hybrid Electric Drive**: Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Unit IV: Electric Trains: Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Unit V: Energy Storage: Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion

motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

Unit VI: Energy Management Strategies: Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

BOOKS RECOMMENDED:

Text Books:

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.

2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.

Reference Books:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and FuelCell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.

2. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

8EP05 POWER SYSTEM PROTECTION – LAB.

Student will perform minimum 08 experiment based on syllabus of Power System Protection. List of experiment is given below for reference.

List of Experiments:

1. Development of control circuit for power supply control of three phase IM.
2. Development of control circuit for direction control of three phase IM.
3. Polarity test & ratio test on CTs & PTs.
4. Plot the characteristics of Inverse Time OC relay.
5. Plot the characteristics of Differential relay.
6. Plot the operating characteristics of MCB & fuses.
7. Plot the characteristics of impedance relay or MHO relay.
8. Develop the combine OC & EF protection scheme for three phase alternators.
9. Develop the protection system for alternator against unbalanced loading.
10. Develop the Merz Price Protection scheme for three phase transformers.
11. Develop the protection system for three phase IM against single phasing.
12. Develop the static over-current relay.
13. Demonstrate Operation of static overvoltage & under voltage relay.
14. Study the protection scheme for three phase IM using microprocessor-based relays.
15. Demonstration of numerical relays.

8EP06: COMPUTER METHODS IN POWER SYSTEM ANALYSIS – LAB.

Student should perform minimum eight (8) practicals based on the syllabus .

List of Experiments:

1. Write a Program for formation of Bus Admittance Matrix (Ybus) for a given Power System network using Singular Transformation.
2. Write a Program for formation of Bus Impedance Matrix (Zbus) for a given Power System network by stepby- step Algorithm.
3. Write a Program for Short circuit Analysis when three phase to ground fault at bus P of a given Power System network.
4. Write a Program for Short circuit Analysis when three phase faults at bus P of a given Power System network.
5. To determine fault voltage and fault current when three phase faults at bus P of a given power system network by using simulation software.
6. To determine fault voltage and fault current when three phase to ground fault at bus P of a given power system network by using simulation software.
7. Write a program for load flow studies on a given power system network by Gauss- Seidel method using bus Admittance Matrix (Ybus).
8. Write a program for load Flow studies on a given power system network by Newton-Raphson method in Polar Coordinates by using bus Admittance Matrix (Ybus).
9. Write a program for load flow analysis on a given power system network using Fast Decoupled Load Flow (FDLF) Method.
10. To find the critical clearing angle when three phase fault occurs at sending end of transmission line of a given power system network by using simulation software.
11. To find the critical clearing angle when three phase fault occurs at mid-point of transmission line of a given power system network by using simulation software.
12. To plot swing curve of a given power system by using simulation software.
13. To study load flow analysis of a power system by using *Gauss-Seidel, Newton*-Raphson and FDLF Methods.
14. To study short circuit analysis of a Power system network.
15. To study Modified Euler method and Runge Kutta 4th order Approximation Methods for stability studies of a Power System network

8EP07 PROJECT & SEMINAR

Seminar:

Each one of the students will be assigned a Seminar Topic in the current and frontier areas. The student has to conduct a detailed study/survey on the assigned topic and prepare a report. The student will make an oral presentation followed by a brief question and answer session. The Seminar (presentation and report) will be evaluated by an internal assessment committee for 50 marks.

Project:

The objective of the project is to enable the students to work in groups of not more than six members in each group on a project involving analytical, experimental, design or combination of these in the area of Electrical Engineering. Each project shall have a guide. The student is required to do literature survey, formulate the problem and form a methodology of arriving at the solution of the problem. On completion of the work, a project report should be prepared and submitted to the department. The evaluation is based on continuous internal assessment by an internal assessment committee for 75 marks. The university examination, which carries a total of 75 marks, will be a Viva Voce examination at the end of VIII Semester, conducted by a committee of one external examiner appointed by the University and one internal examiner/Guide.