

UNIT-I: Power semiconductor Devices: Power semiconductor devices their symbols and static characteristics; Characteristics and specifications of switches, types of power electronic circuits. Thyristor – Operation V- I characteristics, two transistor model; Triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation

UNIT-II: Power Semiconductor Devices (Contd): Protection of devices; Series and parallel operation of thyristors; Commutation techniques of thyristor
DC-DC Converters: Principles of step-down and step-up chopper and their operation with R-L load; Classification of choppers.

UNIT-III: Phase Controlled Converters: Single phase half wave controlled rectifier with resistive and inductive loads, effect of freewheeling diode; Single phase fully controlled and half controlled bridge converters; Three phase half wave converters, three phase fully controlled and half controlled bridge converters; Effect of source impedance; Single phase and three phase dual converters.

UNIT-IV: AC Voltage Controllers: Principle of On-Off and phase controls; Single phase ac voltage controller with resistive and inductive loads; Three phase ac voltage controllers (various configurations and comparison)

Cyclo Converters: Basic principle of operation, single phase to single phase, three phase to single phase and three phase to three phase cyclo converters, output voltage equation.

UNIT-V: Inverters: Single phase series resonant inverter; Single phase bridge inverters
Three phase bridge inverters: 120° and 180° mode of operation; Voltage control of inverters; Harmonics reduction techniques; Single phase and three phase current source inverters.

Text Books:

1. M.H. Rashid, "Power Electronics: Circuits, Devices & Applications", Prentice Hall of India Ltd. 3rd Edition, 2004.
2. P.S.Bimbhra, "Power Electronics" Khanna Publication.
3. Umanand "Power Electronics" Wiley India.

Unit I: The Control System: Open loop & closed control; servomechanism, Physical examples. Transfer functions, Block diagram algebra, Signal flow graph, Mason's gain formula Reduction of parameter variation and effects of disturbance by using negative feedback

Unit II: Time Response analysis: Standard test signals, time response of first and second order systems, time response specifications, steady state errors and error constants.

Controllers: Introduction to P, PI, & PID controller. performance indices

Unit III: Control System Components: Constructional and working concept of ac servomotor, synchros and stepper motor.

Concept of Stability: Routh-Hurwitz criteria, Root Locus Technique

Unit IV: Frequency response Analysis: Frequency response, correlation between time and frequency responses, polar and inverse polar plots, Bode plots: gain margin and phase margin.

Stability in Frequency Domain: Nyquist stability criterion, relative stability.

Unit V: Introduction to Design: The design problem and preliminary considerations lead, lag and lead-lag networks, design of closed loop systems using compensation techniques in time domain and frequency domain.

Text Book:

1. I.J. Nagrath & Gopal, "Control System Engineering", 4th Edition, New age International.
2. K. Ogata, "Modern Control Engineering", Prentice Hall of India.

Reference Books:

1. Norman S. Nise, Control System Engineering 4th edition, Wiley Publishing Co.
2. M.Gopal, "Control System; Principle and design", Tata McGraw Hill.
3. M.Gopal, "Modern Control system", Tata McGraw Hill.
4. D.Roy Choudhary, "Modern Control Engineering", Prentice Hall of India.

UNIT I – POWER SYSTEM COMPONENTS

Single line diagram of Power System, Supply system, Different types of supply system and their comparison, Transmission line configurations, Types of conductors, Skin effect, Kelvin's law, Proximity effect.

UNIT II – OVER HEAD TRANSMISSION LINES

Calculation of inductance and capacitance of single phase, three phase, single circuit, and double circuit transmission lines. Representation of short, medium and long transmission lines, Ferranti effect, Surge impedance loading

UNIT III – CORONA AND LINE INSULATORS

Corona formation, calculation of potential gradient, corona loss, factors affecting corona, Methods of reducing corona and interference. Electrostatic and electromagnetic interference with communication lines. Types of insulators and their application, Potential distribution over a string of insulators, Methods of equalizing the potential, String efficiency

UNIT IV – MECHANICAL DESIGN OF TRANSMISSION LINES

Catenary curve, Calculation of sag & tension, Effects of wind and ice loading, Sag template, Vibration dampers, Types of towers and their design

UNIT V – INSULATED CABLES

Types of cables and their construction, Dielectric stress, Grading of cables, Insulation resistance, Capacitance of single phase and three phase cables, Dielectric losses, Heating of cables.

Text Books

1. W.D. Stevenson, "Element of Power System Analysis", McGraw Hill, USA
2. C.L. Wadhwa, "Electrical Power Systems", New Age International Ltd., Third Edition
3. Ashfaq Husain, "Power System", CBS Publishers & Distributors, India
4. B.R. Gupta, "Power System Analysis & Design", S.Chand & Co, Third Edition
5. M.V. Deshpande, "Electrical Power System Design", Tata McGraw Hill

Reference Books

1. Soni, Gupta & Bhatnagar, "A Course in Electrical Power", Dhanpat Rai & Sons, India
2. S.L. Uppal, "Electric Power", Khanna Publishers
3. S.N. Singh, "Electric Power Generation, Transmission & Distribution", PHI, New Delhi

UNIT 1: COORDINATE SYSTEMS AND TRANSFORMATION

Cartesian Coordinates, Circular Cylindrical Coordinates, Spherical Coordinates Vector Calculus: Differential Length, Area and Volume, Line Surface and Volume Integrals, Del Operator, Gradient of a Scalar, Divergence of a Vector and Divergence Theorem, Curl of a Vector and Stoke's Theorem, Laplacian of a Scalar.

UNIT 2: ELECTROMAGNETIC WAVE PROPAGATION

Faraday's Law, Transformer and Motional Electromotive Forces, Displacement Current, Derivation of Maxwell's Equations For Static and Time-Varying Fields. Differential and integral forms, concept of displacement current. Boundary conditions.

UNIT 3: ELECTROMAGNETIC WAVE PROPAGATION APPLICATIONS

Electromagnetic Wave Propagation: Wave Propagation in Lossy Dielectrics, Plane Waves in Lossless Dielectrics, Plane Wave in Free Space, Plain Waves in Good Conductors, Power and The Poynting Vector, Reflection of a Plane Wave in a Normal incidence.

UNIT 4: TRANSMISSION LINES

Transmission Lines: Transmission Line Parameters, Transmission Line Equations, Input Impedance, Standing Wave Ratio and Power, Smith Chart, Some Applications of Transmission Lines. Time & Frequency Domain analysis of Transmission lines. Low loss RF and UHF transmission lines. Distortion-less condition. Transmission line charts-impedance matching.

UNIT 5: WAVEGUIDES

Wave Guides: Introduction to Planar (Rectangular) Waveguides, Derivation of TE and TM Modes, TEM Mode. Circular Waveguides- Derivation of TE and TM Modes, TEM Mode. Impedance and characteristics impedances. Transmission line analogy for wave guides. Attenuation and factor of wave guides. Dielectric slab wave guides. Resonators

Textbooks Learning:

1. *Elements of Electromagnetics, M N O Sadiku, 2012.*

Reference Learning:

1. *Engineering Electromagnetic, William Hayt, McGraw-Hill, 2011.*

2. *Electromagnetic Fields, K. D. Parsad, 2010.*

Note: Minimum eight experiments are to be performed from the following list. The department may add 3 to 4 more experiments in the following list.

1. To study V-I characteristics of SCR and measure latching and holding currents.
2. To study UJT trigger circuit for half wave and full wave control.
3. To study single-phase half wave controlled rectified with (i) resistive load (ii) inductive load with and without freewheeling diode.
4. To study single phase (i) fully controlled (ii) half controlled bridge rectifiers with resistive and inductive loads.
5. To study three-phase fully/half controlled bridge rectifier with resistive and inductive loads.
6. To study single-phase ac voltage regulator with resistive and inductive loads.
7. To study single phase cyclo-converter
8. To study triggering of (i) IGBT (ii) MOSFET (iii) power transistor
9. To study operation of IGBT/MOSFET chopper circuit
10. To study MOSFET/IGBT based single-phase series-resonant inverter.
11. To study MOSFET/IGBT based single-phase bridge inverter.

Software based experiments (PSpice/MATLAB)

12. To obtain simulation of SCR and GTO thyristor.
13. To obtain simulation of Power Transistor and IGBT.
15. To obtain simulation of single phase full wave ac voltage controller and draw load voltage and load current waveforms for inductive load.

EA5220: CONTROL SYSTEM LAB

Note: Minimum eight experiments are to be performed from the following list. The department may add 3 to 4 more experiments in the following list.

1. To determine response of first order and second order systems for step input for various values of constant 'K' using linear simulator unit and compare theoretical and practical results.
2. To study P, PI and PID temperature controller for an oven and compare their performance.
3. To study and calibrate temperature using resistance temperature detector (RTD)
4. To design Lag, Lead and Lag-Lead compensators using Bode plot.
5. To study DC position control system
6. To study synchro-transmitter and receiver and obtain output V/S input characteristics
7. To determine speed-torque characteristics of an ac servomotor.
8. To study performance of servo voltage stabilizer at various loads using load bank.
9. To study behaviour of separately excited dc motor in open loop and closed loop conditions at various loads.
10. To study PID Controller for simulation proves like transportation lag.

Software based experiments (Use MATLAB, LABVIEW software etc.)

11. To determine time domain response of a second order system for step input and obtain performance parameters.
12. To convert transfer function of a system into state space form and vice-versa.
13. To plot root locus diagram of an open loop transfer function & determine range of gain 'k' for stability.
14. To plot a Bode diagram of an open loop transfer function.
15. To draw a Nyquist plot of an open loop transfer functions and examine the stability of the closed loop system.