Sardar Vallabhbhai National Institute of Technology, Surat-395007
(A DEEMED UNITVERSITY)

DEPARTMENT OF ELECTRICAL ENGINEERING

	L	T	P	C
B. Tech. (All Branches), Semester – I and II				
ELE 205 AF/ELE 205 AS : ELECTROTECHNIQUES	**3**	**1**	**2**	**5**

- **ELECTROMAGNETISM** **(06 Hours)**

  Biot-Savart law, magnetic field due to a current carrying conductor, magnetic field of an infinite linear conductor, magnetic field due to circular loop, field strength inside a solenoid, force on a current carrying conductor in magnetic field, force between two parallel linear conductors, hysteresis loop, Loss calculation, steinmeitz exponent, eddy current loss, energy stored in a magnetic field, lifting power of a magnet.

- **MAGNETIC CIRCUIT** **(04 Hours)**

  Amperes circuital law, analogy between electric & magnetic circuits, fringing, leakage, series, parallel, series-parallel circuits.

- **ELECTROMAGNETIC INDUCTION** **(04 Hours)**

  Faradays law, Lenz law, self-inductance, mutual inductance, coefficient of mutual inductance, coefficient of coupling, inductance in series, parallel, series-parallel.

- **AC FUNDAMENTALS AND CIRCUITS** **(12 Hours)**

  Alternating voltages and currents and their vector and time domain representations, average and RMS values, form factor, phase difference, power and power factor, purely resistive inductive and capacitive circuits, R-L, R-C, R-L-C series circuits, impedance and admittance, circuits in parallel, series and parallel resonance, Complex algebra and its application to circuit analysis.

- **POLYPHASE CIRCUITS** **(08 Hours)**

  Balanced two phase and three phase systems, star and mesh connections, calculations for balanced three phase networks, polyphase vector diagram, and measurement of power in three phase circuits.

- **ELECTRICAL WIRING** **(02 Hours)**

  Various types of residential wiring circuits as simple parallel circuits, stair case wiring, go down wiring.

- **SINGLE PHASE TRANSFORMERS** **(08 Hours)**

  Principle of transformer, construction - shell type, core type, transformer on no-load, with load, phasor diagram for transformer under no-load and loaded condition (with unity, lagging power factor load) equivalent circuit, open circuit and short circuit test, efficiency, voltage regulation.

- **THREE-PHASE INDUCTION MOTORS** **(04 Hours)**

  Rotating magnetic field, Principle of operation, slip, different power stages and equivalent circuit.

Total Hours: 48

BOOKS RECOMMENDED:

1. Kothari and Nagrath, “Basic electrical engineering”, 2nd edition, 2007, Tata McGraw-Hill Education.
2. Harry Cotton, “Principles of Electrical Technology”, 1967, Pitman.
3. V. N. Mittle & Arvind Mittal, “Basic electrical engineering”, 2nd edition, 2005, Tata McGraw-Hill Education.
4. Arthur Eugene Fitzgerald, David E. Higginbotham, “Basic Electrical Engineering”, 3rd edition, 1954, Tata McGraw-Hill Education.

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DEPARTMENT OF ELECTRICAL ENGINEERING

B.TECH.-II-ELECTRICAL TEACHING SCHEME (Revised)

SEMESTER - III

Sr. No.	Course Code	Course	L	T	P	Credits	Examination Scheme				
			Hrs	Hrs	Hrs		Theory Marks	Tutorial Marks	Termwork Marks	Practical Marks	Total Marks
1	MH210	Engineering Mathematics-III	3	1	0	04	100	25	-	-	125
2	EC209	Linear Electronics	3	0	2	04	100	-	20	30	150
3	EE201	Electrical Circuits	4	1	0	05	100	50	-	-	150
4	EE203	Electrical Machines-I	3	1	2	05	100	25	20	30	175
5	CE209	Solids and Fluids Mechanics	4	0	0	04	100	-	-	-	100
		TOTAL	**17**	**3**	**4**	**22**	**500**	**100**	**40**	**60**	**700**
	TOTAL CONTACT HOURS		**24**								
	TOTAL CREDITS		**22**								

SEMESTER - IV

Sr. No.	Course Code	Course	L	T	P	Credits	Examination Scheme				
			Hrs	Hrs	Hrs		Theory Marks	Tutorial Marks	Termwork Marks	Practical Marks	Total Marks
1	ME212	Applied Thermodynamics & Thermal Engineering	3	0	0	03	100	-	-	-	100
2	EC212	Digital Circuits	3	0	2	04	100	-	20	30	150
3	EE202	Network and Systems	4	1	0	05	100	50	-	-	150
4	EE204	Electrical Machines-II	3	1	2	05	100	25	20	30	175
5	EE206	Computer Applications for Electrical Engineering	3	1	2	05	100	25	20	30	175
		TOTAL	**16**	**3**	**6**	**22**	**500**	**100**	**60**	**90**	**750**
	TOTAL CONTACT HOURS		**25**								
	TOTAL CREDITS		**22**								

B.Tech. (Electrical), Semester – III	L	T	P	C
MH210 : ENGINEERING MATHEMATICS III	3	1	0	4

- **CALCULUS, MULTIPLE INTEGRALS** **(08 Hours)**

  Reorientation of concepts of integrals, Double and Triple integrals, evaluation techniques, change of order of Integration, change of variable, Application of double and triple integrals for evaluation of area, volume and mass.

- **BASIC CONCEPTS OF VECTOR CALCULUS** **(08 Hours)**

  Line Integrals, scalar and vector point function, differential operator, gradient, directional derivative, physical meaning of gradient, divergence, curl and Laplacian with their properties, Surface Integral, Volume integral, Green's ,Gauss and Stoke's theorem & application.

- **FOURIER SERIES** **(06 Hours)**

  Definition, Fourier series with arbitrary period, in particular periodic function with period 2π. Fourier series of even and odd function, Half range Fourier series.

- **FOURIER INTEGRAL & TRANSFORM** **(06 Hours)**

  Fourier Integral theorem, Fourier sine and cosine integral complex form of integral, Inversion formula for Fourier transforms, Fourier transforms of the derivative of a function.

- **PARTIAL DIFFERENTIAL EQUATION** **(06 Hours)**

  Second order pde of mathematical physics (Heat, wave and Laplace equation, one dimensional with standard boundary conditions, solution by separation of variable method using Fourier series, Solution by Separation of variables & transformation techniques.

- **COMPLEX VARIABLES** **(08 Hours)**

  Basic mathematical concept, Analytic function, C – R equations, Harmonic functions, its applications, Linear transformation of complex domain, some special transformation, bilinear transformations, conformal mapping and its application, complex integration including contour integration.

Total Hours: 44

BOOKS RECOMMENDED:

1. Kreyszing E., 'Advanced Engineering Mathematics', John Wiley, Int. Student Ed. 1995.
2. Wiley C. R., 'Advanced Engineering Mathematics', McGraw Hill, Int. Student Ed. 1993.
3. O'Neel Peter., 'Advanced Engg. Mathematics', Thompson, Singapore, Ind. Ed. 2002.
4. Greenbar Michael D., 'Advanced Engg. Mathematics', Pearson, Singapore, Ind. Ed. 2007.
5. Ramana D. V., 'Higher Engg. Mathematics', The MaGraw-Hill Inc., New Delhi, 2007.

B.Tech. (Electrical), Semester – III	L	T	P	C
EC209 : LINEAR ELECTRONICS	3	0	2	4

- **BIPOLAR JUNCTION TRANSISTOR ANALYSIS & DESIGN** **(08 Hours)**

  Transistor Characteristic; Plots For NPN And PNP Configurations; Current Flow Mechanism In The Junction Transistor And Calculation Of Alpha And Beta; Analysis Of CE Configuration; Current Amplification In The Transistor; Graphical Analysis Of Transistor Circuits; Power Calculations; Infinite Bypass Capacitor; Infinite Coupling Capacitors; Different Dc Biasing Methods; Fixed Bias, Emitter Stabilized Bias, Potential Divider Bias, Dc Bias With Voltage Feedback; Common Base Configuration Analysis; Emitter Follower.

- **AUDIO FREQUENCY LINEAR POWER AMPLIFIERS** **(08 Hours)**

  Introduction To Class A, B, AB And C Operation; Class A Common-Emitter Power Amplifier; Transformer Coupled Amplifier; Class B Push-Pull Power Amplifier; Amplifiers Using Complementary Symmetry; Class C Amplifier.

- **NEGATIVE FEEDBACK AMPLIFIERS** **(08 Hours)**

  Feedback – Principal Of Negative Voltage Feedback In Amplifiers- Gain Of Negative Feedback Amplifier- Advantages Of Negative Voltage Feedback – Principal Of Negative, Current Feedback- Current Gain With Negative Feedback- Effects Of Negative Feedback- Emitter Follower- D.C. Analysis Of Emitter Follower- Voltage Gain Of Emitter Follower- Input Impedance Of Emitter Follower- Output Impedance Of Emitter Follower- Application Of Emitter Follower- Darlington Amplifier.

- **FIELD EFFECT TRANSISTORS** **(07 Hours)**

  Introduction To Theory And Operations Of N-Channel JFFT & MOSFET; Reversibility Of Drain & Source; P-Channel FET; FET Switch; MOSFET Inverter; Bias Stability In FET; Different FET Configuration.

- **OSCILLATORS** **(07 Hours)**

  Barkhausen's Criteria For Oscillators; Tank Circuit Operation, Basic Transistor AF And RF Oscillators, Phase Shift, Wien Bridge, Colpitts, Hartley, Crystal And Tune Circuit Type Oscillators (AF & RF Range).

- **DIODE CLIPPER & CLAMPER CIRCUITS** **(07 Hours)**

  Series And Shunt Diode Clippers, Clipping At Two Independent Level, Clamping Operation, Clamping Circuit, Clamping Circuit Theorem, Practical Clamping Circuits, Effect Of Diode Characteristics, Applications.

Total Hours: 45

PRACTICAL:

1. Study of BJT Characteristics.
2. Study of C_E Amplifier.
3. Study of RC Coupled / Tuned Amplifier.
4. Study of Voltage Series Amplifier.
5. Study of Current Series Amplifier.
6. Study of FET Characteristics,
7. Study of Hartly Oscillator.
8. Study of Colpit Oscillator / Wein Bridge Oscillator.
9. Study of Diode Clipper Circuits.
10. Study of Diode Clamper Circuits.

BOOKS RECOMMENDED:

1. Millman & Halkias, “Integrated Electronics”, McGraw Hill Publication, 1992
2. Boylestad & Nashlesky, “Electronic Devices & Circuit Theory”, PHI Publication, 2nd edition, 2000.
3. Schilling & Belove, “Electronic Circuits - Discrete and Integrated”, McGraw Hill Publication, 3rd edition 1989, reprint 1994
4. Albert Malvino & David J. Bates, “Electronic Principles”, Tata Mcgraw Hill, 7th Ed. 2007.

B. Tech. (Electrical), Semester – III	L	T	P	C
EE 201 : ELECTRICAL CIRCUITS	**4**	**1**	**0**	**5**

- **NETWORK CONCEPTS** **(03 Hours)**

  Network element symbols and conventions, active element conventions, current and voltage conventions, loops and meshes, nodes, coupled circuits and dot conventions.

- **GRAPH THEORY AND ITS APPLICATIONS** **(08 Hours)**

  Fundamental concepts, definitions of a graph and various related terms, paths and circuit connections, tree of a graph, cut sets and tie sets, non separable planner and dual graphs, matrices of oriented graphs, properties and inter relationships of incidence, tie set and cut set matrices, complete circuit analysis using tie set and cut set matrices.

- **NETWORK ANALYSIS TECHNIQUES AND THEOREMS** **(18 Hours)**

  Mesh currents analysis, node voltages analysis, solutions of linear nodal equations and circuit analysis using matrices, linearity and superposition, independent and dependent sources and their transformations, Thevenin's, Norton's, Millman's, Tellengen's, Reciprocity, Substitution and Maximum power transfer theorems, use of these theorems in circuit analysis, duality and concept of dual network, magnetically couples circuit analysis.

- **POLYPHASE UNBALANCED NETWORKS** **(08 Hours)**

  Analysis of polyphase circuits using Kirchoff's laws, analysis of unbalanced delta connected circuits, analysis of unbalanced three phase three wire and four wire star connected circuits., determination of neutral point potential and phase voltages for unbalanced star connected circuits, symmetrical components, its applications to the analysis of various polyphase unbalanced circuits.

- **LAPLACE TRANSFORMATION** **(08 Hours)**

  Laplace transform fundamentals, properties and theorems, unit step function, other unit functions, the impulse, ramp and doublet, Laplace transforms for shifted and singular functions, initial and final value theorems, waveform synthesis, Convolution integral.

- **AC AND DC TRANSIENTS** **(10 Hours)**

  Initial and final conditions of networks, R-L, R-C and R-L-C DC transients, two mesh transients, R-L, R-C and R-L-C sinusoidal transient analysis using Laplace transform methods, two mesh AC transients, complete response of RL, RC and RLC circuits to step, sinusoidal, exponential, ramp, impulse and the combinations of these excitations.

Total Hours: 55

BOOKS RECOMMENDED:

1. Hayt W. H., Kemmerly J. E, Durbin S. M., "Engineering Circuit Analysis", Tata McGraw Hill, 6th Edition, 2006.
2. Edminister Joseph A., "Electrical circuits", Schaum's outline series, McGraw hill, 2nd edition, 1983.
3. Van Valkenburg M.E., "Network Analysis", Prentice Hall, India, 3rd Edition, 2002.
4. Ghosh Samarjit, "Network Theory, Analysis & Synthesis", Prentice Hall, India, 2005
5. Wadhwa C.L., "Network Analysis & Synthesis", New Age International, Revised 3rd Edition, 2007.

B.Tech. (Electrical), Semester – III	L	T	P	C
EE203 : ELECTRICAL MACHINES - I	3	1	2	5

- **TRANSFORMERS** **(06 Hours)**
  Review of equivalent circuits and vector diagram, circuit parameter determination, per unit impedance, regulation, losses, efficiency, magnetic inrush and effect of saturation, parallel operation.

- **POLYPHASE TRANSFORMERS** **(11 Hours)**
  Standard connections, phase angle difference, harmonic analysis, open delta connection, Scott connections three phase to six phase conversion, three winding transforms, parallel operation.

- **AUTO TRANSFORMERS** **(02 Hours)**
  Construction, voltage and current ratios, phasor diagram and equivalent circuit.

- **TESTS ON TRANSFORMERS** **(04 Hours)**
  Polarity test, Back to back Sumpner's test.

- **INDUCTION MOTORS** **(08 Hours)**
  Review of equivalent circuit and vector diagram, performance analysis, torque-speed characteristics, no load and blocked rotor tests, circle diagram.

- **STARTING, BRAKING AND SPEED CONTROL** **(07 Hours)**
  Double cage motors, starting problems, methods of starting, speed control methods, cascade connections, cogging and crawling, regenerative braking, plugging, ac and dc dynamic (rheostatic) braking.

- **INDUCTION GENERATORS AND REGULATOR** **(03 Hours)**
  Principle of operation, performance analysis, application.

- **SINGLE PHASE INDUCTION MOTORS** **(04 Hours)**
  Principle of operation, revolving field theory, cross field theory, equivalent circuit and performance analysis, determination of circuit parameters by no- load and blocked rotor test, starting methods, unbalanced operation of three phase induction motor.

Total Hours: 45

PRACTICALS:

1. Determination of efficiency & regulation of single- phase transformer from Open circuit and short circuit test.
2. Determination of efficiency & regulation of single- phase transformer from Sumpner's test.
3. Scott connection of 1-phase transformers.
4. Open delta connection of three single-phase transformers.
5. Standard connections for three-phase transformer.
6. Load test on three-phase Induction Motor.
7. Load test on three-phase Induction Generator.
8. Determination of the equivalent circuit parameters from No-Load and Blocked rotor tests of three-phase Induction Motor.
9. Determination of the equivalent circuit parameters from No-Load and Blocked rotor tests of 1-phase Induction Motor.
10. Determination of the performance parameters of three-phase induction motor from circle diagram.
11. Induction regulator.
12. Unbalanced operation of three-phase Induction Motor.

BOOKS RECOMMENDED:

1. Say M. G., "The performance and design of alternating current machines", CBS Publishers and Distributors , Delhi, 1983.
2. Fitzgerald, Kingsley and Umans, "Electric Machinery":, TMH, New Delhi, 2003
3. Mukherjee and chakravorty, "Electrical Machines", Dhanpat Rai Pub., New Delhi, 2005.
4. Nagrath and Kothari, "Electric Machines", TMH, New Delhi, 2005.
5. Bimbhra P. S., "Electrical Machinery", Khanna Pub., Delhi, 1998
6. Taylor E. O., "Performance and Design of A.C. Commutator motor", A. H. Wheeler, Allahabad, 1990.

B.Tech. (Electrical), Semester – III	L	T	P	C
CE209 : SOLID & FLUID MECHANICS	4	0	0	4

SOLID MECHANICS

- **STRESSES AND STRAINS** **(06 Hours)**

  Concept of stresses and strains – Types of stresses – Hook's Law – Lateral strain – Poisson's ratio – Elongation due to own weight – Tapering sections – Varying cross sections – Composite sections – Relation between Modulus of Elasticity, Modulus of Rigidity and Bulk Modulus – Thermal Stresses.

- **SHEAR FORCE DIAGRAM AND BENDING MOMENT DIAGRAM** **(06 Hours)**

  Types of beams – Types of supports – Types of loads – Shear force – Bending moment – Sign convention – Overhanging beams – Point of contra-flexure – varying loads – Relation between SF and BM.

- **STRESSES IN BEAMS** **(06 Hours)**

  Theory of simple bending – Moment of Resistance – Beam of Uniform strength – Fletched beams – Shear stress concept – Derivation of shear stress – Shear stress Variation in rectangular, circular, T-section and I – section.

- **TORSION** **(05 Hours)**

  Basic theory of Torsion – Solid shaft – Hollow shaft – Power transmitted by shaft – Composite shafts.

- **MECHANICAL PROPERTIES OF MATERIAL** **(05 Hours)**

  Tensile Stress – Strain diagram for mild steel – Ductility of metal – Brittleness – Toughness – Hardness – Fatigue.

FLUID MECHANICS

- **FLUID PROPERTIES** **(03 Hours)**

  Scope of fluid mechanics, definition of fluid, fluid continuum concept, fluid properties and classification of fluids.

- **FLUID STATICS** **(05 Hours)**

  Fluid pressure at a point and its measurements, hydrostatic forces on plane and curved surfaces, buoyancy and floatation.

- **FLUID KINEMATICS** **(04 Hours)**

  Velocity field, classification of fluid flows based on space & time, one-D, two-D and three-D flows. Eulerian and Lagrangian approaches, stream lines, path lines and streak lines, stream tubes, continuity equation, translation, linear deformation, rotation and angular deformation of fluid element, vorticity, rotational and irrotational flow, circulation, velocity potential and stream functions, flow net and its characteristics, local, convective and substantial acceleration of fluid particles.

- **FLUID DYNAMICS** **(09 Hours)**

  Basic theory of Torsion – Solid shaft – Hollow shaft – Power transmitted by shaft – Composite shafts

- **FUNDAMENTALS OF LAMINAR FLOW AND TURBULENT FLOW** **(09 Hours)**

  Reynolds experiment, critical Reynolds number and its determination, boundary layer concept and development of laminar and turbulent flow, laminar flow through pipes and equation for head loss - Hagen-Poiseuille law, velocity distribution in smooth and rough turbulent flows, Darcy-Weisbach equation for turbulent flow through pipe, Moody's diagram in estimation of friction factor.

Total Hours: 57

BOOKS RECOMMENDED:

1. Timoshenko S & Young D H "Elements of Strength of Materials", Tata Mc Graw Hill, New Delhi, 2006
2. Ryder G H, "Strength of Material", English Language Book Society, New Delhi,2006
3. Bhavikatti S S "Strength of Materials", Vikas Publication House, New Delhi, 2007
4. Garde R. J. and Mirajgaoker A. G. "Engineering Fluid Mechanics", NemChand & Bros., Civil lines Roorkee, 2002.
5. Fox W.R. and McDonald, A.T., "Introduction to Fluid Mechanics", Wiley and Sons Inc., New York, 1998.
6. Asawa G L, "Fluid flow in pipes and channels", CBS Publishers, New Delhi.
7. Jain A K, "Fluid Mechanics including Hydraulic Machines", Khanna Publishers, New Delhi, 2000.
8. Streeter V.L., "Fluid Mechanics", McGraw Hill Book Company Ltd., New York. 2003

B.Tech. (Electrical), Semester – IV	L	T	P	C
ME212 : APPLIED THERMODYNAMICS AND THERMAL ENGINEERING	3	0	0	3

- **BASIC CONCEPTS OF THERMODYNAMICS** **(06 Hours)**

  Basic concepts of thermodynamics, system & surroundings, Heat and Work, Reversible and Irreversible process.

- **FIRST LAW OF THERMODYNAMICS** **(07 Hours)**

  The first law for a closed system undergoing a cycle and change of state, Internal energy, enthalpy, specific heat at constant volume and constant pressure. First law of thermodynamics for a control volume, Application of first law to boiler, turbines, compressors.

- **SECOND LAW OF THERMODYNAMICS** **(05 Hours)**

  Heat engines and refrigerators, statements of second law of thermodynamics, and corollaries.

- **INTERNAL COMBUSTION ENGINES** **(06 Hours)**

  Different types study of various systems like cooling, ignition, lubrication etc and numericals.

- **STEAM NOZZLE** **(05 Hours)**

  Different types – condition for maximum discharge – effect of friction-numericals.

- **STEAM TURBINES & CONDENSER** **(07 Hours)**

  Classification: - compounding – Rankin cycle- velocity triangles – blade efficiency, condition for maximum blade efficiency, Governing of turbine – losses in steam turbine – types of condenser – quantity of cooling water required for condenser & Condenser efficiency.

- **GAS TURBINE** **(04 Hours)**

  Different types, working of open & closed type gas turbine Methods used for improving efficiency of turbine.

- **HEAT TRANSFER** **(05 Hours)**

  Basic modes of Heat transfer, conduction in solids, thermal conductivity, Insulating materials, one dimensional steady state conduction problems, free and forced convection, laws of radiation.

Total Hours: 45

BOOKS RECOMMENDED:

1. Wylen Van, Sonntag & Borgnakke, “Fundamentals of Classical thermodynamics” 6th ed. John Wiley & Sons, New York 2003.
2. CENGEL Yunus A. & BOLES MICHAEL A., “Thermodynamics” 4th Ed., Tata Mc Graw Hill, New Delhi, 2004
3. Gorden Rogers & Yon Mayhew “Engineering Thermodynamics” 4th Ed., ADDISON WESLEY, 2004.
4. Simonson John, “Thermodynamics” 4th Ed., Mac Millan 1997.
5. Rajput, “Thermal Engineering”, Laxmi Publication, Dariya Ganj, New Delhi, Edition 2005.

B.Tech. (Electrical), Semester – IV	L	T	P	C
EC212: DIGITAL ELECTRONICS	3	0	2	4

- **NUMBER SYSTEMS AND CODES** **(05 Hours)**

  Addition, Subtraction, Multiplication and Division using Different Number Systems; Representation of Binary Number in Sign-Magnitude, Sign 1's Complement and Sign 2's Complement Notation; Rules for Addition and Subtraction with Complement Reprsentation; BCD, EBCDIC, ASCII, Extended ASCII, Gray and other Codes.

- **BOOLEAN FUNCTION AND ITS MINIMIZATION** **(06 Hours)**

  Simplification of Boolean Function using Boolean theorems; Canonical and Standard Forms(SOP and POS) for Boolean Functions; Objectives of the Minimization Procedures; Karnaugh Map Method;Don't Care Conditions;

- **COMBINATIONAL LOGIC CIRCUITS USING DISCRETE LOGIC GATES** **(10 Hours)**

  Half Adder and Full Adder; Half Subtractor and Full Subtractor; Parity Generator and Checker; Code Converters; Carry look ahead generator; Binary Multiplier; Majority Circuits, Magnitude Comparator.

- **COMBINATIONAL LOGIC USING MSI CIRCUITS** **(10 Hours)**

  Binary Parallel Adder; BCD Adder; Encoder, Priority Encoder, Decoder; Multiplexer and Demultiplexer Circuits; Programmable Logic Array (PLA) and Programmable Array Logic (PAL).

- **INTRODUCTION TO FLIP-FLOP CIRCUITS** **(06 Hours)**

  Basic Concepts of Sequential Circuits; Cross Coupled SR Flip-Flop Using NAND or NOR Gates; D-Type and Toggle Flip-Flops JK Flip-Flop & race Condition; Clocked Flip-Flops; Master Slave Configuration; Edge triggered D flip-flop; Elimination of Switch Bounce Using Flip-Flops; Flip-Flops With Preset and Clear.

- **SEQUENTIAL LOGIC CIRCUIT DESIGN & COUNTERS** **(08 Hours)**

  Sequential circuit; state table and state diagram; Design procedure; Basic Concepts of Counters and Registers; Shift Left and Right Register; Registers With Parallel Load; Serial-In-Parallel-Out(SIPO) and Parallel-In-Serial-Out(PISO); Register Using Different Type of Flip-Flops; Ripple(asynchronous) counters; Up Down and Mod-N ripple counters; Design of Synchronous Counter Using State Diagrams and State Table; BCD Counters; Modulo-N Counter; Up Down Counter; Ring counter; Johnson Counter, Sequence Generators

Total Hours: 45

Practical:

1. Half-Adder/Half-Subtractor Circuit using a select input.
2. Full -adder/Full-Subtractor circuit using a select input.
3. 4-Bit Gray to Binary/Binary to Gray code converter using a select input.
4. Logic expression with the help of MUX. IC 74153.
5. Flip-flops using NAND/NOR gate.
6. Modulo-7 ripple counter.
7. 4-bit shift left/right register.
8. Sequence generator.

BOOKS RECOMMENDED:

1. Morris Mano, “Digital Logic And Computer Design”, Prentice Hall Of India, 2005.
2. Jain and Anand : “Digital Electronics”, Practice Using Integrated Circuits, TMH, 2004
3. Charles Kime: “”Logic and Computer Design Fundamentals”, Pearson Education, 2004.
4. Sandige Richard, “Modern Digital Design”, McGraw-Hill, 1990.

B.Tech. (Electrical), Semester – IV	L	T	P	C
EE202 : NETWORK AND SYSTEMS	**4**	**1**	**0**	**5**

- **FOURIER SERIES AND TRANSFORM** **(11 Hours)**

  Dirichlet's conditions, Properties of Fourier series, Trigonometrical and complex exponential forms, the frequency spectra of periodic wave forms, plot of discrete magnitude and phase spectrum, Steady state response to periodic signals, Fourier transforms and its properties, application of Fourier transforms.

- **NETWORK FUNCTIONS AND TWO PORT PARAMETERS** **(11 Hours)**

  Poles and zeros of a function, physical and analytical concepts, terminals and terminal pairs, driving point immittances, transfer functions, restrictions on locations of poles and zeros in S-plane. time domain behavior from pole zero locations in the S plane, procedure for finding network functions for general two terminal pair network, transfer immitances, two port and N-port networks, Ladder, Lattice, Pie, and Tee networks. Definitions, calculations and interrelationships of impedance, admittance, hybrid, and transmission line parameters for two port networks and their interrelations

- **ONE TERMINAL PAIR NETWORKS** **(03 Hours)**

  Reactive networks and their properties, external and internal critical frequencies, separation property for reactive functions and its proof

- **TWO TERMINAL PAIR REACTIVE NETWORKS (FILTERS)** **(11 Hours)**

  Ladder network and its decomposition into tee, pie, and L sections, image impedance, image transfer function and applications to LC networks, attenuation and phase shift in symmetrical Tee and Pie networks, constant K-filters, m-derived filters, composite filters, , lattice filters, Bartlett's bisection theorem. Introduction to the active filters

- **SINUSOIDAL STEADY STATE ANALYSIS** **(08 Hours)**

  Radian frequency and sinusoid, magnitude and phase of network functions, sinusoidal network functions in terms of poles and zeros, resonant circuits, bandwidth and circuit Q, asymptotic change of magnitude and phase of network functions in light of poles and zeros, polar plots and Bode plots of network functions, analysis and applications of symmetrical lattice network.

- **SIGNALS AND SYSTEMS** **(12 Hours)**

  Continuous time and discrete time signals, periodic signals, even & odd signals, exponential and sinusoidal signals, Unit impulse and Unit step functions, Continuous time and Discrete time systems, Basic system properties, Discrete time LTI system, continuous time LTI system, properties of LTI systems, Causal LTI systems described by differential and Difference equations.

Total Hours: 56

BOOKS RECOMMENDED:

1. Van Valkenburg M.E., "Network Analysis", Prentice Hall, India, 3rd Edition, 2002.
2. Oppenheimetal Alan, "Signals & Systems", Prentice Hall India, 2nd Edition, 1998.
3. Edminister Joseph A., "Electrical circuits", Schaum's outline series, McGraw hill, 2nd edition, 1983.
4. Hayt W. H., Kemmerly J. E, Durbin S. M., "Engineering Circuit Analysis", Tata McGraw Hill, 6th Edition, 2006.
5. Wadhwa C.L., "Network Analysis & Synthesis", New Age International, Revised 3rd Edition, 2007.
6. Chakarabati A."circuit theory (analysis &synthesis)",Danpat Rai & Co.2004

B.Tech. (Electrical), Semester – IV	L	T	P	C
EE204 : ELECTRICAL MACHINES - II	3	1	2	5

- **DIRECT CURRENT MACHINES** **(09 Hours)**

  Construction, armature windings, simple lap and wave windings, armature reaction, demagnetizing and cross magnetizing ampere-turns, compensating winding, commutation, commutation time and type, reactance voltage, inter-poles, ampere-turns for inter-poles, self and separate excitations, shunt, series and compound motors and generators, magnetization characteristics, performance characteristics of DC generators and motors.

- **STARTING, SPEED CONTROL AND BRAKING OF DC MACHINES** **(06 Hours)**

  Starting problems, methods of starting, starters, methods of speed control, methods of braking.

- **ANALYSIS OF STEADY STATE PERFORMANCE OF DC MACHINE** **(03 Hours)**

  Losses and efficiency calculations.

- **TESTING OF DC MACHINES** **(04 Hours)**

  Swinburn's test, Hopkinson's test, separation of core losses, retardation test, series field test.

- **BRUSHLESS D.C. MACHINES** **(03 Hours)**

  Construction, equivalent circuit, performance analysis.

- **SYNCHRONOUS MACHINES** **(20 Hours)**

  Construction, cylindrical and salient pole type, basic principles, armature windings, distributed winding, full pitched windings, chording, EMF equation, distribution and pitch factors, excitation system, armature reaction, synchronous machine impedance, SCR, equivalent circuit, phasor diagram, voltage regulations, synchronous impedance method, MMF method, ZPF method, operating characteristics, 'V' and inverted 'V' curves, power angle characteristics, power flow equation for salient and non salient pole type synchronous machines, salient pole synchronous machine - two reaction model, phasor diagram, power angle characteristic, hunting, damper winding, parallel operation of alternators, starting methods of synchronous motors, synchronous condenser, synduction machines

Total Hours: 45

PRACTICALS:

1. Speed control of dc shunt motor.
2. Swinburn's test
3. Speed torque characteristic of a D. C. Shunt motor.
4. D. C. Series motor, Speed -torque characteristic.
5. External & Internal characteristics of D. C. separately excited and Shunt generator.
6. Regulation of an alternator by synchronous impedance method
7. 'V' and 'inverted v' curves of a synchronous motor.
8. Regulation of an alternator By zero power factor method
9. Synchronisation of an alternator with infinite busbar.
10. Power factor improvement using synchronous motor.
11. Hopkinson's Test on DC machines.
12. Retardation Test on DC shunt motor.

BOOKS RECOMMENDED:

1. Clayton A. E., "The performance and design of direct current machines", Pitman and sons, London, 1962.
2. Say M. G., "The performance and design of alternating current machines", CBS Publishers and Distributors, Delhi, 1983.
3. Fitzgerald, Kingsley and Umans, "Electric Machinery", TMH, New Delhi, 2003
4. Mukherjee and chakravorty, "Electrical Machines", Dhanpat Rai Pub., New Delhi, 2005
5. Nagrath and Kothari, "Electric Machines", TMH, New Delhi, 2005.
6. P. S. Bimbhra, "Electrical Machinery", Khanna Pub., Delhi, 1998.

B.Tech. (Electrical), Semester – IV	L	T	P	C
EE206 : COMPUTER APPLICATIONS FOR ELECTRICAL ENGINEERING	**3**	**1**	**2**	**5**

The topics given below shall be taught along with stress on computer programming in C language.

- **ERRORS** **(02 Hours)**
  Errors in Numerical Computation, their types and estimation.

- **SOLUTION OF TRANSCENDENTAL AND POLYNOMIAL EQUATIONS** **(08 Hours)**
  Bisection method, Secant Method, Newton Raphson method for Polynomial equation.

- **SOLUTION TO SYSTEM OF LINEAR ALGEBRAIC EQUATIONS** **(08 Hours)**
  Gauss elimination method, Gauss Jordon Method, Gauss Seidal Iteration method.

- **INTERPOLATION** **(10 Hours)**
  Linear interpolation and high order interpolation using Lagrange's and Newton Interpolation methods, Finite difference operators and difference tables.

- **NUMERICAL INTEGRATION** **(06 Hours)**
  Trapezoidal rule, Simpson's 1/3 and 3/8 rules.

- **SOLUTION TO ORDINARY DIFFERENTIAL EQUATIONS** **(10 Hours)**
  Taylor series, Euler's method, Euler's predictor corrector method, Runge Kutta method of Second and Fourth order.

Total Hours: 44

PRACTICALS:

Practice Exercises based on above syllabus.

BOOKS RECOMMENDED:

1. Shastri S. S., "Introductory Methods of Numerical Analysis", Prentice Hall Ltd., 1977.
2. Bajpai A. C., "Numerical Methods for Engineers and Scientists", John Wiley, 1977.
3. Salaria R. S., "Numerical methods : A computer oriented approach", BPB Publications, 1996.
4. Teukolsky, S. A., Vetterling, W. T. & Flannery, B. P., "Numerical recipes in 'C'", 2nd ed., Foundation Books Pvt. Ltd., 2001.
5. Balagurusamy E., "Numerical methods", Tata McGraw-Hill, New Delhi, 2002.

Sardar Vallabhbhai National Institute of Technology, Surat-395007

DEPARTMENT OF ELECTRICAL ENGINEERING

B.TECH.-III-ELECTRICAL TEACHING SCHEME (Revised)

(Effective from July-2013)

SEMESTER - V

Sr. No.	Course Code	Course	L	T	P	Credits	Examination Scheme				
			Hrs	Hrs	Hrs		Theory Marks	Tutorial Marks	Termwork Marks	Practical Marks	Total Marks
1	EE 301	Elements of Power Systems	3	1	2	05	100	25	20	30	175
2	EE 303	Control Systems	3	1	2	05	100	25	20	30	175
3	EE 305	Electrical Measurements	3	1	2	05	100	25	20	30	175
4	EE 307	Microprocessors & Micro Controllers	3	1	2	05	100	25	20	30	175
5	EE 3XX	EIS - I	3	0	0	03	100	-	-	-	100
		TOTAL	**15**	**4**	**08**	**23**	**500**	**100**	**80**	**120**	**800**
	TOTAL CONTACT HOURS		**27**								
	TOTAL CREDITS		**23**								

ELECTIVE INTERDISCIPLINARY SUBJECTS (EIS-I)

EE 303	Control Systems (For Non Electrical Students)
EE 311	Engineering Electromagnetics
EE 313	Power Station Practice
EE 315	Optimization Methods
EE 317	Special Electrical Machines

SEMESTER - VI

Sr. No.	Course Code	Course	L	T	P	Credits	Examination Scheme				
			Hrs	Hrs	Hrs		Theory Marks	Tutorial Marks	Termwork Marks	Practical Marks	Total Marks
1	EE 302	Microcontroller and Embedded System	3	1	2	05	100	25	20	30	175
2	EE 304	Power Systems Analysis	3	1	2	05	100	25	20	30	175
3	EE 306	Power Electronic Converters	3	1	2	05	100	25	20	30	175
4	EE 308	Instrumentation	3	1	2	05	100	25	20	30	175
5	EE 3XX	EIS - II	3	0	0	03	100	-	-	-	100
		TOTAL	**15**	**3**	**10**	**23**	**500**	**100**	**80**	**120**	**800**
	TOTAL CONTACT HOURS		**28**								
	TOTAL CREDITS		**23**								

ELECTIVE INTERDISCIPLINARY SUBJECTS (EIS-II)

EE 314	Industrial Automation and Process Control
EE 316	State Variable Analysis
EE 318	Energy Audit and Management
EE 322	Power System Planning and Management
EE 324	Power Quality Issues and Remedial Measures.

B.Tech. III (Electrical), Semester – V	L	T	P	C
EE 301 : ELEMENTS OF POWER SYSTEMS	3	1	2	5

- **SUPPLY SYSTEMS** **(04 Hours)**

  AC and DC power supply systems, comparison of ac and dc transmission, advantages of high transmission voltage, various systems of power supply, comparison of conductor materials in overhead system and underground cable system, economic choice of conductor size and economic choice of voltage.

- **D.C. AND A. C. DISTRIBUTION** **(06 Hours)**

  Types of dc distributors, dc distribution calculations, ac distributor, fed at one and fed at both the ends with concentrated loads and uniformly distributed loads, ring distributors with inter connectors, current distribution in three wire and four wire ac systems, overview of distribution automation.

- **MECHANICAL ASPECTS OF OVERHEAD LINES** **(08 Hours)**

  Main components of over head lines, conductor materials, line supports, insulators, types of insulators, potential distribution over suspension insulators, string efficiency, methods of improving string efficiency, corona, factors affecting corona, important terms, advantages and disadvantages of corona, sag in over head lines and sag calculations.

- **UNDERGROUND CABLES** **(05 Hours)**

  Underground cables, construction of cables, classification of cables, cables for three phase services, insulation resistance of a single core cable, capacitance of a single core cable, dielectric stresses in a single core cable, most economical conductor size in a cable, grading of cables, capacitance grading and inter-sheath grading, capacitance of three core cable and measurements of capacitances.

- **ELECTRICAL DESIGN OF OVERHEAD LINES** **(08 Hours)**

  Conductors, types of conductors in use, bundled conductor, spacing of conductors, symmetrical and unsymmetrical spacing, equivalent spacing, transposition, transmission line constants, calculation of resistance, inductance and capacitance for simple arrangements and multi-circuit lines, symmetrical and unsymmetrical spacing, concept of self GMD, mutual GMD and their uses in calculations of parameters of overhead lines, skin and proximity effects.

- **CHARACTERISTICS AND PERFORMANCE OF POWER TRANSMISSION LINES** **(08 Hours)**

  Short and medium transmission lines, Line performance, effect of capacitance, charging currents, short and medium lines, calculation by nominal-T, nominal-π and end-condenser method, regulation and efficiency, Concept of ABCD constants, the long transmission line- rigorous solution, evaluation of ABCD constants, interpretation of long line equation, surge impedance and surge impedance loading, the equivalent circuit of a long transmission line, power flow through a transmission line, circle diagrams, Ferranti effect.

- **ECONOMIC ASPECTS OF POWER SYSTEM** **(03 Hours)**

  Cost of Generation and Tariff, Power factor and its effect on system economy, Power factor improvement

Total Hours:42

REFERENCES:

1. W. D. Stevenson , “Element of Power System Analysis”, Mc Graw Hill, 1982.
2. Nagrath & kothari, “ Power System Engineering”, TMH publishing Company Ltd.
3. S.L.Uppal, “Electric Power”, Khanna Publisher, 1998.
4. A.Chakrabarti, M.L.Soni, P.V.Gupta, & U.S.Bhatnagar, “A Text Book on Power System Engineering”, Dhanpat Rai & Co., 2001
5. C.L.Wadhwa, “Electric Power System”, New Age International Ltd.
6. Ashfaq Hussain , “Electric Power System”, CBS Publisher & Distributors, 2000

B.Tech. III (Electrical), Semester – V	L	T	P	C
EE 303: CONTROL SYSTEMS	**3**	**1**	**2**	**5**

- **INTRODUCTION TO CONTROL SYSTEMS: (02 Hours)**

  Open loop control and close loop control; Illustrative examples of control systems.

- **MATHEMATICAL MODELS OF PHYSICAL SYSTEMS: (10 Hours)**

  Linear and non-linear systems; equations and transfer functions for linear mechanical translational systems and linear electrical network; Force-Voltage and Force-Current analogy; Block diagram representation of control systems; Block diagram reduction; Transfer functions of armature-controlled and field-controlled DC servomotors and 2-phase AC servomotors; Signal flow graph and Mason's gain formula.

- **TIME DOMAIN ANALYSIS OF CONTROL SYSTEMS: (06 Hours)**

  Typical test signals; Response of first-order systems; Transient response of a second order system due to step input; Time domain specifications of a second order system; Impulse and ramp response of second order system; Steady-state errors; Static error coefficients; Error series and dynamic error coefficients.

- **ROOT LOCUS TECHNIQUES: (06 Hours)**

  Basic Properties of Root Loci; Construction of Root Loci; Effects of Adding Poles and Zeros

- **CONCEPTS OF STABILITY: (02 Hours)**

  Introduction to stability, definition through impulse response function, asymptotic stability and relative stability, Routh-Hurwitz stability criterion.

- **FREQUENCY DOMAIN ANALYSIS OF CONTROL SYSTEMS: (08 Hours)**

  Steady state response of a system due to sinusoidal input; Frequency response; Logarithmic plots or Bode diagrams; Log-magnitude versus phase plots; Resonant peak and resonant frequency of a second order system; Polar plots; conformal mapping, principal of argument, Nyquist stability criterion, Stability analysis; Relative stability; Gain margin and phase margin; Closed loop frequency response.

- **DESIGN OF CONTROL SYSTEMS: (08 Hours)**

  Introduction to phase lag, phase lead and phase lag-lead networks and their applications. P, PI, PID Controllers.

Total Hours: 42

LIST OF EXPERIMENTS:

1. To obtain open loop and close loop transfer function for an oven.
2. To obtain transfer function of A.C. Servo Motor.
3. To obtain characteristics of Phase lead compensators
4. To obtain characteristics of Phase lag compensators.
5. To study the effect of change in damping factor on transfer function
6. To tune a system with PID controller.
7. a) To obtain time domain parameters of a second order electromechanical system using MATLAB Simulink. b) To obtain 1) Bode plot 2) Root locus 3) Nyquist plot using MATLAB.
8. To design a PID controller for a DC motor using MATLAB
9. To obtain transfer function of D.C Servo Motor.
10. Design a circuit to act as an inverter, summer and a scale changer using Op-amps.

REFERENCES:

1. Nagrath & Gopal, "Control system engineering", New Age International Publishers, 3rd Edition, 2001.
2. K. Oggata, "Modern control system engineering", Pearson Education Asia, 4th Edition, 2002.
3. B.C.Kuo, "Automatic control system", Prentice Hall of India, 7th Edition, 1995.
4. Richard C Dorf & Robert H Bishop, "Modern control system", Pearson Education Asia. 8th Edition, 2004.
5. Nise N. S. John willey & sons, "Control System Engineering", 4th Edition, 2004

B.Tech. III (Electrical), Semester – V	L	T	P	C
EE 305: ELECTRICAL MEASUREMENTS	**3**	**1**	**2**	**5**

- **STANDARDS** **(03 Hours)**

  Standards and their classification. Electrical Standards: EMF, current, resistance and capacitance standards

- **POTENTIOMETERS** **(04 Hours)**

  Construction, operation, standardization and application of DC and AC potentiometers, VR box.

- **MEASUREMENT OF RESISTANCE** **(06 Hours)**

  Classification of resistances, Kelvin's double bridge, Whetstone's bridge, Carey Foster's bridge, direct deflection method and loss of charge method for measurement of insulation resistance, meg-ohm bridge, measurement of surface resistivity, earth résistance.

- **MEASUREMENT OF INDUCTANCE AND CAPACITANCE** **(07 Hours)**

  General four arm AC bridge network, Maxwell, Hay, Anderson, Schering and Wien bridge networks, Wagner earthling device, headphone and vibration galvanometer as detector

- **MAGNETIC MEASUREMENTS** **(06 Hours)**

  Theory and calibration of ballistic galvanometer; use of it for measurement of flux, Grassot flux meter, Hall effect devices for measurement of flux, measurement of iron loss by wattmeter method, Hibbert magnetic standard.

- **INDICATING AND INTEGRATING INSTRUMENTS** **(09 Hours)**

  Classification, operating principles, general construction details of indicating instruments, balancing, control and damping method, theory and construction of PMMC, moving iron electrostatic and rectifier instruments, measurement of high voltage AC and DC and impulse voltage, electrodynamics wattmeter , induction energy meter

- **INSTRUMENT TRANSFORMERS** **(07 Hours)**

  Theory of current and voltage transformer, ratio error and phase angle ,burden, turns compensation performance characteristics , testing and applications of CT and PT

Total hours: 42

LIST OF EXPERIMENTS:

1. Kelvin's Double Bridge
2. Anderson Bridge
3. Calibration of voltmeter using Potentiometer
4. Schering Bridge
5. Calibration of 1-phase energy meter
6. Calibration of 3phase energy meter
7. Current Transformer Testing using Biffi's method
8. Lloyd fisher square

REFERENCES:

1. Golding and Widdis, "Electrical measurements & Measuring instruments", Wheeler books, 5th edition
2. A. K . Sawhney, "Electrical and electronic Measurements and Instrumentation", Dhanpat Rai & co.,17th edition
3. R. K. Rajput, "Electrical and Electronic Measurements and Instrumentation", S. Chand & Company Ltd., 1st Edition.2008.

B. Tech.III (Electrical), Semester – V	L	T	P	C
EE 307: MICROPROCESSORS & MICRO CONTROLLERS	**3**	**1**	**2**	**5**

- **REVIEW OF DIGITAL LOGIC CONCEPTS (02 Hours)**

  Number systems, gates & De-Morgan's equivalents, 3-state logic gates, flip-flops, buffers, decoders, encoders, multiplexers, de-multiplexers.

- **MICROPROCESSOR SYSTEM ARCHITECTURE (06 Hours)**

  Introduction, Registers, concept of address and data buses, system control signals, basic bus timing, memory (RAM, ROM), input output devices, Microcomputer systems, over view of 8-16-32 bit microprocessors family.

- **INTRODUCTION TO 8085A MICROPROCESSOR ARCHITECTURE (05 Hours)**

  Introduction to 8085A, pin diagram and pin description, bus timing and instruction timing, de-multiplexing of buses, generation of control signals, concept of interrupts.

- **MEMORY INTERFACING WITH 8085A (04 Hours)**

  Different types of memory, memory map, address decoding scheme for different memory, memory timings.

- **INPUT OUTPUT DEVICES INTERFACING WITH 8085A (04 Hours)**

  Basic interfacing concepts**,** peripheral I/O interfacing and memory mapped I/O interfacing, interfacing of 7 segment LED display, keys, relays, interfacing of programmable devices like 8255, 8254.

- **THE 8051 MICROCONTROLLER ARCHITECTURE (08 Hours)**

  Introduction, 8051 family microcontrollers, hardware architecture, input/output pins, I/O ports and circuits, on chip ram ,general purpose registers ,special function registers, timers-counters, concepts of interrupts.

- **ASSEMBLY LANGUAGE PROGRAMMING OF 8051 (13 Hours)**

  Concept of IDE (assembler, compiler, linker, de-bugger), addressing modes, data move instructions, arithmetic and logical instructions, jump, loop and call instructions, concepts of subroutines, interrupt service routine.

Total hours: 42

LIST OF EXPERIMENTS:

1. Addition and subtraction of bytes
2. Memory Block Movements (Forward, reverse, overlapping)
3. Operation on arrays
4. Multiplication and Division of Signed and Unsigned Numbers
5. Ascending and descending arrangement of data string.
6. Code conversion. (Hexadecimal, BCD, Binary, ASCII etc.)
7. Interrupt driven real time clock with 8085 (combination of interrupt, timer)
8. Program exercises based on delay and subroutines.
9. Program exercises based on 8255 peripheral.

References:

1. R.S.Gaonker, "Microprocessor Architecture, programming, and application", wiley eastern limited
2. Kenneth J. Ayala, "The 8051 Microcontroller", Penram International 3rd edition
3. M. Mazidi and others, "The 8051 Microcontroller and Embedded Systems", PRENTICE Hall Of India, 3rf edition
4. Michael slater, "Microprocessor based Design", PRENTICE Hall Of India, 3rd edition
5. Badri Ram, "Fundamentals of microprocessors and microcomputers", Dhanpat Rai.

B.Tech. III, Semester – V	L	T	P	C
EE 311: ENGINEERING ELECTROMAGNETIC	**3**	**0**	**0**	**3**

- **VECTOR ANALYSIS:** **(06 Hours)**

  General Treatment on Cartesian, cylindrical, spherical and general curvilinear co-ordinate systems with reference to vectors, operation of gradient, divergence, curl, Laplacian., Gauss's Divergence theorem, Stoke's theorem.

- **ELECTROSTATICS:** **(10 Hours)**

  Review of electric field quantities and their definitions. Gauss's flux theorem, Poisson's Equation and Laplace Equation, uniqueness theorem, Green's theorem, Coulomb's law, dipole moment. Electrostatic Field in Dielectric: Polarization, electric flux density, boundary conditions, capacitor and capacitance, electrostatic shielding, energy stored in electric fields.

- **MAGNETIC FIELDS AND ELECTROMAGNETIC INDUCTION:** **(10 Hours)**

  Magnetic flux and flux density, static currents in conducting media, Ampere's law, Biot-Savart law, boundary between magnetic media, forces between currents, magnetic potenrials, magnetic torque and moment, Dipole, Energy stored in magnetic field. Faraday's law of induction (transformer and motion), Inductor and Inductances (self and mutual).

- **MAXWELL'S EQUATIONS & ELECTROMAGNETIC WAVES:** **(10 Hours)**

  Maxwell's equations - Equation of continuity - Displacement current - Maxwell's equation in point and integral forms ,Time-varying potentials, wave equations, plane waves in Losses Dielectrics, Free space & Good conductors, Poynting vector and Theorem.

- **TRANSMISSION LINES:** **(06 Hours)**

  Line equations, input impedance, SWR and power, smith chart, some applications of Transmission lines.

Total hours: 42

REFERENCES:

1. William H. Hayt,"Engineering Electromagnetices", Mc-Graw Hill, Eleventh edition ,1998.
2. Matthew N.O. Sadiku, "Element of electromagnetics Electromangnetics", Oxford University Press, 3rd edition, 2003.
3. N. Rao, "Elements of Engineering Electromagnetics", Prentice Hall.
4. Joseph A. Edminister, "Theory and Problems of Electromangnetics", McGraw Hill.
5. Fawwaz T. Ulaby, "Electromangnetics for engineers", pearson education ,first Indian reprint ,2005.

B.Tech. III, Semester – V	L	T	P	C
EE 313: POWER STATION PRACTICE	3	0	0	3

- **STEAM POWER STATION** **(04 Hours)**

  Main flow circuits of thermal power station, thermodynamic cycles of steam flow, general layout of power stations, power station auxiliaries, cooling system of alternators, flue gas flow arrangement, circulating water system, cooling tower.

- **HYDROELECTRIC POWER PLANT** **(06 Hours)**

  Selection of site, water power equations, types of dams, arrangement and layouts of hydroelectric station, classification of plants, water turbines, properties of water wheels, specific speed on the basis of discharge, combined steam and hydro plants, pumped storage hydro station.

- **NUCLEAR POWER STATION** **(07 Hours)**

  Atomic structure, isotopes, energy release by fission, chain reaction, atomic reactor, fuels, moderators and coolants, types of reactors, fast breeder reactor, radioactivity and hazards.

- **DIESEL AND GAS TURBINE STATION** **(06 Hours)**

  Field of use, general layout and principle of operation.

- **NON CONVENTIONAL METHOD OF POWER GENERATION** **(06 Hours)**

  MHD generation, wind power, tidal power, solar power, solar cell, and fuel cell.

- **COMBINATIONS OF DIFFERENT TYPES OF POWER PLANTS** **(10 Hours)**

  Types of power station, advantages of combined working of different types of power station, need for coordination of different types of power station, run-off river plant in combination with steam plant, hydro-electric plants with ample storage in combination with steam plants, pumped storage plant in combination with ordinary hydro-electric plant, co-ordination of hydro-electric and gas turbine plant, co-ordination of hydro-electric and nuclear power station, co-ordination of different types of power plants in power station.

- **POWER STATION CONTROL** **(03 Hours)**

  Excitation systems, excitation control, field protection, commissioning of alternators, power supply for station auxiliaries, power station control.

Total Hours: 42

REFERENCES:

1. Arogyaswamy, “Power Station Practice”, Oxford & IBM Pbs Co., New Delhi.
2. Baptidanov L., “Power Station & Substation”, Moscow Peace Pbs.
3. Leznov S. & Taits, “Power Station & Substation Maintenance”, Moscow Mir Pbs, 1983.
4. Leznov S. & Taits, “Power Station Electrification”, Moscow Mir Pbs, 1983.
5. Bruce, John, London, “Power Station Efficiency Control”, Sir Issac Pitman & Sons Ltd., 1926.
6. Skrotzki B. G. A., Vopat W. A., “Power Station Engineering & Economy”, New Delhi TataMc Graw Hill Pbs. Co. 1960.

B.Tech. III, Semester – V	L	T	P	C
EE 315: OPTIMIZATION METHODS	3	0	0	3

- **MATHEMATICAL PRELIMINARIES** **(04 Hours)**

  convex sets, intersection of convex sets, vertices or extreme points of a convex set, convex polyhedron, hyper-planes, closed and open half space, convex functions, Local & Global Maxima and Minima. Saddle point, Unconstrained optimization- First and second order necessary and sufficient conditions.

- **LINEAR PROGRAMMING** **(12 Hours)**

  Standard form, Geometry of LP problems, Definitions and theorems, formulation of LP problems, graphical representation and solution of LP in two-dimensional space. Feasible, Basic Feasible and Optimal solutions, pivotal reduction of a set of linear equations, slack and surplus variables, Simplex method and algorithm, two phase method, degeneracy, Big M method. Duality in linear programming, duality theorems. Integer Linear programming graphical representation, Gomory's cutting plane method for all Integers programming problem.

- **TRANSPORTATION AND ASSIGNMENT PROBLEM** **(06 Hours)**

  Description, finding initial basic feasible solution, test for optimality, new Basic solution. Assignment Problem and its solution.

- **SINGLE VARIABLE OPTIMIZATION ALGORITHMS** **(06 Hours)**

  Optimality Criteria- Unimodal function-Bracketing Methods-Region-Elimination Methods- Fibonacci & Golden section search –Gradient Based Methods:-Newton-Raphson method, Bisection Method, Secant Method .

- **MULTIVARIABLE OPTIMIZATION ALGORITHMS:** **(07 Hours)**

  Optimality Criteria-Unidirectional Search- Direct Search Methods- Hooke-Jeeves pattern method-Powell's conjugate direction method.
  Gradient Based Methods: Steepest Descent method-Newton's Method-Conjugate Gradient Method-Quasi-Newton method.

- **CONSTRAINED OPTIMIZATION ALGORITHMS:** **(07 Hours)**

  Direct Substitution-Lagrange Multiplier Method-Kuhn-Tucker Conditions- Frank and Wolfe method. Cutting plane method.

Total Hours: 42

REFERENCES:

1. David G Luenberger, "Linear and Non Linear Programming", 2nd Ed, Addison-Wesley Pub. Co., Massachusetts, 1973.
2. W. L. Winston, "Operation Research-Applications & Algorithms", Thomson publications, 2003.
3. S. S. Rao, "Engineering Optimization", 3rd Ed., New Age International (P) Ltd, New Delhi,2004
4. W. F. Stoecker, "Design of Thermal Systems", 3rd Ed., McGraw Hill, 1989.
5. G. B. Dantzig, "Linear Programming and Extensions", Princeton University Press, 1963.
6. L. C. W. Dixton, "Non Linear Optimization: theory and algorithms", Birkhauser, Boston, 1980
7. Bazarra M. S, Sherali H.D. & Shetty C.M., "Nonlinear Programming Theory and Algorithms", John Wiley, New York,1979.
8. Kalyanmoy Deb, "Optimization for Engineering Design-Algorithms and Examples", Prentice Hall India-1998

B.Tech. III (Electrical), Semester – V	L	T	P	C
EE 317: SPECIAL ELECTRICAL MACHINES	**3**	**0**	**0**	**3**

- **SERVO MOTORS** **(06 Hours)**

  Symmetrical components applied to two - phase servo motors - equivalent circuit and performance based on symmetrical components - servo motor torque - speed curves.

- **VARIABLE RELUCTANCE MACHINES** **(07 Hours)**

  Basics of VRM analysis, Practical VRM configurations, current waveforms for torque production, non-linear analysis.

- **STEPPER MOTORS** **(07 Hours)**

  Construction features - method of operation - drive - amplifiers and transistor logic - half stepping and the required switching sequence - the reluctance type stepper motor - ratings and other characteristics.

- **RELUCTANCE MOTORS** **(02 Hours)**

  General - types of synchronous motors - reluctance - motors - definitions - construction - polyphase and split phase reluctance motors - capacitor type reluctance motors.

- **HYSTERISIS MOTORS** **(02 Hours)**

  Construction - polyphase - capacitor type and shaded pole hysteresis motors.

- **UNIVERSAL MOTORS** **(03 Hours)**

  Application and torque - characteristics - essential parts of universal motor.

- **LINEAR MACHINES** **(08 Hours)**

  Basic difference between LEMS and rotating - machine - classification of LEMS, linear motors and levitation machines - linear induction motors - linear synchronous motors - DC linear motors - linear levitation machines.

- **PMDC MOTORS** **(02 Hours)**

  Construction, principle of operation, performance analysis.

- **BRUSHLESS DC MOTORS** **(05 Hours)**

  Construction, principle of operation, phasor diagram, characteristics, performance analysis.

Total Hours: 42

REFERENCES:

1. Toro. V. D, “Electric machines and power systems”, Prentice Hall of India, 1985.
2. Veinott, “Fractional horse power electric motors”, Mc Graw Hill, 1948
3. Nasar. S. A, Boldeal, “Linear Motion Electric machine”, John Wiley,1976
4. Athani, “Stepper Motors”, New Age International Pub., 1997
5. Fitzgerald, Kingsley & Umans, “Electric Machinery”, TMH, 2003
6. Kothari & Nagrath, “Electric Machines”, TMH, 2004

B.Tech. III (Electrical), Semester – VI	L	T	P	C
EE 302 : MICROCONTROLLERS AND EMBEDDED SYSTEMS	3	1	2	5

- **REVIEW OF 8051 ARCHITECTURE (05 Hours)**

  General purpose registers, on-chip RAM, timers-counters, special function registers, 8051 interrupt system, input/output ports and circuits

- **ADDITIONAL FEATURES OF 8051 ARCHITECTURE (08 Hours)**

  UART, concept of SPI & I2C serial interface, programmable counter array (PCA), PWM signal generation, watchdog timers.

- **INTRODUCTION TO EMBEDDED 'C' PROGRAMMING (05 Hours)**

  Variables and constants, storage classes, enumerations and definitions, I/O operations, control statements, functions, pointers and arrays, structure and unions, interrupt service routines.

- **INTERFACING AND PROGRAMMING OF 8051 WITH EXTERNAL HARDWARE (07 Hours)**

  External memory, ADC and DAC, matrix keyboard, LCD, 7 segment display.

- **INTRODUCTION TO 32-BIT TO ARM PROCESSOR ARCHITECTURE (05 Hours)**

  32-Bit Arm 7 and Cortex M-3 core, Harvard and Von-Neuman Architecture, AHB and Bus Matrix, Register Structure

- **INTRODUCTION TO EMBEDDED SYSTEMS (03 Hours)**

  Embedded systems description, definition, design considerations & requirements, embedded processor selection & tradeoffs, embedded design life cycle, product specifications, hardware/software partitioning, Co-Design concept..

- **EMBEDDED SOFTWARE ARCHITECTURE (06 Hours)**

  Concept of real time systems, concept of real-time task scheduling, scheduling methods, and introduction to real time operating systems (RTOS).

- **APPLICATIONS OF EMBEDDED SYSTEMS (05 Hours)**

  Measurement of analog and electrical variables, control of electrical devices, user interface in embedded systems, data communication in embedded systems.

Total Hours:43

LIST OF EXPERIMENTS:

1 Timer driven clock
2 Study of External Hardware Interrupts
3 Measurement of frequency of External waveform
4 Parallel A/D & D/A Converter
5 Study of high speed A/D Converter
6 Study of Synchronous Serial Protocol (I^2C & SPI)
7 Interfacing of Stepper Motor
8 Interfacing of PMDC Motor
9 Firing of Traic
10 Measurement of Electrical Quantity.
11 A Synchronous Serial Communication (UART)

REFERENCES:

1. Kenneth J. Ayala, "The 8051 Microcontroller", Penram International 3rd edition
2. M. Mazidi and others, "The 8051 Microcontroller and Embedded Systems", PRENTICE Hall Of India, 3rd Edition
3. David Seal, "ARM Architecture Reference Manual"
4. Trevor Martin, "The Insider's Guide To The Philips ARM7-Based Microcontrollers", Published by Hitex (UK) Ltd., April 2005.
5. Barnett & others, "Embedded C Programming and Microchip PIC", Thomson Learning Inc. , 1st Edition
6. David E. Simon, "An Embedded Software Primer" , Addision Wesley Pearson Education, 1999.

B.Tech. III (Electrical), Semester – VI	L	T	P	C
EE 304 : POWER SYSTEMS ANALYSIS	3	1	2	5

- **REPRESENTATION OF POWER SYSTEM COMPONENTS (04 Hours)**

  Introduction, single phase solution of balanced three phase networks, the one line diagram and the impedance or reactance diagram, per-unit (pu) system, complex power, synchronous machine, representation of loads.

- **REVIEW OF SYMMETRICAL COMPONENTS AND ITS APPLICATION TO POWER SYSTEM (05 Hours)**

  Symmetrical component transformation, phase shift in star-delta transformers, sequence impedance of transmission lines, sequence impedance and sequence network of power system, sequence impedance and network of synchronous machine, sequence impedance of transmission lines, sequence impedance and networks of transformers, construction of sequence networks of power systems.

- **SYMMETRICAL FAULT ANALYSIS (05 Hours)**

  Introduction, transient on a transmission line, short circuit of a synchronous machine on no load, short circuit of a loaded synchronous machine, balanced three phase fault, short circuit capacity, fault analysis using bus impedance matrix, selection of protective equipments.

- **UNSYMMETRICAL FAULT ANALYSIS (08 Hours)**

  Symmetrical component analysis of unsymmetrical faults, single line to ground (LG) fault, line to line (LL) fault, double line to ground (LLG) fault, open conductor faults, bus impedance matrix method for analysis of unsymmetrical faults.

- **POWER SYSTEM STABILITY (08 Hours)**

  Introduction, dynamics of a synchronous machine, power angle equation, power angle curve, simple systems, steady state stability, transient stability, equal area criteria, numerical solution of swing equation, some factors affecting transient stability.

- **POWER SYSTEM TRANSIENTS (06 Hours)**

  Types of system transients, factors affecting transients, reflection and refraction of traveling waves at different line termination, surge impedance, transient over voltages due to lightning, theory of ground wires, direct stroke to a tower, capacitive switching, kilometric fault, ferro-resonance, protection of power systems against transients and insulation coordination

- **INTRODUCTION TO HVDC AND FACTS (06 Hours)**

  Kinds of HVDC links, Asynchronous and synchronous links, limitations and advantages of HVDC links, converters, Basics of FACTS controllers and different configurations.

Total Hours:42

LIST OF EXPERIMENTS:

Simulations based on different types of faults, stability and transients using MATLAB and ETAP.

REFERENCES:

1. G.W. Stagg & A. H. EI-Abaid, “Computer methods in Power System Analysis”, McGraw Hill, New York.
2. W. D. Stevenson , “Element of Power System Analysis”, Mc Graw Hill, 1982.
3. Nagrath & kothari, “ Power System Engineering”, TMH publishing Company Ltd.
4. C.L.Wadhwa, “Electric Power System”, New Age International Ltd.
5. C. S. Indulkar and D P Kothari, “Power System Transients, A Statistical Approach”, Prentice Hall of India Pvt Ltd., New Delhi.
6. N. G. Hingorani, J Gyugi, “Understanding FACTS”, IEEE Press.
7. K. Bhattacharya, MHT Bollern and J. C. Doolder, “Operation of Restructured Power Systems”, Kluwer Academic Publishers, USA, 2001.

B. Tech.III (Electrical), Semester – VI	L	T	P	C
EE 306 : POWER ELECTRONIC CONVERTERS	**3**	**1**	**2**	**5**

- **INTRODUCTION** **(06 Hours)**

  Power Electronics Scope and Applications, Interdisciplinary Nature of Power Electronics, Types of power electronics circuits, Thyristor Characteristics, Two transistor analogy, Gate Characteristics, Methods of triggering and commutation, Ratings and protection of devices, Introduction to power electronic devices like Power BJT, MOSFET, GTO, IGBT, MCT etc.

- **PHASE CONTROLLED RECTIFIERS** **(12 Hours)**

  Principle of phase control, half wave controlled rectifiers, half wave controlled rectifiers with R, R-L, R-L-E load, single phase full wave controlled converters, 2-pulse mid-point converters, 2-pulse half and fully controlled bridge converters with R, R-L, R-L-E load, Three phase converter system with diodes, 3 phase half and fully controlled bridge converters, triggering scheme, Effect of source impedance on the performance or the converters, Dual converters.

- **CHOPPERS** **(08 Hours)**

  Basic principle of chopper operation, Control strategies – Duty Ration Control and Frequency Control, Types of idealized chopper circuits, Steady state time domain analysis of Type A choppers, Step up chopper.

- **INVERTERS** **(10 Hours)**

  Forced commutated inverters, Single phase voltage source inverters, Half bridge inverters, full bridge inverters, Steady state analysis, Voltage control in single phase inverters, 3-phase bridge inverters, Pulse width modulated inverters, Reduction of harmonics in Inverter.

- **AC VOLTAGE CONTROLLERS** **(08 Hours)**

  Principle of AC Voltage Controllers – Integral Cycle Control and Phase Control, Types of AC voltage controllers, Analysis of 1-phase Integral Cycle Control AC controllers with R load, Analysis of 1-phase Phase Control AC controllers with R and R-L load.

Total Hours: 44

LIST OF EXPERIMENTS:

1. Study Of Igbt, Mosfet, Scr, Triac, Diac Characteristics.
2. Study Of Different Scr Triggering Circuit Trainer – Dc, R, R-C, Ujt.
3. Study Of Single Phase Half Controlled Bridge Converter With R, R-L Load.
4. Study Of Single Phase Fully Controlled Bridge Converter With R, R-L Load.
5. Study Of Single Phase Scr Full Bridge Inverter Circuit.
6. Study Of High Voltage Thyristorised Chopper
7. Study Of Single Phase Ac Voltage Controller Using Scr.
8. Study Of Single Phase Ac Voltage Controller Using Triac.
9. Study Of Single Phase Dual Converter Circuit.
10. Study Of Scr Dc Circuit Breaker Circuit.
11. Study Of Three Phase Scr Triggering Circuit Using Tca785 Ic.
12. Study Of Ac Solid State Relay Using Ic 555, Opto Coupler & Triac.
13. Simulation Of Power Ec CIRCUITS IN PSIM AND SIMULINK.

REFERENCES:

1. Bimbhra, P. S., "Power electronics", Khanna Publishers, New Delhi, 2001.
2. Rasid, M. H., " Power Electronics Circuits, Devices, and Applications, Prentice-Hall of India Pvt. Ltd., New Delhi, 2nd edition, 1999.
3. Singh, M. D., Khanchandani, K. B., "Power electronics", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2001.
4. Ned Mohan, Tore M. Undeland and William P. Robbins, “Power Electronics Converters, Applications, and Design”, John Willey & Sons, Inc., 2nd Edition, 1995.
5. Agrawal, J. P., "Power electronic systems: Theory and design" Addison Wesley Longman (Singapore) Pte. Ltd. New Delhi, 2001.

B.Tech.III (Electrical), Semester – VI	L	T	P	C
EE 308 : INSTRUMENTATION	3	1	2	5

- **PERFORMANCE AND CHARACTERISTIC OF MEASUREMENT SYSTEMS (06 Hours)**

  Elements of generalized measurement system, input-output configuration of instruments and measurement systems, methods of correction for interfering and modifying inputs, static performance characteristics of measurement system, noise, signal to noise ratio, errors in measurement

- **TRANSDUCERS (08 Hours)**

  Classification of transducers, passive transducers: resistive, inductive and capacitive transducers, active transducers: thermocouple, piezoelectric transducer, taco-generator, pH cell, basic signal conditioning circuits for transducers.

- **ELECTRONIC METERS AND OSCILLOSCOPE (07 Hours)**

  DC amplifier voltmeter, AC voltmeter using rectifiers, true RMS responding voltmeter, Hall effect wattmeter, Oscilloscope block diagram, CRT and its circuits, vertical deflection systems, delay line, multiple trace, horizontal deflection system, oscilloscope probes. Special Oscilloscopes: Sampling oscilloscope, storage oscilloscope

- **OPERATIONAL AMPLIFIER FUNDAMENTALS (04 Hours)**

  Operational Amplifier, Basic Op-Amp Configuration, An Op-Amp With Negative Feedback, Voltage Series And Voltage Shunt Configurations, Difference Am plifiers,
  Specification Of An Op-Amp, Offset Voltages And Currents, CMRR, Slew Rate

- **LINEAR APPLICATIONS OF OPERATIONAL AMPLIFIERS (06 Hours)**

  Summing, Scaling And Averaging Amplifiers, Voltage To Current Converter With Floating And Grounded Load, Current To Voltage Converter, Integra tor And Differentiator, Instrumentation Amplifier

- **NON-LINEAR APPLICATIONS OF OPERATIONAL AMPLIFIERS (06 Hours)**

  Schmitt Trigger, Voltage Comparator, Voltage Limiters And Window Detector, Clippers And Clampers, Peak Detector, Precision Rectifiers, Analog Switches

- **TEST INSTRUMENTATION (07 Hours)**

  High voltage oil testing equipment, H.V. breakdown tester and its applications, insulation tester and its applications, calibration and traceability of instruments: calibration of energy meter, oscilloscope, localization of cable faults: loop testing and time domain pulse echo technique.

Total Hours:44

LIST OF EXPERIMENTS:

1. Calibration of LVDT
2. Instrumentation Amplifier and Measurement of temperature using Thermocouple
3. Measurement of liquid level
4. LCR-Q Meter
5. Strain Gauge
6. High voltage oil Testing
7. CRO and Function generator
8. Localization of cable fault
9. Zero Crossing Detector
10. Inverting & Non-Inverting Amplifier
11. Summing, Scaling & Averaging Circuits
12 Integrator & Differentiator
13. Active Filters
14. Application of Timer IC 555
15. Voltage Regulator

REFERENCES:

1. A. K . Sawhney, “Electrical and electronic Measurements and Instrumentation”, Dhanpat Rai & co.,17th edtion
2. Gayakwad Ramakant, “Op-Amps And Linear Integrated Circuits” , PHI, 3rd Ed., 1993
3. Helfrick A D; Cooper W. D., “Modern electronic Instrumentation and Measurement techniques”, PHI ,Edition 1997
4. Rangan; Sarma; Mani, “Instrumentation devices and systems”,TMH, 2nd edition
5. Doebelin E.O, “Measurement Systems - Application and Design”, Fourth edition, McGraw-Hill, New York, 1992
6. Coughlin and Driscol, “Op-Amps And Linear Integrated Circuits”, PHI, 5th Ed., 1998

B.Tech. III, Semester – VI	L	T	P	C
EE 314 : INDUSTRIAL AUTOMATION AND PROCESS CONTROL	**3**	**0**	**0**	**3**

- **INTRODUCTION OF INDUSTRIAL PROCESSES** **(04 Hours)**
  Process with analog variables , discrete state sequential process, hybrid process, overview of automation

- **SENSORS** **(06 Hours)**
  Mechanical sensors: strain ; motion; pressure ; flow: Thermal sensors: RTD; thermisors ;thermocouple Optical sensors: photo detectors ;pyrometers; optical sources

- **ACTUATORS** **(05 Hours)**
  Final control operation :signal conversions ;actuators ;control elements, signal conversions: analog electrical signals; digital signals; pneumatic signals, actuators: electrical ;pneumatic ;hydraulic, fluid valves : control valve principle ;types ;sizing

- **CONTROL SYSTEM CONFIGURATIONS** **(05 Hours)**
  Feedback control, Feed Forward Control, Ratio Control, cascade Control, over-ride control, optimizing control system

- **CONTROLLER PRINCIPLES** **(06 Hours)**
  Controller modes, electronic controller, pneumatic controller, digital controllers, controller software.

- **PROGRAMMABLE LOGIC CONTROLLERS** **(12 Hours)**
  Advantages & disadvantages of PLC with respect to relay logic, PLC architecture, Input Output modules, PLC interfacing with plant, ladder diagram

- **CASE STUDY OF INDUSTRIAL AUTOMATION** **(04 Hours)**
  Boiler, conveyor belt system, Heat Exchanger

Total Hours:42

REFERENCES:

1. JOHN WEBB, “Programmable Logic Controllers Principles & applications”, PHI
2. T. A. HUGHES, “Programmable Controllers”
3. C. D. JOHNSON, “Process Control Instrumentation Technology” fourth edition, PHI.
4. ANDREWS, “Applied Instrumentation in Process Industries” (Volume-IV)
5. D. PATRANABIS, “Principles of Process Control”, TMH
6. LIPTAK, “Process Control”
7. S. K. Singh, “Computer aided process control”, PHI

B.Tech. III (Electrical) Semester-VI	L	T	P	C
EE 316: STATE VARIABLE ANALYSIS	3	0	0	3

- **MATHEMATICAL BACKGROUND-MATRICES: (03 Hours)**

  Definition of Matrices; Matrix Algebra; Matrix Multiplication and Inversion; Rank of a Matrix; Differentiation and Integration of Matrix.

- **STATE SPACE ANALYSIS OF CONTROL SYSTEMS: (16 Hours)**

  State Variables; State-Space Representation of Electrical and Mechanical and Electromechanical Systems; State Space Representation of Nth Order, Linear Differential Equation; Transformation to Phase Variable Canonical Form; Relationship Between Transfer Functions and State Equations; Characteristic Equation; Eigen Values and Eigen Vectors; Transformation to Diagonal Canonical Form; Jordan Canonical Form.

- **SOLUTION OF THE TIME-INVARIANT SYSTEMS: (06Hours)**

  Solution of the Time-Invariant State Equation; State Transition Matrix and its Properties; Transfer Matrix; Transfer Matrix of Closed Loop Systems.

- **CONTROLLABILTY AND OBSERVABILITY: (08 Hours)**

  Concept of Controllability and Observability; Kalman's Theorems on Controllability; and Observability, Alternative Tests (Gilbert's Method) of Controllability and Observability; Principle of Duality; Relationship among Controllability, Observability and Transfer Function, Decomposition of Transfer Function-Direct, Cascade and Parallel Decomposition; State Diagram.

- **LIOPUNOV STABILITY ANALYSIS: (09 Hours)**

  Stability of Equilibrium State in the Sense of Liopunov; Graphical Representation of Stability; Asymptotic Stability and Instability; Sign-Definiteness of Scalar Function; Second Method of Liopunov; Stability Analysis of Linear Systems; Krasovskii's Theorem; Liopunov Function Based on Variable Gradient Method.

Total Hours: 42

References:

1 Nagrath & Gopal, "Control system engineering", New Age International Publishers, 3rd Edition, 2001.
2 K. Oggata, "Modern control system engineering", Pearson Education Asia, 4th Edition, 2002.
3 B.C.Kuo, "Automatic control system", Prentice Hall of India, 7th Edition, 1995.
4 Richard C Dorf & Robert H Bishop, "Modern control system", Pearson Education Asia. 8th Edition, 2004.
5 Nise N. S., "Control System Engineering", John willey & sons, 4th Edition, 2004.

B.Tech.III, Semester – VI	L	T	P	C
EE 318 : ENERGY AUDIT AND MANAGEMENT	3	0	0	3

- **ENERGY SCENARIO** **(02 Hours)**

  Commercial and non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, air pollution, climate change, energy security, energy conservation and its importance, energy strategy for the future, energy conservation act 2001 and its features.

- **BASICS OF ENERGY & ITS VARIOUS FORMS** **(02 Hours)**

  Electricity basics – DC and AC currents, electricity tariff, load management and maximum demand control, power factor. Thermal basics – fuels, thermal energy content of fuels, temperature and pressure, heat capacity, sensible & latent heat, evaporation, condensation, steam, moist air, humidity and heat transfer, units and conversion.

- **ENERGY MANAGEMENT AND AUDIT** **(02 Hours)**

  Definition, energy audit – need, types of energy audit, energy management (audit) approach – understanding energy costs, benchmarking, energy performance, matching energy use to requirement, maximising system efficiencies, optimising the input energy requirements, fuel and energy substitution, energy audit instruments.

- **MATERIAL AND ENERGY BALANCE** **(02 Hours)**

  Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

- **ENERGY ACTION PLANNING** **(03 Hours)**

  Key elements, force field analysis, energy policy purpose, perspective contents, formulation, ratification, organising, location of energy management, top management support, managerial function, roles and responsibilities of energy manager, accountability, motivating – motivation of employees, information system designing barriers, strategies, marketing and communicating, training & planning.

- **FINANCIAL MANAGEMENT** **(02 Hours)**

  Investment – need, appraisal and criteria, financial analysis techniques – simple pay back period, return on investment, net present value, internal rate of return, cash flow, risk and sensitivity analysis, financing options, energy performance contracts and role of ESCOs.

- **PROJECT MANAGEMENT** **(03 Hours)**

  Definition and scope of project, technical design, financing, contracting, implementation & performance monitoring, implementation plan for top management, planning budget, procurement procedures, construction, measurement & verification.

- **ENERGY MONITORING AND TARGETING** **(02 Hours)**

  Defining monitoring and targeting, elements of monitoring and targeting, data and information analysis, techniques – energy consumption, production, cumulative sum of differences (CUSUM)

- **GLOBAL ENVIRONMENTAL CONCERNS** **(02 Hours)**

  United nations framework convention on climate change (UNFCC), Kyoto protocol, conference of parties (COP), clean development mechanism (CDM), prototype carbon fund (PCF), sustainable development.

- **ELECTRICAL SYSTEM** **(04 Hours)**

  Electricity billing, electrical load management & maximum demand control, power factor improvement & it's benefits, selection & location of capacitors, performance assessment of pf capacitors, distribution & transformer losses.

- **ELECTRIC MOTORS** **(03 Hours)**

  Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding & motor replacement issues, energy saving opportunities with energy efficient motors.

(Continued…)

- **FANS AND BLOWERS** **(02 Hours)**

  Types and applications, fan characteristics and performance curves, fan laws, performance evaluation, efficient system operation, flow control strategies, energy conservation opportunities.

- **PUMPS AND PUMPING SYSTEM** **(02 Hours)**

  Types of pumps, significance of head flow curve & operating point of a pump, factors affecting pump performance, performance evaluation, efficient pumping system operation, various flow control strategies, energy conservation opportunities in pumping system.

- **LIGHTING SYSTEM** **(03 Hours)**

  Light source, choice of lighting, luminance requirements, terminologies used in lighting systems, recommended illuminance standards, methodology of energy efficiency audit in lighting systems, good practices, energy conservation avenues.

- **DG SET SYSTEM** **(04 Hours)**

  basics of internal combustion engines, factors affecting selection & performance, waste heat recovery to enhance cost effectiveness of DG sets, energy performance assessment, energy conservation avenues and troubleshooting.

- **ENERGY EFFICIENT TECHNOLOGIES IN ELECTRICAL SYSTEM** **(04 Hours)**

  Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

Total Hours:42

REFERENCES:

1. "Encyclopedia of Energy", McGraw Hill Publication.
2. Albert Thumann, "Handbook of Energy Engineering", The Fairmont Press Inc.
3. Wayne C. Turner, "Energy management Handbook", John Wiley and sons.
4. Cleaner Production, "Energy Efficiency Manual for GERIAP, UNEp, Bangkok prepared by National Productivity Council.
5. Prasanna Chandra, "Financial management", Tata Mc-Graw Hill.
6. S. Choudhury, "Projects: Planning, Analysis, Selection, Implementation and Review", Tata McGraw Hill.

B.Tech. III, Semester – VI	L	T	P	C
EE 322 : POWER SYSTEM PLANNING AND MANAGEMENT	**3**	**0**	**0**	**3**

- **FORECASTING-NEEDS & USES** **(11 Hours)**

  Current Status Of Forecasting, Fundamentals Of Quantitative Forecasting, Explanatory And Time Serious Forecasting, Least Square Estimates, Peak Load Forecasting, Accuracy Of Forecasting Methods, Regression Methods, Box Jenkins Time Serious Methods.

- **SHORT AND LONG TERM FORECASTING TECHNIQUES** **(11 Hours)**

  Problems facing electricity industry, Long term forecasting techniques, Methods of long term forecasting, Spatial load forecasting, Multivariate procedures, Short term forecasting techniques

- **FORECASTING AND PLANNING** **(10 Hours)**

  The role of forecasting in planning, Comparison and selection of forecasting methods, The accuracy of forecasting methods, Pattern of the Data and its effects on individual forecasting methods, Time horizon effects on forecasting methods.

- **GENERATION PLANNING** **(10 Hours)**

  Fundamental economic analysis, Generation planning optimized according to generating unit categories, distribution & Transmission system planning.

Total Hours:42

REFERENCES:

1. Makridakis, Spyros, “Forecasting methods and application”, John Wiley, 1993.
2. X.Wang & J.R. Mc Donald , “Modern Power system planning”, McGraw. Hill, 1993
3. A.S Pabla , “Electrical Power system planning”, Mac Millan,Delhi,1998
4. Sullivan, “Power system planning”, McGraw. Hill ,1977
5. Lakervi E, E J Holmes, “Electricity distribution network design”, IEE, 2nd edition, 2003

B.Tech. III, Semester – VI	L	T	P	C
EE 324 : Power Quality Issues and Remedial Measures	**3**	**0**	**0**	**3**

- **Power quality:** **(04 Hours)**

  Understanding power quality, types of power quality disturbance, power quality indices, causes and effects of power quality disturbances.

- **TRIGGERING & SEGMENTATION:** **(06 Hours)**

  Basic concepts, Overview of existing method, triggering method: changes in RMS waveforms, detecting singular point form wavelet transforms, segmentation.

- **HARMONICS: SOURCES & ITS EFFECT** **(07 Hours)**

  Causes and effect of harmonics, converter configuration and their contribution to supply harmonics and other sources of harmonics, standards-IEEE guides, standards and recommended practices, effect of power system harmonics on power system equipment and loads.

- **POWER FACTOR CORRECTION & MITIGATION OF HARMONICS:** **(13 Hours)**

  Modeling of networks and components under non-sinusoidal conditions: transmission and distribution systems, power quality problems created by drives and its impact on drives, Power factor improvement, Passive Compensation, Active Power Factor Correction -Single Phase APFC, Three Phase APFC and Control Techniques, static VAR compensators-SVC and STATCOM - Active Harmonic Filtering, Dynamic Voltage Restorers for sag ,swell and flicker problems. Grounding and bonding-introduction.

- **ELECTROMAGNETIC INTERFERENCE:** **(06 Hours)**

  Electromagnetic Interference: frequency classification, electric and magnetic field, EMI terminology, EMT Mitigation, Health concern of EMI.

- **POWER QUALITY MEASUREMENT:** **(06 Hours)**

  Measuring and solving power quality problems, Power Quality measurement device and its measurement, test : Location, Duration, Instrument set-up and its guide lines.

Total Hours:42

REFERENCES:

1. Bollen Math H.J, “Understanding Power quality Problems: Voltage Sags and Interruptions”, IEEE Press (Standard Publishers Distributors), Edition First 2001.
2. Sankaran C., “Power Quality”, CRC Press, Edition 2001.
3. Padiyar K.R. “FACTS controller in power transmission and Distribution” ,New Age international, 1st Ed., 2007.
4. Bollen math H.J.,GU Irene Y.H.,“ signal processing of power quality Disturbances”, wilely inter-science publication (copyright IEEE Inc-2006).
5. Recent Publications on power system and Power Delivery.

APPROVED AT SENATE MEETING HELD ON 19/07/2008

Sardar Vallabhbhai National Institute of Technology, Surat-395007

DEPARTMENT OF ELECTRICAL ENGINEERING

B.TECH.-IV-ELECTRICAL TEACHING SCHEME (Revised)

(Effective From July-2009)

SEMESTER - VII

Sr. No.	Course Code	Course	L	T	P	Credits	Examination Scheme				
			Hrs	Hrs	Hrs		Theory Marks	Tutorial Marks	Termwork Marks	Practical Marks	Total Marks
1	EE 401	Electronic Instrumentation	3	1	0	04	100	25	-	-	125
2	EE 403	Electrical Drives	3	1	2	05	100	25	20	30	175
3	EE 405	Switch Gear & Protection	3	1	2	05	100	25	20	30	175
4	EE 4XX	ES-I	3	1	0	04	100	25	-	-	125
5	EE 407	Seminar	0	0	2	01	-	-	20	30	50
6	EE 409	Project Preliminary	0	0	4	02	-	-	40	60	100
		TOTAL	**12**	**4**	**10**	**21**	**400**	**100**	**100**	**150**	**750**
	TOTAL CONTACT HOURS		**26**								
	TOTAL CREDITS		**21**								

ELECTIVE SUBJECTS (ES-I)

EE 411 High Voltage Engineering
EE 413 Renewable energy sources
EE 415 Utilization of Electrical Energy and Electric Traction
EE 417 Discrete Control system
EE 419 Digital Signal Processing
EE 421 Restructuring in Power System

SEMESTER – VIII

Sr. No.	Course Code	Course	L	T	P	Credits	Examination Scheme				
			Hrs	Hrs	Hrs		Theory Marks	Tutorial Marks	Termwork Marks	Practical Marks	Total Marks
1	EE 402	Power System Operation and Control	3	1	0	04	100	25	-	-	125
2	EE 404	Electrical Machine Design	3	1	0	04	100	25	-	-	125
3	EE 406	Advanced Power Electronic Converters & Applications	3	1	0	04	100	25	-	-	125
4	EE 4XX	ES – II	3	1	0	04	100	25	-	-	125
5	EE 408	Project	0	0	12	06	-	-	120	180	300
		TOTAL	**12**	**4**	**12**	**22**	**400**	**100**	**120**	**180**	**800**
	TOTAL CONTACT HOURS		**28**								
	TOTAL CREDITS		**22**								

ELECTIVE SUBJECTS (ES-II)

EE 412 Flexible AC Transmission System (FACTs)
EE 414 EHV AC/DC Transmission
EE 416 Computer Methods in Power System Analysis
EE 418 Industrial Instrumentation
EE 422 Advanced Microprocessor and System Programming
EE 424 Non linear and Optimal Control Theory

B.Tech. IV (Electrical), Semester – VII	L	T	P	C
EE 401 : ELECTRONIC INSTRUMENTATION	**3**	**1**	**0**	**4**

- **DIGITAL MEASUREMENT** **(07 Hours)**

  Digital measurement techniques for voltage, current, power, energy, resistance, capacitance and loss angle (TAN ∂), impedance and quality factor

- **DIGITAL FREQUENCY AND TIME MEASURING INSTRUMENTS** **(04 Hours)**

  Frequency counter, period duration meter, pulse width meter, frequency ratio meter, error in digital instruments

- **SENSORS** **(04 Hours)**

  Principle and applications of photosensitive, and fiber optic sensors

- **SIGNAL CONDITIONING, DATA ACQUISITION AND CONVERSION** **(09 Hours)**

  Instrumentation amplifiers, isolation techniques, sample and hold circuits, multiplexers and demultiplexers, digital to analog converters, data acquisition systems, encoders, grounding and shielding techniques.

- **AN OVERVIEW OF PLC** **(06 Hours)**

  Introduction, definitions and history of PLC, manufacturing and assembly processes, PLC advantages and disadvantages, overall PLC system, CPU, PLC, input and output modules, program recording devices

- **PROGRAMMING PLC** **(08 Hours)**

  Ladder diagrams, programming ON/OFF inputs to produce ON/OFF outputs, digital gate logic and contact coil logic, creating ladder diagrams from process control descriptions ,register, timer function, counter function, arithmetic functions, comparison functions

- **INTRODUCTION TO DISTRIBUTED CONTROL SYSTEM** **(04 Hours)**

  DCS architecture, communication protocol

Total Hours:42

REFERENCES:

1. Helfrick A D; Cooper W. D. , “Modern electronic Instrumentation and Measurement techniques”, PHI ,Edition 1997
2. Rangan; Sarma; Mani , “Instrumentation devices and systems”, TMH , 2nd edition
3. Doebelin E.O, “Measurement Systems - Application and Design”, Fourth edition, McGraw-Hill, New York, 1992.
4. T.S Rathore, “Digital Measurement Technique”, Narosa publishing house,2nd edition
5. Curtis Johnson, “Process control instrumentation technology”, PHI, 6th edition
6. John. W .Webb Ronald A Reis , “Programmable Logic Controllers - Principles and Applications”, Fourth edition, Prentice Hall Inc., New Jersey, 1998.

B.Tech. IV (Electrical), Semester – VII	L	T	P	C
EE 403 : ELECTRICAL DRIVES	3	1	2	5

- **FUNDAMENTALS OF ELECTRIC DRIVES** **(03 Hours)**

  Electrical drives and introduction: Electric drives, advantages of electrical drives, parts of electrical drives, choice of electrical drives, status of ac and dc drives. types of load, load with translational motion, load with rotational motion, load torque that vary with time, Speed Sensing , and current Sensing

- **DYNAMICS OF ELECTRICAL DRIVES** **(04 Hours)**

  Fundamental torque equation, speed-torque convention and multi quadrant operation, , dynamics of motor load combination, nature and classification of load torque, measurement of moment of inertia, calculation of acceleration time in transient operation, acceleration time for specific nature of motor and load torque, load equalization, stability of electrical drives. Selection of Motor Power Rating,

- **POWER ELECTRONICS CONTROL OF DC DRIVES** **(05 Hours)**

  Review of DC Motors and its performance, starting, braking, controlled rectifier fed DC drives with continuous and discontinuous mode of operation, Supply Harmonics, Power Factor and ripple in motor current, Chopper Controlled DC Drives, Sources current harmonics in chopper, Converter Ratings and closed loop control.

- **POWER ELECTRONICS CONTROL OF AC DRIVES** **(13 Hours)**

  Review of Three phase Induction Motor and its performance, starting, braking, Static Voltage control , Variable Frequency Control (VSI, CSI, Cyclo-converter based), static rotor resistance control and slip power recovery control schemes.

- **THREE PHASE SYNCHRONOUS MOTORS** **(12 Hours)**

  Review of Three phase Synchronous Motor and its performance, Self controlled schemes, Variable frequency control of multiple synchronous motor, Permanent magnet AC motor drives, Brushless DC Motor Drives

- **INDUSTRIAL APPLICATIONS** **(05 Hours)**

Total Hours:42

LIST OF EXPERIMENTS:

1. Study Of Speed Control Of Dc Shunt Motor Using Single Phase Fully Controlled Converter.
2. Controlling Of Dc Motor With Single Phase Dual Converter.
3. Study Of Speed Control Of (V/F Control) Of Single Phase Induction Motor.
4. Study Of Speed Control Of (V/F Control) Of Three Phase Ac Induction Motor.
5. Study Of Ac Servo Motor Position Control Trainer.
6. Study Of Hitachi Makes 5 Hp Induction Motor Drives.
7. Study Of Dsp Controlled Induction Motor Drive.
8. Study Of Dsp Controlled Bldc Motor Drives.

REFERENCES:

1. Dubey G.K, “Fundamentals of Electrical Drives”, Narosa Publishing House, Second Edition, 2001.
2. Pillai S.K., “A First Course on Electrical Drives”, New Age International , Second Edition, 2006.
3. De N.K., Sen P.K. “Electric Drives”, Prentice Hall of India, Second Edition , 2001.
4. Krishnan, R, “Electric Motor Drives: Modeling, Analysis and Control ” ,Prentice Hall of India, Second Edition , 2001.
5. Ned Mohan et al, “Power Electronics: Converters, Applications, and Design”, John Wiley & Sons. Inc., 2nd Edition, 1995.
6. Werner Leonhard, “Control of electrical drives”, Springer, 1995.

B.Tech. IV(Electrical), Semester – VII	L	T	P	C
EE 405 : SWITCHGEAR & PROTECTION	3	1	2	5

- **FUSES, SWITHCHES AND NEUTRAL GROUNDING** **(03 Hours)**

  Rewirable fuses, HRC fuses, isolators and earthing switches, selection of fuses. Effectively grounded and ungrounded systems, resonant grounding Methods of neutral grounding.

- **BASIC PRINCIPLES AND RATINGS OF CIRCUIT BREAKERS** **(05 Hours)**

  Arc phenomenon, arc Interruption theories, arc control devices, recovery and restriking voltages, current chopping, Interruption of capacitive current, resistance switching, circuit breaker operating mechanism and control systems, making current, breaking current symmetrical and unsymmetrical, continuous current rating, MVA capacity.

- **CIRCUIT BREAKERS** **(06 Hours)**

  Bulk oil circuit breaker, arc controlled devices, MOCB, ACB, ABCB, SF_6 circuit breaker, vacuum circuit breaker and DC circuit breakers, circuit breaker ratings, autoreclouser. Testing of circuit Breaker.

- **FUNCTIONS OF PROTECTIVE RELAYING** **(03 Hours)**

  Fundamental characteristics of relays, standard definition of relay terminologies, relay classifications, operating principles of single and double actuating quantity type electromechanical relays, directional relay, reverse power relay.

- **GENERATOR & MOTOR PROTECTION** **(04 Hours)**

  Modern methods of protecting generators against faults in stator, rotor and prime movers and other abnormal conditions. Abnormal operating conditions, under voltage, phase and earth fault, overload and unbalanced voltage protections for motors.

- **TRANSFORMER PROTECTION** **(04 Hours)**

  Protection of transformers, basic differential over current relays, restricted earth fault protection, gas relays, overall generator-transformer differential protection, magnetizing inrush protection.

- **BUSBAR PROTECTION** **(03 Hours)**

  Protection of out door and indoor busbar by current differential, voltage differential and directional comparison principles, linear coupler, high impedance schemes.

- **TRANSMISSION LINE PROTECTION** **(07 Hours)**

  Operating characteristics of impedance, reactance relays on R-X diagram, overreach and memory action, ohm and mho types relays and their characteristics, relay response under power swings and effect of fault resistance, setting of distance relays.
  Carrier Current Protection- Phase comparison and directional comparison principles.

- **SOLID STATE RELAYS** **(04 Hours)**

  Phase and amplitude comparators, duality between phase and amplitude comparators, general equation for comparators, realization of directional, ohm, reactance, impedance and mho characteristics using general characteristic equation, qualitative concepts of switched and non-switched scheme of static distance relays.

- **INTRODUCTION TO COMPUTER AIDED RELAYING** **(03 Hours)**

  Introduction to microcomputer based relays, general functional diagram of microcomputer based relays.

Total Hours:42

(Continued…)

LIST OF EXPERIMENTS:

1. To obtain the operating characteristics of an instantaneous overcurrent relay.
2. To obtain the operating characteristics of an inverse time overcurrent / overvoltage relay.
3. To study the operating characteristics of directional overcurrent relay.
4. To study the operating characteristics of the transformer percentage differential relay.
5. To study the transient in the s/c applied at the terminals of synchronous machine.
6. To study the magnetic inrush current in a transformer.

REFERENCES:

1. M. A. Date, B.Oza, N.C. Nair, “Power System Protection”, Bharti Prakashan,2004
2. J. Lewis Blackburn, “Protective Relaying”, Marcel Dekker INC. 1997
3. Russel Mason, “Art and Science of Protection relaying”
4. Allen Greenwood, “Electrical Transients in Power Systems”, 1991.
5. Van. C. Warrington A.R., “Protective Relays Vol. 1 & 2”, Chapman & Hall, 1998.
6. T S Madhav Rao, “Power system protection static relays with microprocessor Applications”, Tata McGraw hill Publication,1998.
7. Badri Ram, D N Vishwakarma, “Power System Protection and Switchgear”, Tata Mc Graw Hill, 2005.
8. Anderson P M, “Power System Protection”, IEEE publication, 1999.
9. Walter -Marcel Dekker, “Protective relaying theory and applications”, 2ed, Elmore, 2004.

B.Tech. IV (Electrical), Semester – VII	L	T	P	C
EE 411 : HIGH VOLTAGE ENGINEERING	3	1	0	4

- **GENERATION OF VARIOUS TYPES OF HIGH VOLTAGES (13 Hours)**

  Generation of High DC Voltages: Half Wave and full wave circuits –Ripple voltages in HW and FW rectifiers. Voltage doubler circuits – Simple voltage doubler, cascade voltage doubler. Voltage multiplier circuits – Crockroft Walton voltage multiplier circuits. Ripple and regulation. Electrostatic machines – principles – Van de Graff generator.

  Generation of high AC voltages: Cascade transformers, resonant transformers – parallel and series resonant test systems. Generation of high frequency high voltages – Tesla coil.

  Generation of impulse voltages – Standard impulse wave shape Basic circuits for producing impulse waves – Analysis of commercial impulse generator circuits – Wave shape control, multi-stage impulse generators – Marx circuit – modified Marx impulse generator circuit – Components of multi stage impulse generator. Generation of Switching surges. Generation of impulse current. Definition of impulse current waveform – Circuit for producing impulse current waves.

- **MEASUREMENTS OF HIGH VOLTAGES & CURRENTS (06 Hours)**

  Measurement of high voltages and currents-DC,AC and impulse voltages and currents-DSO, electrostatic and peak voltmeters, sphere gaps-factors affecting measurements, potential dividers(capacitive and resistive)-series impedance ammeters, rogowski coils, hall effect generators.

- **ELECTRICAL BREAKDOWN IN GASES, LIQUIDS & SOLID DIELECTRICS (10 Hours)**

  Introduction to Insulation materials. Breakdown in gas and gas mixtures-breakdown in uniform and non uniform fields, Paschens law, Townsends criterion, streamer mechanism, corona discharge, breakdown in electro negative gases, Breakdown in liquid dielectrics-suspended particle mechanism, Breakdown in solid dielectrics-intrinsic, streamer, thermal breakdown.

- **DESIGN, PLANNING AND LAYOUT OF HV LABORATORY (03 Hours)**

  Test Facilities, Activities & Studies in HV lab, Classification of hv lab, Size & rating of hv lab, grounding of impulse testing laboratories.

- **HV TESTING OF ELECTRICAL APPRATUS (10 Hours)**

  Non-destructive testing of dielectric materials – measurement dielectric constant and loss factor. Testing of Insulators, Bushings, Isolators, Circuit breakers, Cables, Transformers, Surge diverters, RI Measurement.

Total Hours:42

REFERENCES:

1. E. Kuffel, W.S.Zaengl, J.Kuffel, “High voltage Engineering Fundamentals” , Newnes, 2nd edition,2002.
2. M. S. Naidu, V. Kamaraju, “High voltage Engineering”, TMH, 2nd edition, 2001.
3. L. L. Alston, “High voltage Technology”, BS Publications, 2007.
4. Nils Hylten-Cacallius, “High voltage Laboratory Planning, High voltage test system”, Asea Haefely.
5. “Standard techniques for high voltage testing”, IEEE Publication 1978.
6. Relevant IS standards and IEC standards

B.Tech. IV (Electrical), Semester – VII	L	T	P	C
EE 413 : RENEWABLE ENERGY SOURCES	3	1	0	4

- **NEW & RENEWABLE ENERGY SOURCES** **(04 Hours)**

  Solar, biomass, wind, tidal, geothermal, microhydel, etc. – their availability & potential. Conversion of solar energy into various forms of energy (heat, electricity, mechanical etc.)

- **GEOTHERMAL & TIDAL ENERGY** **(05 Hours)**

  Basic principles, systems used in practice and applications, resource assessment criteria, status in India.

- **SOLAR THERMAL ENERGY** **(04 Hours)**

  Solar thermal devices: Radiation geometry, various types of solar collectors, flat plate & concentrating collectors, their construction working & application, hot water & hot air systems, industrial hot water systems, low pressure steam generation, solar dryers, solar pond, space heating & space conditioning, design criteria and methodologies for solar thermal applications. Solar concentrator and their applications, solar thermal power generation. use of solar thermal systems with existing systems, economic analysis of solar thermal systems, example of hybrid systems.

- **SOLAR PHOTOVOLTAIC** **(12 Hours)**

  Solar photovoltaic conversion: Basic principle of SPV conversion, types of solar cells, fabrication of SPV cells, modules.SPV systems : Different configurations, SPV system components and their characteristics, applications, hybrid SPV system.SPV system designing: Block diagram of general SPV system, load estimation, selection of inverter, battery sizing, array sizing, wiring for SPV system. Grid synchronized inverter system.

- **WIND ENERGY** **(04 Hours)**

  Wind energy conversion technologies, aerodynamics of wind turbine rotor, site selection. Wind resource assessment, various models to predict wind pattern and their analysis, concept of wind farms, various aspects of wind turbine design, hybrid wind energy systems – Wind + diesel power, wind + conventional grid, wind + photovoltaic system etc.

- **HYDROGEN & FUEL CELL** **(06 Hours)**

  Hydrogen as a renewable energy source, source of hydrogen, fuel for vehicles. Hydrogen production: Direct electrolysis of water, direct thermal decomposition of water, biological and biochemical methods of hydrogen production. Storage of hydrogen: Gaseous, cryogenic and metal hydride. Utilization of hydrogen fuel cell – Principle of working, construction and applications.

- **HYDEL & INTEGRATED ENERGY SYSTEMS** **(05 Hours)**

  Mini & micro hydel power (MHP) generation, classification of hydel plants, concept of micro hydel, merits, MHP plants – components, design & layout, turbines, efficiency etc, status in India. Integrated energy systems & their cost benefit analysis.

Total Hours:40

REFERENCES:

1. S. P. Sukhatme, “Solar Energy – Principals of thermal collection and storage”.
2. J. Twidell and T. Weir, “Renewable Energy recources”, E & F N spon Ltd., London
3. N.S. Rathore and N. L. Panwar, “Renewable Energy Sources for Sustainable Development”, New India Publishing Agency, New Delhi, 2007.
4. G. N. Tiwari, M. K. Ghosal, “Fundamentals of Renewable Energy Sources”, Narosa Publication 2007.
5. Godfrey Boyle (editor), “Renewable Energy”.

B.Tech. IV (Electrical), Semester – VII	L	T	P	C
EE 415 : UTILIZATION OF ELECTRICAL ENGEGY & ELECTRIC TRACTION	3	1	0	4

- **ILLUMINATION** **(10 Hours)**

  Nature of light, visibility spectrum curve of relative sensitivity of human eye and wave length of light. Definition: Luminous flux, solid angle, luminous intensity, illumination, luminous efficiency, depreciation factor, coefficient of utilization, space to height ratio,reflection factor, glare, shadow, lux. Laws of illumination. Different type of lamps, construction and working of incandescent and discharge lamps – their characteristics, fittings required for filament lamp, mercury vapour lamp, fluorescent lamp, metal halide lamp, neon lamp. Calculation of number of light points for interior illumination, calculation of illumination at different points, considerations involved in simple design problems. Illumination schemes; indoor and outdoor. Illumination levels. Main requirements of proper lighting; absence of glare, contrast and shadow. General ideas about street lighting, flood lighting, monument lighting and decorative lighting.

- **HEATING** **(09 Hours)**

  Advantages of electrical heating. Heating methods: Resistance heating – direct and indirect resistance heating, electric ovens, their temperature range, properties of resistance heating elements, domestic water heaters and other heating appliances and thermostat control circuit. Induction heating; principle of core type and coreless induction furnace. Electric arc heating; direct and indirect arc heating, construction, working and applications of arc furnace. Dielectric heating, applications in various industrial fields. Infra-red heating and its applications. Microwave heating.

- **WELDING** **(09 Hours)**

  Advantages of electric welding. Principles of resistance welding, types – spot, projection seam and butt welding and welding equipments used. Principle of arc production, electric arc welding, characteristics of arc, carbon arc, metal arc, hydrogen arc welding method of and their applications. Power supply required. Advantages of using coated electrodes, comparison between AC and DC arc welding, welding control circuits, welding of aluminum and copper. Introduction to TIG, MIG Welding.

- **ELECTRIC TRACTION** **(14 Hours)**

  Advantages of electric traction. Different systems of electric traction, DC and AC systems. Types of services – urban, sub-urban, and main lines and their speed-time curves. Train movement & energy consumption. Different accessories for track electrification; such as overhead catanary wire, conductor rail system, current collector- pantograph. Factors affecting scheduled speed. Electrical block diagram of an electric locomotive with description of various equipment and accessories. Types of motors used for electric traction. Starting and braking of traction motors. Control of traction motors. Power supply for electric traction. Introduction to EMU and metro railways.

Total Hours:42

REFERENCES:

1. Taylor E Openshaw, “Utilisation of Electric Energy”, Orient Longman,1986.
2. J B Gupta, “Utilization of electric power and electric traction”, S K Kataria & Sons, 2002.
3. Wadhwa. C.L., “Generation, Distribution and utilization of electrical energy”, Wiley Eastern Limited,1993.
4. Soni, Gupta, Bhatnagar, “A course in electric power”, Dhanapat Rai & sons, 2001.
5. S. L. Uppal, “Electrical Power” Khanna pulishers,1988.
6. Garg and Girdhar, “Utilisation of Electric energy”.
7. Partab H., “Art and Science of Utilisation of Electrical Energy”, Dhanpat Rai and Sons, New Delhi. Second edition
8. Tripathy S. C., “Electric Energy Utilization And Conservation”, Tata McGraw Hill,1993 .
9. Web sites: bee-india.org, eia.doe.gov, www.irfca.org.

B.Tech. IV (Electrical) Semester-VII	L	T	P	C
EE 417 : DISCRETE CONTROL SYSTEM	3	1	0	4

- **INTRODUCTION TO DISCRETE-TIME CONTROL SYSTEMS (03 Hours)**

  Introduction, digital control systems, quantizing and quantization error, data acquisition, conversion, and distribution systems.

- **THE Z TRANSFORMATION (08 Hours)**

  The z transform, transforms of elementary functions, important properties and theorems of the z transform, the inverse z transform, z transform method for solving difference equations.

- **Z-PLANE ANALYSIS OF DISCRETE-TIME CONTROL SYSTEMS (08 Hours)**

  Impulse sampling and data hold, obtaining the z transform by the convolution integral method, reconstructing original signals from sampled signals, the pulse transfer function, realization of digital controllers and digital filters.

- **DESIGN OF DISCRETE-TIME CONTROL SYSTEMS (10 Hours)**

  Introduction, mapping between the S plane and the z plane, stability analysis of closed-loop systems in the z plane, transient and steady-state response analysis, design based on the root-locus method, design based on the frequency-response method, analytical design method.

- **STATE-SPACE ANALYSIS (08 Hours)**

  State-space representations of discrete-time systems, solving discrete-time state-space equations, pulse-transfer-function matrix, discretization of continuous-time state-space equations, liapunov stability analysis.

- **POLE PLACEMENT AND OBSERVER DESIGN (05 Hours)**

  Controllability, observability, useful transformations in state-space analysis and design, via pole placement, state observers, servo systems.

Total Hours:42

REFERENCES:

1. K.Ogata, “Discrete time control system”, Pearson Education ,Inc.
2. Kuo, B.C., “Discrete data control system”, Prentice-Hall.
3. Nagrath & Gopal, “Control system engineering” New Age International Publishers, 3rd Edition, 2001.
4. M.Gopal, “Digital control System”.
5. B.C.Kuo, “Automatic control system”, Prentice Hall of India, 7th Edition, 1995.

B.Tech. IV (Electrical), Semester – VII	L	T	P	C
EE 419 : DIGITAL SIGNAL PROCESSING	3	1	0	4

- **Introduction** **(03 Hours)**

  Review of continuous-time signals and systems, convolution of continuous-time signals, Laplace transform, the Fourier series and Fourier transform.

- **Discrete-time Signals and Systems** **(05 Hours)**

  Sequences, discrete-time systems, linear time-invariant systems, convolution representation of linear time-invariant discrete-time systems, convolution of discrete-time signals, linear difference equations with constant coefficients, realizations, frequency-domain representation of discrete-time signals and systems.

- **Sampling of Continuous-time Signals** **(08 Hours)**

  Periodic sampling, frequency-domain representation of sampling, reconstruction of a band-limited signal, discrete-time processing of continuous-time signals, continuous-time processing of discrete-time signals, changing the sampling rate using discrete-time processing.

- **The Z-Transform** **(08 Hours)**

  The Z-transform, properties of the Z-transform, transfer function representation, Inverse Z-transform, Z-transform applied to difference equations, the complex convolution theorem, stability of discrete-time systems, frequency response of discrete-time systems. .

- **The Discrete Fourier Transform** **(09 Hours)**

  Discrete-time Fourier transform (DTFT), the discrete Fourier series, the Fourier transform of periodic signals, discrete Fourier transform (DFT), properties of the DFT, system analysis via the DTFT and DFT, circular convolution, linear convolution using the DFT.
  The Fast Fourier Transform (FFT) Algorithms: Decimation in time FFT, introduction to radix-2 FFTs, some properties of radix-2 decimation in time FFT, decimation in frequency algorithm, computing the inverse DFT by doing a direct DFT.

- **Introduction to Digital Filters** **(09 Hours)**

  Recursive digital filters-infinite impulse response (IIR) Filters: Analog approximations, impulse invariant method, bilinear transformation method, matched Z-transform method, realizations, non-recursive digital filters – finite impulse response (FIR).

Total Hours: 42

REFERENCES:

1. Proakis and Manolakis, “Digital Signal Processing”, PHI.
2. Ashok Ambardar, “Analog and Digital Signal Processing”, Brooks/Cole Publication.
3. Oppenhein-Schafer, “Discrete Time Signal Processing”, PHI.
4. Rabiner-Gold, “Theory and Application of Digital Signal Processing”, PHI.
5. Vinay Ingle, “DSP using MATLAB”, Thomson Learning.

B.Tech. IV (Electrical), Semester – VII	L	T	P	C
EE 421 : RESTRUCTURING IN POWER SYSTEM	3	1	0	4

- **DEREGULATION OF THE ELECTRICITY SUPPLY INDUSTRY** **(06 Hours)**

  Deregulation, Reconfiguring Power systems, unbundling of electric utilities, Background to deregulation and the current situation around the world, benefits from a competitive electricity market, after-effects of deregulation

- **POWER SYSTEM OPERATION IN COMPETITIVE ENVIRONMENT** **(10 Hours)**

  Role of the independent system operator, Operational planning activities of ISO: ISO in Pool markets, ISO in Bilateral markets, Operational planning activities of a GENCO: Genco in Pool and Bilateral markets, market participation issues, competitive bidding

- **TRANSMISSION OPEN ACCESS AND PRICING ISSUES** **(08 Hours)**

  Power wheeling, Transmission open access, pricing of power transactions, security management in deregulated environment, congestion management in deregulation

- **ANCILLARY SERVICES MANAGEMENT** **(08 Hours)**

  General description of some ancillary services, ancillary services management in various countries, reactive power management in some deregulated electricity markets

- **RELIABILITY AND DEREGULATION** **(10 Hours)**

  Reliability analysis: interruption criterion, stochastic components, component models, calculation methods, Network model: stochastic networks, series and parallel connections, minimum cut sets, reliability costs, Generation, transmission and distribution reliability, Reliability and deregulation: conflict, reliability analysis, effects on the actual reliability, regulation of the market

Total Hours:42

REFERENCES:

1. K. Bhattacharya, MHT Bollen and J.C Doolder, “Operation of Restructured Power Systems”, Kluwer Academic Publishers, USA, 2001.
2. Lei Lee Lai, “Power System restructuring and deregulation”, John Wiley and Sons, UK. 2001.
3. Fred I Denny and David E. Dismukes, “Power System Operations and Electricity Markets”, CRC Press, LLC, 2002.

B.Tech. IV (Electrical), Semester – VIII	L	T	P	C
EE 402 : POWER SYSTEM OPERATION AND CONTROL	3	1	0	4

- **LOAD FLOW STUDIES** **(07 Hours)**

  Network model formulation, formation of Y bus, power flow problem, different types of buses, approximate power flow, Gauss Seidel method, Newton-Raphson method, Decoupled Power flow studies, Fast Decoupled power flow studies, comparison of power flow methods.

- **ECONOMIC LOAD DISPATCH** **(05 Hours)**

  Economic dispatch of thermal units and methods of solution, Transmission losses, B matrix loss formula, Composite generation production cost function-solution by gradient search techniques, Nonlinear function optimization

- **AUTOMATIC GENERATION CONTROL** **(05 Hours)**

  Single area load frequency control, speed governing system and characteristics, Multiarea load frequency control; flat frequency, flat tie-line load and tie-line load bias control, Economic Dispatch and AGC, EMS, SCADA

- **METHODS OF VOLTAGE CONTROL** **(04 Hours)**

  Reactive power and its relation to voltage control, location of voltage control equipment, methods of voltage control, excitation control, voltage regulators, tap changing transformers, booster transformers, induction regulators, reactive power injection and voltage control by synchronous condenser

- **UNIT COMMITMENT** **(05 Hours)**

  Constraints in Unit commitment, Spinning reserve, Thermal and hydro constraints, Unit commitment solution methods- Priority list methods, Dynamic programming solution

- **HYDRO THERMAL SCHEDULING** **(06 Hours)**

  Short and long range hydro-thermal scheduling, hydroelectric plant models, scheduling problems, Short range hydro-thermal scheduling: Gradient approach, Pumped storage hydro plants, Dynamic programming solution to the hydrothermal scheduling problems

- **POWER SYSTEM SECURITY** **(06 Hours)**

  Factors affecting power system security, Contingency analysis: Detection of network problems, Correcting the generation approach: Sensitivity methods, compensated factors, correcting the generation dispatch using linear programming

- **STATE ESTIMATION IN POWER SYSTEMS** **(04 Hours)**

  Power system state estimation, least square estimation, state estimation of an AC network, Detection and identification of bad measurements

Total Hours:42

REFERENCES:

1. A. J. Wood and B.F. Wollenberg, “Power Generation Operation and Control”, John Wiley & Sons, ICN., 2nd Edition.
2. A. K.Mahalanabis, “Computer Aided Power system analysis and control”, Tata McGraw Hill 1991
3. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill, 2nd Edition, 1982,Dec
4. Stevenson J V, William D, “Elements of Power System Analysis”, McGraw Hill, 1988.
5. I. J. Nagrath & D.P. Kothari, “Modern Power System Analysis”, Tata McGraw Hill,1989
6. Arthur R Bergen, Vijay Vittal, “Power system Analysis”, Pearson Education (Singapore) Pte, Ltd., 2004
7. Hadi Saadat, “Power System Analysis”, Tata Mc Graw Hill, 2003.
8. J Arrilaga, C P Arnold, B J Harker, “Computer Modelling of Electric Power Systems”.
9. Elgerd olleI, “Electric Energy Sytems Theory- An Introduction”, Tata Mc Graw Hill, 2ed. 1995.
10. Wadhwa C L, “Electrical Power Systems”, New Age Publication, 3ed., 2002

B.Tech. IV (Electrical), Semester-VIII	L	T	P	C
EE 404 : ELECTRICAL MACHINE DESIGN	3	1	0	4

- **TRANSFORMERS** **(10 Hours)**

  Output equation - single phase and three phase power transformers - main dimensions - choice of specific electric and magnetic loadings- design of core, LV winding, HV winding, tank and cooling tubes - prediction of no load current, forces on winding during short circuit, leakage reactance and equivalent circuit based on design data - design examples.

- **DC MACHINES** **(11 Hours)**

  Output equation - main dimensions - choice of specific electric and magnetic loadings - choice of speed and number of poles - design of armature conductors, slots and winding - design of air-gap, field system, commutator, interpoles, compensating winding and brushes – Carter's coefficient - real and apparent flux density - design examples.

- **ALTERNATORS** **(10 hours)**

  Output equation - salient pole and turbo alternators - main dimensions - choice of specific electric and magnetic loadings - choice of speed and number of poles - design of armature conductors, slots and winding - design of air-gap, field system and damper winding - prediction of open circuit characteristics and regulation of the alternator based on design data - design examples.

- **INDUCTION MACHINES** **(11 Hours)**

  Output equation - main dimensions - choice of specific electric and magnetic loadings - design of stator and rotor windings, stator and rotor slots and air-gap of slip ring and squirrel cage motors – calculation of rotor bar and end ring currents in cage rotor - calculation of equivalent circuit parameters and prediction of magnetising current based on design data - design examples.

Total Hours:42

REFERENCES:

1. Clayton & Hancock, "Performance & Design Of DC Machines", CBS, 3rd edition, 2001
2. Sawhney, Chakrabarti, "A Course in Electrical Machine Design", Dhanpat Rai & Co., 2006.
3. Say M. G, "Performance & Design of AC Machines", Pitman, ELBS.3rd edition, 1983.
4. S.K.Sen, "Principles of Electrical Machine Design", Oxford & IBH Pub., 2006
5. R. K. Agarwal, "Principles of Electrical Machine Design", S. K. Kataria & Co., 2005.

B. Tech. IV (Electrical), Semester – VIII	L	T	P	C
EE 406 : ADVANCED POWER ELECTRONIC CONVERTERS & APPLICATIONS	3	1	0	4

- **MODERN SEMICONDUCTOR DEVICES** **(04 Hours)**

  Power Diodes, Power BJT, Power MOSFETs, Thyristor, GTOs, IGBT, MCT – Basic characteristics and controlling, Emerging devices and circuits, Power Integrated Circuits.

- **PRACTICAL DESIGN CONSIDERATION** **(06 Hours)**

  Gate and Base drive circuits – Design Consideration for different Devices, DC-Coupled Circuits, Isolated Drive Circuits, and Protection in Drive Circuits. Snubber circuits Designing, Temperature control and Heat sink design consideration, Design of Magnetic Components.

- **DC-DC SWITCHED MODE CONVERTERS** **(08 Hours)**

  Introduction, Step-Down (Buck) Converter, Step-Up (Boost) Converter, Buck-Boost Converter, C uk Converter, Control Principles, Applications of DC-DC Converters.

- **SWITCHING DC POWER SUPPLIES** **(08 Hours)**

  Introduction, Linear Power Supplies, Switching Power Supplies, DC-DC Converter with isolation - Flyback converters, Half Bridge Converters, Full Bridge converters, Forward Converter, Push-pull converter, Protection, Isolation and Design criteria for SMPS.

- **STATIC POWER ELECTRONICS APPLICATIONS** **(06 Hours)**

  Electronic Ballasts, UPSs, Power Electronics in Capacitor Charging Applications, Power Electronics for Renewable Energy Sources HVDC Transmission, Automotive Applications of Power Electronics.

- **POWER ELECTRONICS IN POWER QUALITY** **(05 Hours)**

  Power Quality, Reactive Power and Harmonic Compensation, IEEE Standards, Static VAR Compensator, Thyristor Controlled Reactor (TCR), Thyristor Switched Capacitors (TSC), Principal of Active Filters, Types of Active Power Filters, Shunt Active Power Filters, Series Active Power Filters.

- **COMPUTER SIMULATION OF POWER ELECTRONICS AND CONTROL METHODS** **(05 Hours)**

  Introduction, Use of Simulation Tools for Design and Analysis, Simulation of Power Electronics Circuits with PSpice, PSIM, Matlab-Simulink, Control Methods for Power Converters like Power Converter Control using State-Space Averaged Models, Sliding Mode Control of Power, Fuzzy Logic Control of Power.

Total Hours:42

REFERENCES:

1. Rashid, M. H., “Power Electronics Handbook”, Elsevier Academic Press, 2001
2. Ned Mohan, Tore M. Undeland and William P. Robbins, “Power Electronics Converters, Applications, and Design”, John Willey & Sons, Inc., 2nd Edition, 1995.
3. Agrawal, J. P., “Power electronic systems: Theory and design”, Addison Wesley Longman (Singapore) Pte. Ltd. New Delhi, 2001.
4. Rashid, M. H., “Introduction to PSpice Using OrCAD for Circuits and Electronics”, Prentice-Hall of India Pvt. Ltd., New Delhi, Eastern Economy Edition, Third Edition 2006.
5. Singh, M. D., Khanchandani, K. B., “Power electronics”, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2001

B.Tech. IV (Electrical), Semester – VIII	L	T	P	C
EE 412 : FLEXIBLE AC TRANSMISSION SYSTEMS	3	1	0	4

- **REACTIVE POWER CONTROL IN TRANSMISSION SYSTEMS (08 Hours)**

  Reactive power, Uncompensated transmission line: load compensation, system compensation, Lossless distributed parameter line: symmetrical lines, mid point conditions of a symmetrical line, Passive compensation: shunt compensation, series compensation, effect on power transfer capacity.

- **STATIC VAR SYSTEMS (08 Hours)**

  Types, characteristics, compensative SVS-power system characteristics, thyristor controlled reactor (TCR), principle of operation, characteristics, and harmonics, control strategies, thyristor switched capacitors (TSC), principle of operation, characteristics, and dynamic response, series capacitors, reinsertion schemes, protective gear, modeling of static VAR systems, FC-TCR type, representation in power flow, dynamic and transient stability studies, FC-TCR steady state characteristics, modeling of controller dynamics, protection of SVS-brief outline of schemes.

- **THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) (08 Hours)**

  Basic scheme, principle and application, thyristor controlled phase angle regulator, basic scheme, principle and application, reactive power generation/absorption using solid-state devices, VSI configuration & principle of operation.

- **STATIC COMPENSATOR (STATCOM) (06 Hours)**

  Principle of operation, 6 pulse & multiple configurations, steady state characteristics, control strategy, comparison with FC-TCR SVC.

- **STATIC SYNCHRONOUS SERIES COMPENSATOR (SSSC) (05 Hours)**

  Introduction, Operation of SSSC and control of power flow, Modeling and control of SSSC, SSSC with an energy source, Application of SSSC.

- **UNIFIED POWER FLOW CONTROLLER (UPFC) (07 Hours)**

  General configuration combined voltage control, series compensation and phase angle regulation, practical implementation schemes, comparison of UPFC with conventional controllers.

Total : 42 (Hours)

REFERENCES:

1. Padiya K. R, “FACTS Controllers in power transmission and distribution”, New Age Pub, 1st. Edtion,2007.
2. Hingorani N. G, L Gyugyi, “Understanding FACTS”, IEEE Press, 2000.
3. Mathur R. N., Verma R.K., “Thyristor based FACTS Controllers for Electrical Transmission Systems”, John willey,2002.
4. E Acha, V G Agelidis, O Anaya-Lara, T J E Miller, “Power Electronic Control in Electrical Systems”, NewnessPower Engineering Series, 2006.
5. T J E Miller, “Reactive Power Control in Electrical Systems”, John willey, 1982.

B.Tech. IV(Electrical), Semester – VIII	L	T	P	C
EE 414 : EHV AC/DC Transmission	3	1	0	4

- **HVDC POWER TRANSMISSION** **(04 Hours)**

  Comparison of AC and DC Transmission, Application of DC transmission, types of DC links, recent trends.

- **ANALYSIS OF HVDC CONVERTERS** **(10 Hours)**

  Three phase and six phase converter circuits, voltage current waveforms and ratios, apparent power factor and utilization factor, delay angle, transformer rating pulse number, commutation group, Graetz Circuit, Overlap, advance angle and extinction angle, analysis of two and three valve conduction mode, equivalent commutation resistance, reactive power requirements of HVDC converters.

- **CONTROL OF HVDC CONVERTERS** **(06 Hours)**

  Power flow in HVDC transmission system, constant ignition angle control, constant extinction angle control, constant current control, actual control characteristics.

- **EHV AC TRANSMISSION LINES** **(06 Hours)**

  Introduction, calculation of line and ground parameters, bundled conductors, bundle spacing and bundle radius, sequence inductance and capacitance parameters, line parameters for modes of propagation, digitalization procedure, interpretation of eigen vectors, Resistance and Inductance of ground return.

- **VOLTAGE GRADIENT OF CONDUCTORS** **(08 Hours)**

  Field of a point charge and its properties, field of a sphere gap, method of image charges, field of line charges and their properties, corona inception gradient, charge potential relations for multi-conductor lines, maximum charge condition on a three phase line. **Surface voltage gradients on conductors:** single conductor, 2 conductor and multi conductor bundle, maximum surface voltage gradient, Mangoldt (Markt-Mengle) formula, design of cylindrical cage for corona experiments, single conductor concentric as well with eccentricity inside a cylinder.

- **CORONA EFFECTS** **(04 Hours)**

  Power loss: Corona loss formulas, attenuation of traveling waves due to corona losses. Audible noise: generation and characteristic, formula for audible noise. Radio interference: The CIGRE formula, measurement of RI and RIV.

- **SWITCHING OVER VOLTAGES** **(04 Hours)**

  Origin of over voltages and their types, over voltages due to interruption of low inductive current and interruption of capacitive currents, Reduction of switching surges on EHV systems.

Total : 42 (Hours)

REFERENCES:

1. E W Kimbark, “Direct current Transmission”, Vol. I, Wiley Interscience.
2. J. Arrillaga, “High Voltage Direct Current Transmission”, Peter Peregrines.
3. KR Padiyar, “HVDC Power Transmission Systems”, New Age International (P) Ltd., Publishers, 3rd Edition.
4. Begamudre, “EHV AC Transmission engineering”, Wiley Easter Ltd. 2nd Ed.
5. Edison Electric Institute, “EHV transmission reference book”, GE Co.
6. EPRI, Palo Alto, “Transmission line reference book 345 KV & above”.

B.Tech. IV(Electrical), Semester – VIII	L	T	P	C
EE 416 : COMPUTER METHODS IN POWER SYSTEM ANALYSIS	3	1	0	4

- **SOLUTION OF LINEAR SYSTEMS** **(06 Hours)**

  Gaussian elimination, LU factorization with partial and complete pivoting, condition numbers and error propagation, relaxation methods, conjugate gradient methods

- **SOLUTION OF NONLINEAR SYSTEMS** **(08 Hours)**

  Fixed point iteration, Newton–Raphson iteration, Power system applications: Power flow, regulating transformers, Decoupled power flow, Fast Decoupled power flow, PV curves and continuation power flow, Three phase power flow

- **SPARSE MATRIX SOLUTION TECHNIQUES** **(06 Hours)**

  Storage methods, sparse matrix representation, Ordering schemes: Scheme O, Scheme I, Scheme II, Other scheme, Power system applications

- **NUMERICAL INTEGRATION** **(06 Hours)**

  One step method, Multistep method, accuracy and error analysis, numerical stability analysis, stiff systems, step size selection, differential algebraic systems, Transient stability analysis

- **POWER SYSTEM STATE ESTIMATION** **(08 Hours)**

  Power system state estimator, Weighted LS estimator: Optimality conditions for a LS estimator, equality constrained power system state estimation, Numerical methods for equality constrained least squares estimation: Constraint weighting approach, normal equations approach, QR decomposition approach, Fast decoupled estimator, Bad data processing

- **OPTIMAL POWER FLOW** **(08 Hours)**

  OPF: Mathematical formulation, solution methodologies, compact model formulation, SLP based OPF algorithm, OPF by Newton approach, SQP approach

Total Hours:42

References:

1. S.A. Soman, S. A. Khaparde, and Shubha Pandit, “Computational methods for large sparse power system analysis”, Kluwer academic publishers.
2. Mariesa Crow, “Computational methods for electric power systems”, CRC Press.

B.Tech. IV (Electrical), Semester – VIII	L	T	P	C
EE 418 : INDUSTRIAL INSTRUMENTATION	**3**	**1**	**0**	**4**

- **TRANSDUCER FOR INDUSTRIAL MEASUREMENTS** **(07 Hours)**

  Working principles and characteristics of transducers used for measuring weight, density, vibration, distance, thickness, torque and shaft power

- **TRANSDUCERS FOR PROCESS MEASUREMENTS** **(07 Hours)**

  Working principle and characteristic of transducer used for measuring pressure, level, temperature, flow, moisture, humidity and pH value

- **INSTRUMENTS FOR ANALYSIS** **(07 Hours)**

  Classification of analytic instruments, sampling for online analysis, pH measurements, electrical conductivity measurement, gas analyzer, liquid analyzer, oxygen determination

- **CONTROL ELEMENTS** **(04 Hours)**

  Final control operations, signal conversions, actuators, control elements

- **INDUSTRIAL COMMUNICATION SYSTEMS** **(06 Hours)**

  Role of data communication systems in industrial automation, the OSI (open system interconnection) model , RS 485 specifications, multi-drop system, automatic address recognition, biasing and termination requirements of RS 485 network, RS 485 transceiver IC, modbus protocol.

- **SIGNAL TRANSMISSION** **(05 Hours)**

  Architecture of current loop, HART protocol for sensor calibration, data transmission systems, field BUS and industrial Ethernet technology.

- **INSTRUMENTATION SYSTEM DESIGN** **(06Hours)**

  Data acquisition systems and its input and output interfacing with microcontroller and microprocessors, PC based data acquisition systems, Electromagnetic interference (EMI) and Electromagnetic Compatibility (EMC) in instrumentation system.

Total Hours: 42

REFERENCES:

1. Rangan ; Sarma ; Mani , “Instrumentation devices and systems”, TMH , 2nd edition
2. Doebelin E.O, “Measurement Systems - Application and Design”, Fourth edition, McGraw-Hill, New York, 1992.
3. Patranabis D, “Principles of Industrial Instrumentation”, Second edition, Tata McGraw Hill, New Delhi, 1997.
4. M.M.S.Anand, “Electronic instruments and instrumentation Technology”, Prentice-Hall of India,2004.

B.Tech. IV (Electrical) Semester-VIII	L	T	P	C
EE 422: Advanced Microprocessor and System Programming	3	1	0	4

- **Introduction to x86 architecture:** **(10 Hours)**

  8086 architecture, Machine language instructions, internal operations, Addressing modes, System bus timing and timing diagram. Introduction to 80386/486/Pentium processor architecture, multi-user, multi-tasking operating system concept, memory management unit (MMU), Virtual memory, Real and protected modes, memory paging.

- **x86 Family Assembly Language Programming:** **(07 Hours)**

  Program development with assembler and other development tools like compiles, debuggers, simulator and in-circuit emulator etc., Use of DOS and BIOS interrupts INT21H , INT10 H etc., Addressing modes, Data transfer instructions, branch instructions, string instructions, stack-manipulations, procedures and multi module programming, parameter passing mechanisms, re-entrant and recursive procedures

- **System programming in 'C'**: **(06Hours)**

  Structure and union, Function pointers, intdos () and int86 () functions, Using 'C' with assembly language programming.

- **Peripheral Interfacing:** **(05 Hours)**

  8086 hardware overview of minimum mode systems, memory and I/O interfacing.

- **Interrupt Management and DMA process:** **(05 Hours)**

  Intel 8086 interrupts acknowledgment cycle, typical 8086 response, Interrupt service routines, programmable interrupt controller 8259, concept of direct memory access, DMA controller 8237

- **Microcomputer system architecture and programming**: **(12 Hours)**

  Mother board, PCI bus, HDD, PC hardware interrupts and programming, Programming and interfacing of parallel port, USB, and Keyboard.

Total Hours: 45

References:

1 Douglas V. Hall, "Microprocessor and interfacing", TMH, 2ND Edition 2007.
2 John Uffenbeck, "The 8086/8088 family Design", Programming, Interfacing, PHI 2001..
3 K.R.Venugopal, "Microprocessor x86 programming", BPB publications,
4 Brey and Sarma, "The Intel Microprocessors 8086/8088, 808186/80188 … Pentium-IV: Architecture, Programming and Interfacing", 7/E, Pearson Education, 2005.
5 B. Govindrajalu, "IBM PC and clones", TMH , 2nd edition,2003.

B.Tech. IV (Electrical), Semester – VIII	L	T	P	C
EE 424 : NON LINEAR AND OPTIMAL CONTROL SYSTEMS	3	1	0	4

- **INTRODUCTION TO NONLINEARITY: (04 Hours)**

  Introduction to nonlinear components and systems, inherent and intentional nonlinearity, specific example of non linear spring for introducing non linearity like jump resonance and variation of resonant frequency with amplitude of input.

- **DESCRIBING FUNCTION ANALYSIS OF NONLINEAR CONTROL SYSTEM: (08 Hours)**

  Introduction to Nonlinear Systems Describing Functions for Common Types of Nonlinearities Describing Function Analysis, Stability and Limit Cycles.

- **PHASE-PLANE ANALYSIS: (14Hours)**

  Introduction, Analytical Methods for constructing Trajectories, Graphical Methods for constructing Trajectories, Isocline Method, Delta Method, Pell's Method, Lienard's Method, Classification of Singular Points, Limit Cycles, Phase-Plane Analysis of Linear control systems, Phase-Plane Analysis of' Non-linear control systems, Minimum Time Trajectory, Optimum Switching Curve.

- **OPTIMAL CONTROL SYSTEM: (16 Hours)**

  Introduction, Calculus of Variation Fixed-End-Point Problem, Free-End-Point Problem and constrained variation problem, Optimal Control Problems, The Hamiltonian Formulation, A Linear Regulator Problem, Pontryagin's Minimum Principle, Minimum Time problems, Fuel optimal problem.

Total Hours: 42

REFERENCES:

1. Nagrath & Gopal, “Control system engineering”, New Age International Publishers, 3rd Edition, 2001.
2. K. Oggata, “Modern control system engineering”, Pearson Education Asia, 4th Edition, 2002.
3. B.C.Kuo, “Automatic control system”, Prentice Hall of India, 7th Edition, 1995.
4. Richard C Dorf & Robert H Bishop, “Modern control system”, Pearson Education Asia. 8th Edition, 2004.
5. Nise N. S., “Control System Engineering”, John willey & sons, 4th Edition, 2004

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DEPARTMENT OF ELECTRICAL ENGINEERING

OTHER DEPARTMENT SUBJECTS

B.TECH.-II- TEACHING SCHEME

SEMESTER - III

Sr. No.	Course Code	Course	L Hrs	T Hrs	P Hrs	Credits	Examination Scheme				
							Theory Marks	Tutorial Marks	Termwork Marks	Practical Marks	Total Marks
#	**B.Tech-II (Electronics), Semester – III**										
1	EE205	Network Theory	3	1	0	04	100	25	-	-	125
#	**B.Tech-II (Computer), Semester – III**										
1	EE207	Electrical Network Analysis	3	1	0	04	100	25	-	-	125

SEMESTER - IV

Sr. No.	Course Code	Course	L Hrs	T Hrs	P Hrs	Credits	Examination Scheme				
							Theory Marks	Tutorial Marks	Termwork Marks	Practical Marks	Total Marks
#	**B.Tech-II (Electronics), Semester – IV**										
1	EE208	Electrical Technology	3	1	2	05	100	25	20	30	175
#	**B.Tech-II (Computer), Semester – IV**										
1	EE212	Control System	3	1	2	05	100	25	20	30	175
#	**B.Tech-II (Chemical), Semester – IV**										
1	EE214	Electrical Technology	3	0	2	05	100	0	20	30	150

B.Tech. (Electronics), Semester – III	L	T	P	C
EE205 : NETWORK THEORY	**3**	**1**	**0**	**4**

- **MESH CURRENT NETWORK ANALYSIS** **(04 Hours)**

  Kirchoff's voltage law & mesh current analysis, Mesh equations in the impedance matrix form by inspection, solution of linear mesh equations and circuit analysis using matrices, driving point impedance & transfer impedance.

- **NODE VOLTAGE NETWORK ANALYSIS** **(04 Hours)**

  Kirchoff's current law & Nodal voltage analysis, nodal equations in the form of admittance matrices by inspection, solutions of linear nodal equations and circuit analysis using matrices, driving point admittance & transfer admittance.

- **NETWORK THEOREMS** **(10 Hours)**

  Linearity and superposition, Star-Delta Transformation, independent and dependent sources and their transformations, Thevenin, Norton, Reciprocity, and Maximum power transfer theorems. Use of these theorems in circuit analysis, Duality and dual of aplanner network.

- **AC/DC CIRCUIT TRANSIENTS** **(07 Hours)**

  Laplace Transform, Inverse Laplace transform, R-L, R-C and R-L-C transients, two mesh transients, applications to circuit analysis using Laplace Transform method. Initial and Final value theorems.

- **MUTUAL INDUCTANCE** **(04 Hours)**

  Magnetically coupled circuits and dot conventions, magnetically coupled circuit analysis.

- **TWO PORT NETWORK ANALYSIS** **(06 Hours)**

  Two port network concepts, impedance, admittance, hybrid and transmission line parameters for two port networks and their interrelationship. Bridged T, Parallel T and Lattice network.

- **TWO TERMINAL PAIR REACTIVE NETWORKS** **(10 Hours)**

  Concept of Poles and zeros of a function, Properties of reactive network, Ladder network and its decomposition into tee, pie, and L sections, image impedance, image transfer function and applications to L-C networks, constant K-filters, m-derived filters, composite filters, problem of termination, lattice filters, Bartlett's bisection theorem.

Total Hours: 45

BOOKS RECOMMENDED:

1. Hayt W. H., Kemmerly J. E, Durbin S. M., "Engineering Circuit Analysis", Tata McGraw Hill, 6th Edition, 2006.
2. Edminister Joseph A., "Electrical circuits", Schaum's outline series, McGraw hill, 2nd edition, 1983.
3. Van Valkenburg M.E., "Network Analysis", Prentice Hall, India, 3rd Edition, 2002.
4. Ghosh Samarjit, "Network Theory, Analysis & Synthesis", 2005 Edition, Prentice Hall, India.
5. Wadhwa C.L., "Network Analysis & Synthesis", New Age International, Revised 3rd Edition, 2007.

B.Tech. (Computer), Semester – III	L	T	P	C
EE207 : ELECTRICAL NETWORK ANALYSIS	3	1	0	4

- **NETWORK CONCEPTS** **(04 Hours)**

  Network element symbols and conventions; Active element conventions; current and voltage conventions; loops and meshes; Nodes; coupled circuits and Dot conventions.

- **MESH CURRENT AND NODE VOLTAGE NETWORK ANALYSIS** **(07 Hours)**

  Definitions of mesh currents and nodal voltages; Choice of mesh currents or nodal voltages for setting up operating equations necessary for network analysis. Self and mutual inductances. Setting up network equations by inspection in impedance or admittance matrix forms.

- **NETWORK THEOREMS** **(08 Hours)**

  Linearity and superposition; Independent and dependent sources and their transformations; Thevenin's, Norton's, and maximum power transfer theorems. Use of these theorems in circuit analysis; Duality and dual of a planner network.

- **TOPICS IN TIME-DOMAIN AND FREQUENCY DOMAIN** **(06 Hours)**

  Laplace transforms, unit step function; other unit functions, the impulse, ramp and doublet; the Laplace transforms for shifted and singular functions; the convolution integral.

- **CIRCUIT TRANSIENTS** **(06 Hours)**

  D.C. and A.C. transients of R-L, R-C, R-L-C, and two mesh transient analysis using Laplace transform method; Initial and Final value theorems and their applications for s-domain circuits.

- **WAVE FORM ANALYSIS BY FOURIER SERIES** **(06 Hours)**

  Trigonometric and complex exponential forms; the frequency spectra of periodic wave forms; the Fourier Integral and continuous frequency spectra; Fourier transform and their relationship with Laplace transform.

- **NETWORK FUNCTIONS AND TWO PORT PARAMETERS** **(08 Hours)**

  Poles and zeros of a function, physical and analytical concepts, Terminal and terminal pairs, Driving point immitances, transfer functions,. Definitions, calculations and interrelationship of impedance, admittance, hybrid and transmission line parameters for four terminal networks. Image impedance and its calculations for symmetrical and unsymmetrical p, T and Ladder Networks.

Total Hours: 45

BOOKS RECOMMENDED:

1. Engineering Circuit Analysis by W.H.Hyat, J.E.Kemmerly, S.M.Durbin, 6th Edition, TMH, 2006.
2. Electric Circuits, Joseph A Edminister, SI (metric) edition, Schaum's outline series, McGraw hill, 2nd edition, 1983.
3. Network Analysis, by Van Valkenburg M E, 3rd Edition, PHI, 2002.
4. Network Theory, Analysis & Synthesis by Samarjit Ghosh, PHI, 2005.
5. Network Analysis & Synthesis by C.L.Wadhwa, Revised 3rd Edition, New Age International Publishers, 2007.

B.Tech. (Electronics)(Chemical), Semester – IV	L	T	P	C
EE208/EE214 : ELECTRICAL TECHNOLOGY	3	1	2	5

- **D.C. MACHINES** **(08 Hours)**

  Construction, windings, EMF, torque and power equations, circuit model, Generating and Motoring modes, introduction to armature reaction, Types of generators and motors and their characteristics, Efficiency and Losses, Speed control of D C motors

- **TRANSFORMERS** **(07 Hours)**

  Review of equivalent circuit, no load and short circuit tests, per unit system, voltage regulation, Efficiency, Auto-transformer, three phase transformers, star and delta connection .

- **INDUCTION MACHINE** **(06 Hours)**

  Review of equivalent circuit, torque speed characteristics, No load and blocked rotor tests, load test, efficiency and losses, starting, Braking & speed control.

- **SYNCHRONOUS-MACHINE** **(07 Hours)**

  Construction and basic principals, EMF equation, Synchronous speed, armature reaction, synchronous reactance, voltage regulation, vector diagram for generating and motoring modes, synchronous motor starting, Synchronous condensers.

- **SPECIAL MACHINE** **(06 Hours)**

  Theory, performance and applications of Servo motors, Stepper motors.

- **ELECTRICAL MEASUREMENT AND INSTRUMENTS** **(04 Hours)**

  Principles of measurement of voltage, current, Power, Energy, Electrical parameters and measuring instruments.

- **ELECTRICAL MEASUREMENT AND INSTRUMENTS** **(04 Hours)**

  Principles of measurement of voltage, current, Power, Energy, Electrical parameters and measuring instruments.

- **PRINCIPLES OF ELECTRICAL POWER SYSTEMS** **(03 Hours)**

  Generation of Electrical power, transmission of Electrical power, distribution of Electrical power .

- **ECONOMIC ASPECTS OF POWER SYSTEM** **(04 Hours)**

  Cost of Generation and Supply (Tariff), Power factor and its effect on system economy, power factor improvement.

Total Hours: 49

PRACTICALS:

1. Speed control of D.C. shunt motor.
2. Speed –Torque Characteristics of D.C. Shunt motor.
3. D.C. Series motor N.T. characteristics.
4. D.C. Generator Characteristics.
5. Efficiency and regulation of 1 Phase Transformer from O.C. and S.C. test.
6. Load test on Induction motor.
7. Circle –diagram.
8. Regulation of an alternator by synchronous impedance method.
9. V and inverted V curve .
10. Calibration of single phase energy meter.

BOOKS RECOMMENDED:

1. Mehta V. K., “Principles of Power System”, S. Chand & Co., 2005.
2. Husain Ashfaq, “Fundamentals of Electrical Engineering”, Dhanpat Rai & Co., 2001.
3. Bimbhra P.S., “Electrical machinery”, Khanna pub., Delhi, 1998.
4. Mukherjee P.K.& Chakravorti S., “Electrical Machines”, Dhanpat Rai Publications, 2001.
5. Ghosh Smarajit, “Fundamentals of Electrical and Electronics Engineering”, Prentice-Hall of India, 2005.

B.Tech. (Computer), Semester – IV	L	T	P	C
EE212 : CONTROL SYSTEM	**3**	**1**	**2**	**5**

- **INTRODUCTION TO CONTROL SYSTEMS** **(02 Hours)**

  Open loop control and close loop control; Illustrative examples of control systems.

- **MATHEMATICAL MODELS OF PHYSICAL SYSTEMS** **(12 Hours)**

  Linear and non-linear systems; equations and transfer functions for linear mechanical translational systems and linear electrical network; Force-Voltage and Force-Current analogy; Block diagram representation of control systems; Block diagram reduction; Transfer functions of armature-controlled and field-controlled DC servomotors and 2-phase AC servomotors; Signal flow graph and Mason's gain formula.

- **TIME DOMAIN ANALYSIS OF CONTROL SYSTEMS** **(06 Hours)**

  Typical test signals; Response of first-order systems; Transient response of a second order system due to step input; Time domain specifications of a second order system; Impulse and ramp response of second order system; Steady-state errors; Static error coefficients; Error series and dynamic error coefficients.

- **ROOT LOCUS TECHNIQUES** **(06 Hours)**

  Basic Properties of Root Loci; Construction of Root Loci; Effects of Adding Poles and Zeros.

- **FREQUENCY DOMAIN ANALYSIS OF CONTROL SYSTEMS** **(14 Hours)**

  Steady state response of a system due to sinusoidal input; Frequency response; Logarithmic plots or Bode diagrams; Log-magnitude versus phase plots; Resonant peak and resonant frequency of a second order system; Polar plots; Routh's stability criterion, Nyquist stability criterion; Stability analysis; Relative stability; Gain margin and phase margin; Closed loop frequency response.

- **INTRODUCTION OF THE COMPENSATORS** **(05 Hours)**

  Introduction to phase lag, phase lead and phase lag-lead networks and their applications. P, PI, PID Controllers.

Total Hours: 45

PRACTICALS:

1. Study of Synchro Transmitter and Receiver.
2. Study of control transformer.
3. To obtain characteristic of Magnetic Amplifier.
4. To obtain transfer function of Servo Motor.
5. To obtain characteristics of Phase lead compensators.
6. To obtain characteristics of Phase lag compensators.
7. To obtain transfer function and to design PID controller for an oven.
8. To obtain time domain parameters of a second order electromechanical system using MATLAB Simulink.
9. To design a PID controller for a DC motor using MATLAB Simulink.

BOOKS RECOMMENDED:

1. Nagrath & Gopal, "Control System Engineering", New Age International Publishers, 3rd Edition, 2001.
2. Oggata K., "Modern Control System Engineering", Pearson Education Asia, 4th Edition, 2002.
3. Kuo B.C., "Automatic control system", Prentice Hall of India, 7th Edition, 1995.
4. Dorf Richard C. & Bishop Robert H., "Modern control system", Pearson Education Asia, 8th Edition, 2004.
5. Nise N. S., "Control System Engineering", John Willey & Sons, 4th Edition, 2004.