EMABST301	Mathematics –III	3L:1T:0P	4 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Objectives:
1. To introduce the solution methodologies for second order Partial Differential Equations with applications in engineering
2. To provide an overview of probability and statistics to engineers

Course Outcomes: Upon completion of this course, students will be able to
1. Solve field problems in engineering involving PDEs.
2. They can also formulate and solve problems involving random variables and apply statistical methods for analysing experimental data.

UNIT I

Complex analysis - I: Analytical functions - Cauchy-Riemann equations – Construction of Analytic functions- Complex integration - Cauchy's theorem - Integral formula - Evaluation of integrals.

UNIT II

Complex analysis - II: Taylor’s and Laurent’s’ series- Transformations- Conformal mapping - Bilinear transformations - Transformation of 1/z, z^2, sin z and cos z.

UNIT III

Complex analysis –III: Singularities - Poles - Residues - Residue theorem – Contour integration- Evaluation of real integrals

UNIT IV

Partial differential equations - I : Formation of differential equations - Classification - First order linear partial differential equations – Lagrange’s’ linear equation - Method of multipliers - first order non-linear partial differential equations - Charpits method.

UNIT V

Partial differential equations - II: Method of separation of variables - One dimensional wave equation - Heat equation – Laplace’s equation.

Text Books:

1. Grewal B S, Higher Engineering Mathematics, 40th Edition, Khanna Publications, 2007.
2. Venkataraman M K, Engineering Mathematics, Vol. I & II, National Publishing Company, 1993.
3. Venkataraman M K, Engineering Mathematics, National Publishing Company, 1995.
4. Grewal B S, Engineering Mathematics, 13th Edition, Khanna Publications.
5. Kreyszig E, Advanced Engineering Mathematics, 8th edition, Wiley, 1998.

Course Outcomes	Program Outcomes											
	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
CO1												
CO2												

EEPCT302	Electro Magnetic Fields	3L:0T:0P	3 Credits
Sessional Marks : **40**	End Semester Examination Marks: **60**		

Course Outcomes:

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

1. To understand the basic laws of electromagnetism.
2. To obtain the electric and magnetic fields for simple configurations under static conditions.
3. To analyse time varying electric and magnetic fields.
4. To understand Maxwell's equation in different forms and different media.
5. To understand the propagation of EM waves.

UNIT-I

Review of Vector Calculus (6 hours)

Vector algebra- addition, subtraction, Components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical).

Vector calculus - differentiation, partial differentiation, integration, vector operator Del, gradient, divergence and curl; integral theorems of vectors. Conversion of a vector from one coordinate system to another.

UNIT-II

Static Electric Field, Conductors, Dielectrics and Capacitance (12Hours)

Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.

Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.

UNIT-III

Static Magnetic Fields Magnetic Forces, Materials & Inductance (12Hours)

Biot- Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors. Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Magnetic circuits, inductances and mutual inductances.

UNIT-IV

Time Varying Fields and Maxwell’s Equations (4 Hours)
Faraday’s law for Electromagnetic induction, Displacement current, Point form of Maxwell’s equation, Integral form of Maxwell’s equations, Motional Electromotive forces.

UNIT-V

Electromagnetic Waves (8 Hours)
Derivation of Wave Equation, Uniform Plane Waves, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect. Poynting theorem.

Text / References:

1. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.
2. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009.
3. Pramanik, "Electromagnetism-Problems with solution", Prentice Hall India, 2012.
4. G. W. Carter, "The electromagnetic field in its engineering aspects", Longmans, 1954.
5. W. J. Duffin, "Electricity and Magnetism", McGraw Hill Publication, 1980.
6. W. J. Duffin, "Advanced Electricity and Magnetism", McGraw Hill, 1968

EEPCT303	Electrical Circuit Analysis	3L:1T:0P	4 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Apply network theorems for the analysis of electrical circuits.
2. Obtain the transient and steady-state response of electrical circuits.
3. Analyse circuits in the sinusoidal steady-state domain (single-phase and three phase).
4. Analyse two port circuit behaviour.

UNIT-I

Network Theorems (10 Hours)

Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Node and Mesh Analysis. Concept of duality and dual networks.

UNIT-II

Solution of First and Second order networks (8 Hours)

Solution of first and second order differential equations for Series and parallel R-L, R-C, R-L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.

UNIT-III

Sinusoidal steady state analysis (8 Hours)

Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, effective or RMS values, average power and complex power, Current Locus diagrams, Three-phase circuits. Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer.

UNIT-IV

Electrical Circuit Analysis Using Laplace Transforms (8 Hours)

Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), series and parallel resonances

UNIT-V

Two Port Network and Network Functions (6 Hours)

Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks.

Text / References:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.
3. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
4. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
5. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.

EEPCT304	Electrical Machines-I	3L:1T:0P	4 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Understand the concepts of magnetic circuits.
2. Understand the operation of dc machines.
3. Analyse the differences in operation of different dc machine configurations.
4. Analyse single phase and three phase transformers circuits.

UNIT-I

Magnetic Circuits:

Introduction, Magnetic materials and their properties, magnetically induced emf and force, AC operation of magnetic circuits, hysteresis and eddy current losses, permanent magnets, and applications of permanent magnet materials.

Principles of electromechanical energy conversion:

Energy in magnetic system, field energy and mechanical force, multiply-excited magnetic field systems, forces/torques in systems with permanent magnets, energy conversion via electric field, dynamical equations of electro mechanical systems

UNIT-II

DC Generators (10 Hours)

Constructional details of dc machine, armature windings and its types, Emf equation, wave shape of induced emf, armature reaction, effect of brush lead, demagnetizing and cross magnetizing ampere turns, compensating windings, commutation, emf induced in a coil undergoing commutation, time of commutation, methods of improving commutation, OCC and load characteristics of different types of generators.

UNIT-III

DC Motors (10 Hours)

Force on conductor carrying current, Torque and power developed by armature, speed control of dc motors, starting of dc motors: constructional details of 3-point and 4-point starters, load characteristics of dc motors Losses in dc machine, condition for maximum efficiency

Parallel operation of DC Generators: dc shunt and series generators in parallel, equalizing connections

Testing of dc machines: Brake test, Swinburne's test, Hopkinson's test, Fields test, Retardation test, Separation of iron and frictional losses

UNIT-IV

Transformers (10Hours)

Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses

UNIT-V

Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current

Three-phase transformer – construction, types of connection and their comparative features, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers. **(10 HOURS)**

Text / References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
4. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
5. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

ECPCT305	Analog Electronics	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Understand the characteristics of transistors.
2. Design and analyse various rectifier and amplifier circuits. Design sinusoidal and non-sinusoidal oscillators.
3. Understand the functioning of OP-AMP and design OP-AMP based circuits.

UNIT-I

Diode circuits (10Hours)

P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits. Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits, current mirror; common-emitter, common-base and common-collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuits

UNIT-II

MOSFET circuits (8 Hours)

MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, trans-conductance, high frequency equivalent circuit.

UNIT-III

Differential, multi-stage and operational amplifiers (8 Hours)

Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

UNIT-IV

Linear applications of op-amp (8 Hours)

Idealized analysis of op-amp circuits. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P, PI and PID controllers and lead/lag compensator using an op-amp, voltage regulator, oscillators (We in bridge and phase shift).

UNIT-V

Nonlinear applications of op-amp (6 Hours)

Analog to Digital Conversion., Hysteresis Comparator, Zero Crossing Detector, Square wave and triangular-wave generators. Precision rectifier, peak detector, Mono-shot.

Text/References:

1. A. S. Sedra and K. C. Smith, “Microelectronic Circuits”, New York, Oxford UniversityPress, 1998.
2. J. V. Wait, L. P. Huelsman and G. A. Korn, “Introduction to Operational Amplifier theory and applications”, McGraw Hill U. S., 1992.
3. J. Millman and A. Grabel, “Microelectronics”, McGraw Hill Education, 1988.
4. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press, 1989.
5. P. R. Gray, R. G. Meyer and S. Lewis, “Analysis and Design of Analog Integrated Circuits”, John Wiley & Sons, 2001.

EOHST306	Economics	2L:0T:0P	2 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

1. At the end of this course, students will demonstrate the ability to
2. Analyse the demand Analysis and Demand forecasting
3. Understand the cost and supply analysis of the products
4. Understand the different market structures and their profit analysis

UNIT-I

Introduction - Nature and Scope of Managerial Economics, Economic Theory and Managerial Economics, Managerial Economist: Role and Responsibilities. Demand Analysis and Forecasting – Demand Determinants, Demand Distinctions, Demand Forecasting: General Considerations, Methods of Demand Forecasting.

UNIT-II

Cost Analysis – Cost Concepts, Classifications and Determinants; Cost-Output Relationship, Economies and Diseconomies of Scale, Cost Control and Cost Reduction. Production and Supply Analysis – Production Functions, Supply Analysis.

UNIT-III

Price and Output Decisions Under Different Market Structures – Perfect competition, Monopoly and Monopsony; Price Discrimination, Monopolistic Competition, Oligopoly and Oligopsony.

UNIT-IV

Pricing Policies and Practices – Pricing Policies, Pricing Methods, Specific Pricing Policies, Price Discounts and Differentials; Product-line Coverage and Pricing; Price Forecasting.

UNIT-V

Profit Management – Nature of Profit, Measuring Accounting Profit, Profit Policies, Profit Planning and Forecasting. Capital Management - Capital Budgeting, Cost of Capital, Appraising Project Profitability, Risk, Probability and Investment Decisions.

Text Book:

1. Varshney R L and Maheshwari K L, Managerial Economics, 19th Edition, Sultan Chand and Sons, 2009.

References :

1. Froeb L M, and McCann B T, Managerial Economics: A Problem Solving Approach, Cengage Learning, 2008.

EEPCP307	Electrical Circuit Analysis Lab	0L:0T:2P	1 Credit
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Hands-on experiments related to the course contents of **Basic Electrical Engineering** & **Electrical Circuit Analysis**

EEPCP308	Electrical Machines-I Lab	0L:0T:2P	1 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Hands-on experiments related to the course contents of **ELECTRICAL MACHINES-I**

ECPCP309	Analog Electronics Lab	0L:0T:2P	1 Credit
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Hands-on experiments related to the course contents of **Analog Electronics**

PAMCT310	INDIAN CONSTITUTIONAL RIGHTS	2L:0T:0P	No Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

Students will be able to

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Unit-I

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working)

Philosophy of the Indian Constitution: Preamble Salient Features

Unit-II

Contours of Constitutional Rights & Duties: Fundamental Rights- Right to Equality - Right to Freedom - Right against Exploitation- Right to Freedom of Religion - Cultural and Educational Rights - Right to Constitutional Remedies- Directive Principles of State Policy- Fundamental Duties.

Unit-III

Organs of Governance: Parliament- Composition-Qualifications and Disqualifications-Powers and Functions- Executive- President – Governor- Council of Ministers - Judiciary, Appointment and Transfer of Judges, Qualifications - Powers and Functions

Unit-IV

Local Administration:

- District's Administration head: Role and Importance,
- Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation.
- Pachayati raj: Introduction, PRI: ZilaPachayat.
- Elected officials and their roles, CEO ZilaPachayat: Position and role.
- Block level: Organizational Hierarchy (Different departments),
- Village level: Role of Elected and Appointed officials,
- Importance of grass root democracy

Unit-V

Election Commission:

- Election Commission: Role and Functioning.
- Chief Election Commissioner and Election Commissioners.
- State Election Commission: Role and Functioning.
- Institute and Bodies for the welfare of SC/ST/OBC and women.

References:

The Constitution of India, 1950 (Bare Act), Government Publication.

1. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
2. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
3. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

EEPCT401	Power Systems-I	3L:1T:0P	4 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objectives:
Students will

1. Understand the basic concepts of power systems.
2. Understand the various power system components.
3. Acquire knowledge on different types of generation stations.
4. Acquire knowledge on design of transmission lines
5. Acquire knowledge on transformers and steady state response of synchronous machines

UNIT-I

Fundamentals of 5s (8Hours): Evolution of Power Systems and Present-Day Scenario. Structure of a power system: Bulk Power Grids and Micro-grids.
Generation: Conventional and Renewable Energy Sources. Distributed Energy Resources.
Energy Storage. Transmission and Distribution Systems: Synchronous Grids and Asynchronous (DC) interconnections.

UNIT-II

Power Stations(8Hours): Hydro-electric, Thermal Power Stations, Gas Turbine Stations, Nuclear power Stations, Renewable Energy generation, Selection of site , Main parts, lay out and working principle.

UNIT–III

Mechanical Design of Transmission lines(8Hours):: Overhead line insulators-Introduction-Types of insulators-Potential distribution over a string of insulators-Methods of equalizing the potential, string efficiency-Testing of insulators.

Sag tension calculations- Catenary curve, Supports at equal levels, supports at different levels, effect of wind and ice loading – stringing chart – sag template – conductor vibrations.

UNIT-IV

Electrical Design of Transmission lines (10 hours)

Overhead Transmission Lines: Parameters of lines. Capacitance and Inductance calculations for simple configurations. Sinusoidal Steady state representation of Lines: Short, medium and long lines.

Corona: Introduction- critical disruptive voltages-Corona loss-factors affecting corona loss-Methods of reducing corona loss-Disadvantages of corona-Inductive interference between power and communication lines

UNIT-V

Transformers and Synchronous Machines(8Hours): Three-phase connections and Phase-shifts. Three-winding transformers, auto-transformers, Neutral Grounding transformers. Tap-Changing in transformers.
Synchronous Machines: steady state, transient and sub-transient equivalent circuits.

Text Books:

1. Power plant Engineering by A.K.Rajaetc, New age International Publishers.
2. Elements of Power Station Design by M.V.Deshpande, 3rd edition, Wheeler’s Publication.
3. Electric Power Generation, Transmission and Distribution by S.N.Singh, Prentice- Hall of India.
4. A Course in Electrical Power by J.B.Gupta, S.K, Kataria & Sons.
5. Generation, Distribution and Utilization if Electrical Power by CL Wadhwa, Wiley Eastern, Ltd., New Delhi.

ECPCT 402	Digital Electronics	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Understand working of logic families and logic gates.
2. Design and implement Combinational and Sequential logic circuits.
3. Understand the process of Analog to Digital conversion and Digital to Analog conversion.
4. Be able to use PLDs to implement the given logical problem.

UNIT-I

Fundamentals of Digital Systems and logic families (7Hours)

Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.

UNIT-II

Combinational Digital Circuits (7Hours)

Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization.

UNIT-III

Sequential circuits and systems (7Hours)

A 1-bit memory, the circuit properties of Bi stable latch, the clocked SR flip flop, J- K-T and D-types flip flops, applications of flip flops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters.

UNIT-IV

A/D and D/A Converters (7Hours)

Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, duals lope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs

UNIT-V

Semiconductor memories and Programmable logic devices. (7Hours)

Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

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Text/References:

1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.
3. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.

ECPCT 403	Signals and Systems	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:
At the end of this course, students will demonstrate the ability to
1. Understand the concepts of continuous time and discrete time systems.
2. Analyse systems in complex frequency domain.
3. Understand sampling theorem and its implications.

UNIT I

Introduction to Signals and Systems:
Definition and classification of signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character, Elementary signals such as Impulse, step, ramp, sinusoidal and exponential signals, Operations on signals. Basic System Properties (Continuous-Time and Discrete-Time): linearity: additivity and homogeneity, shift-invariance, causality, stability, reliability, Examples, Causal LTI Systems Described by Differential and Difference Equations.
Signal Analysis:
Analogy between vectors and signals, orthogonal signal space, Signal approximation using orthogonal functions, Mean square error, Closed or complete set of orthogonal functions, Orthogonality in complex functions.

UNIT II

Fourier series and Fourier Transform:
The Response of LTI Systems to Complex Exponentials. Fourier series Representation of Continuous-Time Periodic Signals, Convergence of the Fourier series, Properties of Continuous-Time Fourier Series. The Continuous-Time Fourier Transform – properties. Discrete-Time Fourier Transform – Properties, Basic Fourier Transform Pairs. Introduction to Hilbert Transform.

UNIT III

Convolution and Correlation of Signals:
Concept of convolution in time domain and frequency domain, Graphical representation of convolution, Convolution property of Fourier transforms, Cross correlation and auto correlation of functions, properties of correlation function, Energy density spectrum, Parseval's theorem, Power density spectrum, Relation between auto correlation function and energy/power spectral density function. Relation between convolution and correlation, Detection of periodic signals in the presence of noise by correlation, Extraction of signal from noise by filtering.

UNIT IV

Behaviour of continuous and discrete-time LTI systems:
The Magnitude-Phase Representation of the Fourier Transform, The Magnitude-Phase Representation of the Frequency Response of LTI Systems, Distortion less transmission through a system, signal bandwidth, system bandwidth, Ideal LPF, HPF and BPF characteristics, Causality and Poly-Wiener criterion for physical realization, relationship between bandwidth and rise time, State-space

Representation of systems, State-Space Analysis, Multi-input, multi-output representation.

Sampling and Reconstruction:
The Sampling Theorem and its implications, Spectra of sampled signals, Reconstruction: ideal interpolator, zero-order hold, first-order hold, Aliasing and its effects. Relation between continuous and discrete time systems, Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

UNIT V

Laplace and z -Transform:

The Laplace Transform -The Region of Convergence - Properties, The Inverse Laplace Transform, Laplace Transform Pairs, Analysis and Characterization of LTI Systems Using the Laplace Transform, Unilateral Laplace Transform. The Z-Transform -Region of Convergence - Properties, the Inverse z-Transform, Common z-Transform Pairs, Analysis and Characterization of LTI Systems using z-Transforms, Unilateral z-Transform.

Text / Reference Books:

1. Alan V. Oppenheim, Alan S. Willsky, & S. HamidNawab, "Signals and Systems," Pearson
   Higher Education, 2nd Ed., 1997.
2. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson, 2006.
3. Simon Haykin and B. Van Veen, "Signals & Systems," John Wiley and Sons, 2nd Edition, 2007.
4. B.P. Lathi, "Principles of LINEAR SYSTEMS and SIGNALS," Oxford Univ. Press, Second Edition, International version, 2009.
5. H. P. Hsu, "Signals and systems", Schaum's series, McGraw Hill Education, 2010.
6. Luis F. Chaparro, "Signals and Systems using MATLAB," Academic Press, 2011.
7. C. L. Philips, J. M. Parr and Eve A. Riskin, "Signals, Systems and Transforms," Pearson Education, 4th Edition, 2008.

EEPCT404	Electrical Machines – II	3L:1T:0P	4 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Understand the concepts of rotating magnetic fields.
2. Understand the operation of ac machines.
3. Analyse performance characteristics of ac machines.
4. Determine performance of ac machines

UNIT-I

Fundamentals of AC machine windings (8 Hours)

Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single-turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, Air-gap MMF distribution with fixed current through winding - concentrated and distributed, Sinusoidally distributed winding, winding distribution factor.

Pulsating and revolving magnetic fields (4 Hours)

Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current ,Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.

UNIT-II

Induction Machines (10 Hours)

Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of
parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency).

UNIT-III

Starting methods of Induction machines (6 Hours)

Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.

Single-phase induction motors (6 Hours)

Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications,

UNIT-IV

Synchronous generators (10 Hours)

Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

UNIT-V

Synchronous motors (10 hrs)

Principle of operation, methods of starting , Phasor diagram of synchronous motor, variation of current and power factor with excitation , Predetermination of V and inverted V curves, Hunting and use of damper bars, Synchronous condenser and power factor correction, Excitation and power circles.

Text/References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
5. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.

   P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007

EOHST405	Accountancy	2L:0T:0P	2 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course outcomes: At the end of the course Students will be able to

1. **Know the functions of Accounting**
2. **Understand the financial Analysis**
3. **Understand the concepts of Depreciation**
4. **Learn the payback period of capital Budget**

UNIT-I

Management Accounting – Definition, Objectives, Scope and Functions. Financial Accounting – Introduction, Process, Principles and Concepts. Financial Statements – Trading Account, Balancing Process, Profit & Loss Account and Balance Sheet.

UNIT-II

Financial Statement Analyses – Trend Percentage Analysis, Ratio Analysis, Fund Flow Statement Analysis, Cash Flow Statement Analysis.

UNIT-III

Methods of Depreciation – Straight line, Depletion, Machine Hour Rate, Diminishing Balance, Sum of Digits, Sinking Fund and Insurance Policy Methods. Inventory Valuation Methods – FIFO, LIFO, Average Weighted Average, Base Stock and HIFO Methods.

UNIT-IV

Capital Budgeting – Pay Back Period, ARR, NPV, PI and IRR Methods. Unit Costing – Introduction, Direct Cost Classification and Indirect Cost Classification. Introduction to Process Costing, Job Costing and Activity Based Costing

UNIT-V

Marginal Costing – Introduction, Definition, Meaning and BEP Analysis and BEP in units. Standard Costing – Introduction, Variance Analysis Material Cost Variance, Material Price Variance, Labor Variance, and Sales Variance. Budgetary Control – Introduction and Classification of Budgets, Production, Material / Purchase, Sales, Sales Overhead, Cash and Factory Overheads Budgets. Flexible Budget.

Text Book:

Pandi Kumar M P, Management Accounting*:* Theory and Practice, 1st Edition, Excel Books, 2007.

EEPCP406	Measurements and Instrumentation Laboratory	2L:0T:2P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Design and validate DC and AC bridges.
2. Analyze the dynamic response and the calibration of few instruments.
3. Learn about various measurement devices, their characteristics, their operation and their limitations.
4. Understand statistical data analysis.
5. Understand computerized data acquisition.

Lectures/Demonstrations:

1. Concepts relating to Measurements: True value, Accuracy, Precision, Resolution, Drift, Hysteresis, Dead-band, Sensitivity.
2. Errors in Measurements. Basic statistical analysis applied to measurements: Mean, Standard Deviation, Six-sigma estimation, C_p, C_{pk}.
3. Sensors and Transducers for physical parameters: temperature, pressure, torque, flow. Speed and Position Sensors.
4. Current and Voltage Measurements. Shunts, Potential Dividers. Instrument Transformers, Hall Sensors.
5. Measurements of R, L and C.
6. Digital Multi-meter, True RMS meters, Clamp-on meters, Meggers.
7. Digital Storage Oscilloscope.

Experiments

1. Measurement of a batch of resistors and estimating statistical parameters.
2. Measurement of L using a bridge technique as well as LCR meter. Measurement of C using a bridge technique as well as LCR meter.
3. Measurement of Low Resistance using Kelvin's double bridge.
4. Measurement of High resistance and Insulation resistance using Megger.
5. Usage of DSO for steady state periodic waveforms produced by a function generator. Selection of trigger source and trigger level, selection of time-scale and voltage scale. Bandwidth of measurement and sampling rate.
6. Download of one-cycle data of a periodic waveform from a DSO and use values to compute the RMS values using a C program.
7. Usage of DSO to capture transients like a step change in R-L-C circuit.
8. Current Measurement using Shunt, CT, and Hall Sensor.

Text books:

1. Measurement systems: Applications and Design by E.O.Doebelin, Mcgraw Hill publications
2. Electronic Instrumentation and measurement Techniques by William D.Cooper
3. Electronic Instrumentation by Kalsi H.S
4. Electrical measurements and measuring instruments by Golding E.W
5. 5.Electronics measurements and instrumentation by A.K.Sawhney

EEPCP407	**Electrical Machines-II Lab**	**0L:0T:2P**	**1 Credits**
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Hands-on experiments related to the course contents of Electrical Machines-II.

ECPCP408	Digital Electronics Lab	0L:0T:2P	1 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Hands-on experiments related to the course contents of Digital Electronics.

EEPCT501	Control Systems	3L:1T:0P	4 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Understand the modelling of linear-time-invariant systems using transfer function and state-space representations.
2. Understand the concept of stability and its assessment for linear-time invariant systems.
3. Design simple feedback controllers.

UNIT-I

Introduction to control problem (10 hours)

System Representation-Classification of systems-Feedback Control-Benefits of Feedback- Open-Loop and Closed-loop systems. Advantages and Dis-advantages of control systems-Industrial Control examples – Transfer functions and limitations.

UNIT-II

Modelling of control Systems (10 hours)

Mathematical models of Physical systems-Transfer function models of linear time-invariant systems- Electrical, Mechanical and Electro-Mechanical Systems-Electrical Analogues-Block diagram and their Reduction techniques-Signal flow graph.

UNIT-III

Time Response and Stability Analysis (10 hours)

Standard test signals. Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for second-order systems based on the time-response-Steady state error -Static and generalized error constants.

Concept of stability–Absolute and Relative Stability analysis-Routh-Hurwitz Criteria, Root-Locus technique. Construction of Root-loci –problems.

UNIT-IV

Frequency-response analysis (8 hours)

Introduction to Frequency domain specifications -Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – Gain and Phase margin.

UNIT-V

State variable Analysis (8 hours)

Concepts of state variables- State space model- Diagonalization of State Matrix-Solution of state equations- Eigenvalues and Stability Analysis-State Transition Matrix(STM) -Concept of controllability and observability.

Text/References:

1. M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.
2. B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.
3. 3.K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.
4. 4.I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009

EEPCT502	Power Systems – II	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Understand the concepts of Compensation in transmission lines.
2. Understand the generation of over-voltages and insulation coordination
3. Understand the various power system components.
4. Evaluate fault currents for different types of faults.

UNIT-I

Transmission line characteristics (8 hrs)

Surge Impedance Loading. Series and Shunt Compensation of transmission lines. Power Transfer, Voltage profile and Reactive Power. Per-unit System and per-unit calculations.

UNIT-II

Over-voltages and Insulation Requirements (4 hours)

Generation of Over-voltages: Lightning and Switching Surges. Protection against Over-voltages, Insulation Coordination. Propagation of Surges. Voltages produced by traveling surges. Bewley Diagrams.

UNIT- III

Distribution - Comparison of AC single phase, Types of primary distribution systems-Types of secondary Distribution systems-AC distributors fed at one end and at both ends-Kelvin's law-Limitations of Kelvin's law- Choice of scheme-Size of feeders, voltage & power factor correcting methods, substations, load modelling and characteristics.

UNIT-IV

Cables: Introduction-The insulation types-Insulating materials for EHV voltage cables-Classification of cables - Parameters of single core cable-Grading of cables-Capacitance of three core belted cable break down of cables-Heating of cables – dielectric loss and Sheath losses-Current rating of cables.

UNIT -V

Power Flow Analysis (8 hours)

Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications. Application of numerical methods for solution of non-linear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations.

Text/References Books:

1. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
2. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.
3. A. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 1999.
4. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003.
5. 5.B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power Systems”, Wiley, 2012.
5. Electrical Power Systems by C.L.Wadhava

ECPCT503	Microprocessors	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Do assembly language programming.
2. Do interfacing design of peripherals like I/O, A/D, D/A, timer etc.
3. Develop systems using different microcontrollers.

UNIT-I

Fundamentals of Microprocessors: (7Hours)

Fundamentals of Microprocessor Architecture.8-bitMicroprocessor and Microcontroller architecture, Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers. Definition of embedded system and its characteristics, Role of microcontrollers in embedded Systems. Overview of the 8051 family.

UNIT-II

The 8051 Architecture (8 Hours)

Internal Block Diagram, CPU, ALU, address, data and control bus, Working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory, Timing diagrams and Execution Cycles.

UNIT-III

Instruction Set and Programming (8 Hours)

Addressing modes: Introduction, Instruction syntax, Data types, Subroutines Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, Bit inherent addressing, bit direct addressing. 8051 Instruction set, Instruction timings. Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instruction. Assembly language programs, C language programs. Assemblers and compilers. Programming and debugging tools.

UNIT-IV

Memory and I/O Interfacing (6 Hours):

Memory and I/O expansion buses, control signals, memory wait states. Interfacing of peripheral devices such as General Purpose I/O, ADC, DAC, timers, counters, memory devices.

UNIT-V

External Communication Interface (6 Hours)

Synchronous and Asynchronous Communication. RS232, SPI, I2C. Introduction and interfacing to protocols like Blue-tooth and Zig-bee.

Applications (06 Hours)

LED, LCD and keyboard interfacing. Stepper motor interfacing, DC Motor interfacing, sensor interfacing.

Text / References Books:

1. M .A.Mazidi, J. G. Mazidi and R. D. McKinlay, “The8051Microcontroller and Embedded Systems: Using Assembly and C”,Pearson Education, 2007.
2. K. J. Ayala, “8051 Microcontroller”, Delmar Cengage Learning,2004.
3. R. Kamal, “Embedded System”, McGraw Hill Education,2009.
4. R. S. Gaonkar, “, Microprocessor Architecture: Programming and Applications with the 8085”, Penram International Publishing, 1996
5. D. A. Patterson and J. H. Hennessy, "Computer Organization and Design: The Hardware/Software interface”, Morgan Kaufman Publishers, 2013.
6. D. V. Hall, “Microprocessors & Interfacing”, McGraw Hill Higher Education, 1991.

EEPET 504	Professional Elective-I	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

List of subjects: Professional Elective-I

1. CSPET 504.1 **Computer Organisation and Architecture**
2. EEPET 504.2 **Digital Signal Processing**
3. EEPET 504.3 **MATLAB and SIMULINK**

CSPET504.1	**Computer Organisation and Architecture**	**3L:0T:0P**	**3 Credits**
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Understand the concepts of microprocessors, their principles and practices.
2. Write efficient programs in assembly language of the 8086 family of microprocessors. Organize a modern computer system and be able to relate it to real examples.
3. Develop the programs in assembly language for 80286, 80386 and MIPS processors in real and protected modes.
4. Implement embedded applications using ATOM processor.

UNIT-I

Introduction to computer organization (6 hours)

Architecture and function of general computer system, CISC Vs RISC, Data types, Integer Arithmetic - Multiplication, Division, Fixed and Floating point representation and arithmetic, Control unit operation, Hardware implementation of CPU with Micro instruction, microprogramming, System buses, Multi-bus organization.

Memory organization (6 hours)

System memory, Cache memory - types and organization, Virtual memory and its implementation, Memory management unit, Magnetic Hard disks, Optical Disks.

UNIT-II

Input – output Organization (8 hours)

Accessing I/O devices, Direct Memory Access and DMA controller, Interrupts and Interrupt Controllers, Arbitration, Multilevel Bus Architecture, Interface circuits - Parallel and serial port. Features of PCI and PCI Express bus.

UNIT-III

16 and 32 microprocessors (8 hours)

80x86 Architecture, IA – 32 and IA – 64, Programming model, Concurrent operation of EU and BIU, Real mode addressing, Segmentation, Addressing modes of 80x86, Instruction set of 80x86, I/O addressing in 80x86

UNIT-IV

Pipelining(8 hours)

Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP, Data hazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence on instruction set.

UNIT-V

Different Architectures (8 hours)

VLIW Architecture, DSP Architecture, SoC architecture, MIPS Processor and programming

Text/Reference Books

1. V. Carl, G. Zvonko and S. G. Zaky, “Computer organization”, McGraw Hill, 1978.
2. B. Brey and C. R. Sarma, “The Intel microprocessors”, Pearson Education, 2000.
3. J. L. Hennessy and D. A. Patterson, “Computer Architecture A Quantitative Approach”, Morgan Kauffman, 2011.
4. W. Stallings, “Computer organization”, PHI, 1987.
5. P. Barry and P. Crowley, “Modern Embedded Computing”, Morgan Kaufmann, 2012.
6. N. Mathivanan, “Microprocessors, PC Hardware and Interfacing”, Prentice Hall, 2004.
7. Y. C. Lieu and G. A. Gibson, “Microcomputer Systems: The 8086/8088 Family”, Prentice Hall India, 1986.
8. J. Uffenbeck, “The 8086/8088 Design, Programming, Interfacing”, Prentice Hall, 1987.
9. B. Govindarajalu, “IBM PC and Clones”, Tata McGraw Hill, 1991.
10. P. Able, “8086 Assembly Language Programming”, Prentice Hall India.

EEPET 504.2	Digital Signal Processing	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
2. Analyse discrete-time systems using z-transform.
3. Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms. Design digital filters for various applications.

UNIT-I

Discrete-time signals and systems (6 hours)

Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.

UNIT-II

Z-transform (6 hours)

Z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z-transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.

UNIT-III

Discrete Fourier Transform (10 hours)

Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.

UNIT-IV

Design of Digital filters (12 hours)

Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band-stop and High-pass filters. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.

UNIT-V

Applications of Digital Signal Processing (6 hours)

Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

Text/Reference Books:

1. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill,
2. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.
3. J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms And Applications", Prentice Hall, 1997.
4. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.
5. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
6. D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

EEPET 504.3	MATLAB And SIMULINK	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

COURSE OBJECTIVES

1. To learn the MATLAB environment and its programming fundamentals
2. Ability to write Programs using commands and functions
3. Able to handle and solve the problems using matlab and Able to draw the plots
4. Able to create Simulink model

UNIT-I

MATLAB Introduction (8 HOURS), Fundamentals of MATLAB programming, Variables, Arrays, Matrices, MATLAB operators: Arithmetic operators, Relational operators, Logical operators, Operators precedence's, Examples

UNIT-II

MATLAB graphics(8 HO URS), **:** Plots, Sub plots, Other types of plots, Multiple plots in a graph, Logarithmic plots a graph, Various types of two dimensional plots, Plotting complex number sensional plots, Three dimensional plots, Examples

UNIT-III

Branching & looping functions: Branching functions, If Function, Switch Function Try/catch function, The error function, Looping functions, For function, While function

Break & continue functions, Examples.

Miscellaneous functions: String functions, Input/output functions, Input functions Output functions, Examples

Script Files: Example of a script file **(8 HOURS)**

UNIT-IV

MATLAB Applications(8 HOURS),**:** Solving a linear systems, Finding Eigen values and Eigen vectors, Matrix factorizations, Single value decomposition, Examples

UNIT-V

Fundamentals of SIMULINK(8 HOURS),**:** Introduction, Application block sets, Application toolboxes, The symbolic Math toolbox, Constructing a SIMULINK model, Taking variables from MATLAB, Running &analyzing a SIMULINK model, Discrete time systems, Examples

Text Books:

1. MATLAB and SIMULINK for Engineers by Agam Kumar Tyagi, Oxford university press
2. Getting started with MATLAB by Rudra Pratap, Oxford university press
3. Hanselman and Littlefield, "MasterigMatlab 7", Pearson Education Etter, Kuncickly, Hull, "Introduction to Matlab 6", Pearson Education

EEOET 505	**Open Elective-I**	**3L:0T:0P**	**3 Credits**
Sessional Marks : **40**		End Semester Examination Marks: **60**	

The Open Elective-I courses offered by other departments

(Chemical Engineering, Civil, CSE, ECE & Mechanical)

EEPCP506	**Control Systems Lab**	**0L:0T:2P**	**1 Credit**
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Hands-on experiments related to the course contents of Control Systems

EEPCP507	Power Systems - I Lab	0L:0T:2P	1 Credit
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Hands-on experiments related to the course contents of power system I.

ECPCP508	Micro Processors Lab	0L:0T:2P	1 Credit
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Hands-on experiments related to the course contents of Microprocessors.

EEPCT601	Power Systems -III	03L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Use numerical methods to analyse a power system in steady state.
2. Understand stability constraints in a synchronous grid.
3. Understand methods to control the voltage, frequency and power flow.
4. Understand the monitoring and control of a power system.
5. Understand the basics of power system economics.

UNIT-I

Fault analysis: Introduction to symmetrical fault analysis- The short circuit currents and the reactance of synchronous machines- Expressions for fault MVA in terms of per unit and percentage quantities-Need for current limiting reactors and their location.

UNIT-II

Sequence Networks: Symmetrical components-Power in terms of symmetrical components - sequence impedances and sequence networks-Sequence impedances of generators-Sequence impedances of transmission lines-Sequence impedances of transformers

Unsymmetrical fault Analysis: Fault current calculations for single line to Ground fault, Line to Line fault and Double line to Ground fault, open conductor fault.

UNIT-III

Stability Constraints in synchronous grids (8 hours)

Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three--phase fault. Analysis using numerical integration of swing equations (using methods like Forward Euler, Runge-Kutta 4^{th} order methods), Equal Area Criterion. Impact of stability constraints on Power System Operation.

UNIT-IV

Economic operation of power systems: Introduction – operating cost of a thermal plant – Economic dispatch neglecting losses and no generation limits –Economic dispatch including losses – derivation of loss formula - Unit commitment and optimal power flow constraints of unit commitment problem – Solution methods of unit commitment – priority list methods – Dynamic programming approach to solve the unit commitment problem.

UNIT-V

Control of Frequency and Voltage (8 hours)

Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control. Generation and absorption of reactive power by various components of a Power System. Excitation System Control in synchronous generators, Automatic Voltage Regulators. Series and Shunt Compensators.

Text/References:

1. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
2. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.
3. A. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 1999.
4. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003.
5. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power Systems”, Wiley, 2012.
6. Power System Analysis and design by B.R.Gupta, S.Chand publications.

EEPCT-602	Power Electronics	03L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Understand the differences between signal level and power level devices.
2. Analyse controlled rectifier circuits.
3. Analyse the operation of DC-DC choppers.
4. Analyse the operation of voltage source inverters.

UNIT-I

Power switching devices (8Hours)

Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

UNIT-II

Thyristor rectifiers (7Hours)

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.

UNIT-III

DC-DC buck converter (5Hours)

Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.

DC-DC boost converter (5Hours)

Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

UNIT-IV

Single-phase voltage source inverter (10Hours)

Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage

UNIT-V

Three-phase voltage source inverter (8Hours)

Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, operation in 120 deg and 180 deg modes, Output voltage expressions, harmoinc components in output voltage, average output voltages over a sub-cycle, three-phase sinusoidal modulation

Text/References:

1. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson
1. Education India, 2009.
2. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
3. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.
4. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

EEPET 603	**Professional Elective-II**	**3L:0T:0P**	**3 Credits**
EEPET 604	**Professional Elective-III**	**3L:0T:0P**	**3 Credits**
Sessional Marks : **40**		End Semester Examination Marks: **60**	

List of subjects- Professional Elective-II& III

1. EEPET 603.1 **Utilization of Electrical Energy**
2. EEPET 603.2 **Electrical Machine Design**
3. EEPET 603.3 **Special machines**

4. EEPET604.1 **Control System Design**
5. EEPET 604.2 **Digital Control Systems**
6. EEPET 604.3 **PLC's and Applications**

EEPET 603.1	Utilization Of Electrical Energy	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objectives: Students will be able to

1. To provide students basic practical knowledge of illumination and to get general ideas about street lighting, building lighting.
2. To provide students' knowledge about the various electric heating methods and their advantages.
3. To make students to learn electrical welding methods and their advantages
4. To provide students basic practical knowledge of electric drives and to learn the characteristics of different mechanical loads.
5. To provide students' knowledge about the electric traction &their advantages.

UNIT–I

Illumination(8 HOURS): Nature of light, definitions, Laws of illumination, different types of lamps, construction and working of incandescent lamp, fluorescent lamp and discharge lamps, Illumination schemes; indoor and outdoor, Illumination levels. General ideas about street lighting, building lighting.

UNIT–II

Electric Heating(8 HOURS): Advantages of electrical heating, Heating methods: Resistance heating, Induction heating, Electric arc heating, construction and working of arc furnace, Dielectric heating, Infra-red heating, Microwave heating, design problems of resistance heating element.

UNIT –III

Electric Welding (8 HOURS): Advantages of electric welding, Welding methods, Principles of resistance welding, welding equipments used, Principle of electric arc welding, carbon arc, metal arc, hydrogen arc welding methods and their applications. Advantages of using coated electrodes, comparison between AC and DC arc welding, welding control circuits.

UNIT –IV

Electric Drives(8 HOURS): Introduction, Advantages of electric drives, Characteristics of different mechanical loads, Types of motors used in electric drive, types of braking, Methods of power transfer, selection of motors for different types of domestic loads.

UNIT –V

Electric Traction(8 HOURS): Advantages of electric traction, Different systems of electric traction, DC and AC systems, diesel electric system, types of services – urban, sub-urban, and main lines and their speed-time curves, pentagraph, Factors affecting scheduled speed, types of motors used for electric traction, Starting and braking of traction motors.

<u>Text Books :</u>

1. Art and Science of Utilization of Electrical Energy by H Partap, DhanpatRai & Sons, Delhi.
2. Utilization of Electrical Energy by JB Gupta, Kataria Publications, Ludhiana.
3. A.Text Book. of Electrical Power by Dr. SL Uppal, Khanna Publications, Delhi.
4. Modern Electric Traction by H Partap, DhanpatRai& Sons, Delhi.
5. Utilization of Electrical Energy by OS Taylor, Pitman Publications.
6. Generation, Distribution and Utilization if Electrical Power by CL Wadhwa, Wiley Eastern, Ltd., New Delhi.

EEPET 603.2	Electrical Machine Design	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Understand the construction and performance characteristics of electrical machines.
2. Understand the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines
3. Understand the principles of electrical machine design and carry out a basic design of an ac machine.
4. Use software tools to do design calculations.

UNIT-I

Introduction

Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.

UNIT-II

Transformers

Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.

UNIT-III

Induction Motors

Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of polyphase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.

UNIT-IV

Synchronous Machines

Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.

UNIT-V

Computer aided Design (CAD):

Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design. Introduction to **c**omplex structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines.

Text / References:

1. A. K. Sawhney, “A Course in Electrical Machine Design”, DhanpatRai and Sons, 1970.
2. M.G. Say, “Theory & Performance & Design of A.C. Machines”, ELBS London.
3. S. K. Sen, “Principles of Electrical Machine Design with computer programmes”, Oxford and IBH Publishing, 2006.
4. K. L. Narang, “A Text Book of Electrical Engineering Drawings”, Satya Prakashan, 1969.
5. A. Shanmugasundaram, G. Gangadharan and R. Palani, “Electrical Machine Design Data Book”, New Age International, 1979.
6. K. M. V. Murthy, “Computer Aided Design of Electrical Machines”, B.S. Publications, 2008.
7. Electrical machines and equipment design exercise examples using Ansoft’s Maxwell 2D machine design package.

EEPET 603.3	Special Machines	3L:0T:0P	3 Credits
Sessional Marks : **40**	End Semester Examination Marks: **60**		

Course Outcomes:
At the end of the course, student will be able to
1.understand field aspects of electrical machines
2.understand the operation and control of
(i) stepper motors
(ii) BLDC motors
(iii) SR motors

UNIT-I

Field aspects of electrical machines: Review of Maxwell's equations and solution of Laplace's and Poisson's equations., Concept of magnetic vector potential. Eddy current braking. Linear motors: Basic principle of operation and types. End effects & transverse edge effects. Field analysis & Propulsion force; equivalent circuit.

UNIT-II

Stepper motors: Construction and operation of Stepper Motors: variable reluctance, permanent magnet, hybrid stepper motors, characteristics of stepper motors. Drive Circuits for Stepper motors: Block diagram of stepper motor controller, logic sequence generator, power drivers, current suppression circuits, acceleration and deceleration circuits.

UNIT-III

Microprocessor control of stepper motors: microprocessor based stepper motor controller, PC based stepper motor controller. Micro-stepping Control of Stepper motors: the micro-stepping principle, advantages of micro stepping, design of basic micro-stepping controller. Applications of stepper motor

UNIT-IV

Brushless DC motor: principle of operation of BLDC motor, squre wave permanent magnet brushless motor drives, sine wave permanent magnet Brushless DC motor drives, phasor diagram, torque speed characteristics, controllers for BLDC motors, alternating current drives with PM and synchronous reluctance hybrid motors.

UNIT-V

Switched Reluctance Motor Drives: Types of SR motors , principle of operation, static torque production, energy conversion loop, dynamic torque production. Converter Circuits, Control of SR motors: current regulation, commutation, torque speed characteristics, shaft position sensing.

Text Books :

1. V VAthani, " Stepper Motors Fundamentals, Applications, and Design", New Age.
1. 2. TJE Miller, " Brushless Permanent-Magnet and Reluctance Motor Drives" Clarendon Press , Oxford

EEPET 604.1	Control Systems Design	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes: At the end of this course, students will demonstrate the ability to understand various design specifications.

1. Design controllers to satisfy the desired design specifications using simple controller structures (P, PI, PID, compensators).
2. Controller design with time domain and frequency domain approach.
3. Design controllers using the state-space approach.

UNIT- I

Introduction to Controllers and compensators (10 hours)

Control Action response with Proportional, Integral and Derivative Controllers-Application of Controllers-problems.

Need for compensators- Lead -Lag – Lead lag compensators – Applications of compensators – Comparison of controllers and compensators-Problems. Effect of addition of poles and zeros on system performance.

UNIT- II

Design of PID controllers (6 hours)

Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback – Feed forward control.

UNIT III

Design of Classical Control System (8 hours)

Design of lead, Lag, and lag-lead compensator in time domain- Root locus approach-Feedback and Feed forward compensator design-Realization of compensators.

UNIT IV

Design of Classical Control System in frequency domain (8 hours)

Compensator design - lead, Lag and lag-lead compensator in frequency domain to improve steady state and transient response- Feedback and Feed forward compensator design using bode diagram.

UNIT V

Control System Design in state space (8 hours)

Review of state space representation. Concept of controllability and observability, effect of pole zero cancellation on the controllability and observability of the system, pole placement design through state feedback. Ackerman's Formula for feedback gain design. Design of Observer. Reduced order observer. Separation Principle.

Text and Reference Books :

1. K. Ogata, "Modern Control Engineering", Prentice Hall, 2010.
2. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
3. B. C. Kuo, "Automatic Control system", Prentice Hall, 1995.
4. R. T. Stefani and G. H. Hostetter, "Design of feedback Control Systems", Saunders College Pub, 1994.
5. J. J. D'Azzo and C. H. Houpis, "Linear control system analysis and design (conventional and modern)", McGraw Hill, 1995.
6. I. J. Nagrath and M. Gopal, "Control system engineering", Wiley, 2000.
7. N. Nise, "Control system engineering", John Wiley, 2000.

EEPET 604.2	Digital Control Systems	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Obtain discrete representation of LTI systems.
2. Analyse stability of open loop and closed loop discrete-time systems.
3. Design and analyse digital controllers.
4. Design state feedback and output feedback controllers.

UNIT-I

Discrete Representation of Continuous Systems (6 hours)

Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.

UNIT-II

Discrete System Analysis (6 hours)

Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane.Solution of Discrete time systems. Time response of discrete time system.

UNIT-III

Stability of Discrete Time System (4 hours)

Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design.

UNIT-IV

State Space Approach for discrete time systems (10 hours)

State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability.

UNIT-V

Design of Digital Control System(8 hours)

Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator.

Discrete output feedback control (8 hours)

Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

Text Books :

1. K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs.
2. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
3. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems", Addison-Wesley, 1998.
4. B.C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980.

EEPET 604.3	PLC's and Applications	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objectives:

At the end of the course, the student will demonstrate

1. understand applications of PLCs and different types of PLCs
2. use Easy Veep software
3. learn hardware details of Allen bradely PLC
4. programming of PLCs

UNIT-I

Introduction:

Process to rewind, test, and integrate with extrusion process for wiring and fiber optic industries Food industry – yeast, flour distribution and control
Process Medical equipment Industry – Gas analyzer, Leak tester (using CO2), plastic wrapping machines etc., Mechanical relays versus PLC
Different types of PLC's – Allen-Bradley – Micrologix:
ML1000, ML1100, SLC500, Compact Logix, Mitsubishi FX series, HMI's
Processor and I/O cards

UNIT-II

Introduction to EasyVeep software
Link between mechanical, electrical and programming documentation Food industry – Yeast distribution system - Example Logic diagrams
Flip-Flop Logic, M8000, M8001 internal bits interpretation
Binary code, data table, manipulation and search engine in Mitsubishi environment Communication between PC and PLC
Communication between PC and HMI, PLC and HMI Serial Local network Introduction to SLC500

UNIT-III

Programming software and applications ,Boolean algebra – understanding binary code, ADD and SUB functions ,UP and Down Counters ,Introduction to k1Y0
MOV function, CPR and ZCP functions ,SHWT and SHRD instructions, Introduction to Absolutely Drum Instruction
Allen Bradley PLC :Introduction to Rockwell Software ,Hardware focus Hardware considerations (Field wiring, Master Control Relay, VFD) ,Basic programming applications, Cascade control – subroutine, Different programs and detail explanation

UNIT-IV

Programming instructions :Instructions and binary interpretation, Bit Instruction Timers and counters, Comparison instructions ,Programming Instructions Math instructions, Move and Logical Instructions, Discussions of programming communications for PLC-Robotic arm ,Exercise of setup and monitoring

UNIT-V

Analog and Digital parameters by using SLC5/03-VFD-Panel Mate series 1700 Practical Troubleshooting, troubleshooting technique, Control system stability and tuning basics.

Text Books/References:

1. Automating manufacturing system With PLCS by Hough Jack
2. PLC Hand Book (Automating Direct Seimens PLC Hand Book
3. Programmable Logic Controllers –by R. Bliesener, F Ebel, (Festo. publishers)

EEOET 605	**Open Elective-II(MOOCS)**	**3L:0T:0P**	**3 Credits**
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Moocs Courses selected by the Students

MGHST606	Management Science	3L:0T: 0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Objectives of the course:
To expose the students to the following:
Course Outcomes: At the end of this course, student will demonstrate the ability to
1. Work more creatively, work in groups
2. Presenting ideas more effectively and efficiently in formal and informal ways
3. Development of fundamental rethinking and radical redesign in the organizations.
4. Applying the ideas of the course to identifying and solving real world problems.
5. Development of Group Dynamic Skills.

Unit -I

Concept of Management – Administration, Organization – Functions of Management, evolution of management thought – Organization, principles of organization – Types – Organization charts – Managerial objectives and social responsibilities.

Unit -II

Corporate planning – Mission, Objectives, and programs, SWOT analysis – Strategy formulation and implementation – Plant location and Plant layout concepts – Production control.

Unit -III

Human resources management – Manpower planning – Personnel management – Basic functions of personnel management job evaluation and merit rating – Incentive plans- Marketing, Functions of marketing.

Unit -IV

Productivity - Batch and mass production – Work study – Basic procedure involved in method study - work measurement – Elements of cost – Methods of calculation of overhead charges – Depreciation

Unit -V

Network Analysis to project management – PERT/CPM – Application of network techniques to engineering problems. – Cost Analysis – Project crashing.

Texts/Reference Books:
1. Principles of Management by Koontz and O Donnel.
2. Industrial Engineering and Management by O.P.Khanna.
3. Marketing by Philips KotherPERT/CPM by L.S.Srinath
   Business policy by Gluck (TMH)

EEPCP607	**Power Electronics Lab**	**03L:0T:0P**	**3 Credits**
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Hands-on experiments related to the course contents of **Power Electronics**.

ECPCP608	Electronics Design Laboratory	0L:0T:4P	2 credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Understand the practical issues related to practical implementation of applications using electronic circuits.
2. Choose appropriate components, software and hardware platforms.
3. Design a Printed Circuit Board, get it made and populate/solder it with components. Work as a team with other students to implement an application.

List of Experiments:

1. Basic concepts on measurements; Noise in electronic systems;
2. Sensors and signal conditioning circuits;
3. Introduction to electronic instrumentation and PC based data acquisition;
4. Electronic system design, Analog system design, Interfacing of analog and digital systems, Embedded systems, Electronic system design employing microcontrollers, CPLDs, and FPGAs, PCB design and layout; System assembly considerations.
5. Group projects involving electronic hardware (Analog, Digital, mixed signal) leading to implementation of an application.

Text/Reference Books

1. A. S. Sedra and K. C. Smith, "Microelectronic circuits", Oxford University Press, 207.
2. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1997.
3. H.W.Ott, "Noise Reduction Techniques in Electronic Systems", Wiley, 1989.
4. W.C. Bosshart, "Printed Circuit Boards: Design and Technology", Tata McGraw Hill, 1983.
5. G.L. Ginsberg, "Printed Circuit Design", McGraw Hill, 1991.

EEPET 701	**Professional Elective-IV**	**3L:0T:0P**	**3 Credits**
EEPET 702	**Professional Elective-V**	**3L:0T:0P**	**3 Credits**
EEPET 703	**Professional Elective-VI**	**3L:0T:0P**	**3 Credits**
Sessional Marks : **40**		End Semester Examination Marks: **60**	

List of subjects- Professional Elective-IV, V & VI

1. EEPET 701.1 **Power System Protection**
2. EEPET 701.2 **Advanced Microprocessors**
3. EEPET 701.3 **Line Commutated and Active Rectifiers**
4. EEPET 702.1 **Electric Drives**
5. EEPET 702.2 **Power System Dynamics and Control**
6. EEPET 702.3 **High Voltage Engineering**
7. EEPET 703.1 **Energy Management & Auditing**
8. EEPET 703.2 **Electrical and Hybrid Vehicles**
9. EEPET 703.3 **Wind and Solar Energy Systems**

EEPET 701.1	Power System Protection	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objectives: Students will be able to

1. Understand the different components of a protection system.
2. Evaluate fault current due to different types of fault in a network.
3. Understand the protection schemes for different power system components.
4. Understand the basic principles of digital protection.
5. Understand system protection schemes, and the use of wide-area measurements.

UNIT-I (8 HOURS)

Fuses and Circuit breakers:

Fuses: Definitions, characteristics, types, HRC fuses.

Circuit breakers: Introduction - Formation of Arcs in CBs - arc interruption theories - Definitions - Current chopping - Classification of circuit breakers - Oil circuit breakers- Air blast circuit breaker - SF6 circuit breaker-Vacuum circuit breaker - Testing of circuit breakers.

UNIT-II (8 HOURS)

Protective Relaying fundamentals :Protective Relaying fundamentals-– Need for protective systems in a power system – Zones of protection - Primary and backup protection – definition and functional characteristics of a protective relay – operating principles of various electromagnetic relays.

UNIT–III (8 HOURS)

Types of Protective Relays: Overcurrent relays – Directional overcurrent relays – applications of over current relays. Distance relays: the universal torque equation – impedance, reactance and mho relays - differential relays – percentage differential relays – Static relays

UNIT–IV(8 HOURS)

Generator Protection: Protection against stator faults, against rotor faults and against abnormal conditions.

Transformer Protection: Buchholtz relay, differential protection, percentage differential protection.

Bus-bar protection: Bus bar arrangement Schemes ,Frame leakage protection scheme.

UNIT-V (8 HOURS)

Digital Protection

Instrument Transformers, Synchro-phasors, Phasor Measurement Units and Wide-Area Measurement Systems (WAMS). Application of WAMS for improving protection systems. Computer-aided protection.

Text/References

1. J. L. Blackburn, “Protective Relaying: Principles and Applications”, Marcel Dekker, New York, 1987.
2. Y. G.Paithankar and S. R. Bhide, “Fundamentals of power system protection”, Prentice Hall, India, 2010.
3. A. G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, John Wiley & Sons, 1988.
4. A. G. Phadke and J. S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer, 2008.
5. D. Reimert, “Protective Relaying for Power Generation Systems”, Taylor and Francis, 2006.

EEPET 701.2	Advanced Microprocessors	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objectives:

At the end of the course, student will be able to do

1. learn architectural differences between different Intel processors
2. learn different types of RISC processors
3. know PC hardware and its overview

UNIT I

80186, 80286, 80386 AND 80486 MICROPROCESSORS 80186 Architecture, Enhancements of 80186 – 80286 Architecture Real and Virtual Addressing Modes
80386 Architecture Special Registers Memory Management Memory PagingMechanism
80486 Architecture – Enhancements – Cache Memory Techniques – ExceptionHandling
Comparison of Microprocessors (8086 – 80186 –80286 – 80386 – 80486).

UNIT II

PENTIUM MICROPROCESSORS

Pentium Microprocessor Architecture – Special Pentium Registers – Pentium Memory Management – New Pentium Instructions – Pentium Pro Microprocessor Architecture – Specialfeatures –Pentium II Microprocessor Architecture –Architecture – Pentium III Architecture – Pentium IV Architecture – Comparison of Pentium Processors.

UNIT III

RISC PROCESSORS I

PowerPC620 – Instruction fetching – Branch Prediction – Fetching – Speculation, Instruction dispatching – dispatch stalls – Instruction Execution – Issue stalls-Execution Parallelism–Instructioncompletion – Basics of P6 micro architecture –Pipelining – our-of-order core pipeline – Memory subsystem.

UNIT IV

RISC PROCESSORS II(SUPERSCALAR PROCESSORS)

Intel i960 – Intel IA32- MIPS R8000 – MIPS R10000 – Motorola 88110 – Ultra SPARC processor- SPARC version 8 – SPARC version 9.

UNIT V

PC HARDWARE OVERVIEW

Functional Units & Interconnection, New Generation Mother Boards 286 to Pentium 4Bus Interface- ISA- EISA- VESA- PCI-PCIX.
Peripheral Interfaces and Controller, Memory and I/O Port Addresses.

Text Books:

1. B.B.Brey The Intel Microprocessor 8086/8088 /80186/80188, 80286, 80386, 80486PENTIUM, PENTIUM Pro, PII, PIII & IV Archietecture, Programming & Interfacing, PearsonEducation , 2004.
2. John Paul Shen, Mikko H.Lipasti, “Modern Processor Design”, Tata Mcgraw Hill, 2006.

References

1. Douglas V.Hall, “Microprocessors and Interfacing”, Tata McGraw Hill, II Edition2006
2. Mohamed Rafiquzzaman, “Microprocessors and Microcomputer Based System
3. Design”, II Edition, CRC Press, 2007.
4. Computer Control of Processes – M.Chidambaram. Narosa 2003.
5. PC Based Instrumentation and Control Third Edition by Mike Tooley ; Elsevier PC Interfacing and Data Acquisition Techniques for Measurement, Instrumentation and Control. By Kevin James; Elsevier.

EEPET 701.3	Line-Commutated and Active Rectifiers	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objectives:

Students will be able to Analyze controlled rectifier circuits.

1. Understandtheoperationofline-commutatedrectifiers– 6pulseandmultipulseconfigurations.
2. Understand the operation of PWM rectifiers – operation in rectification and regeneration modes and lagging, leading and unity power factor mode.

UNIT-I

Dioderectifiers with passive filtering (8 HOURS)

Half-wavedioderectifierwithRLandRCloads;1-phasefull-wavedioderectifierwithL,dLCfilter;3-phasedioderectifierwithL,CandLCfilter;continuousanddiscontinuousconduction,inputcurrentwaveshape,effectofsourceinductance;commutationoverlap.

UNIT-II

Thyristorrectifiers with passive filtering (8 HOURS)

Half-wave thyristor rectifier with RL and RCloads;1-phasethyristorrectifierwithL and LCfilter; 3-phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current wave shape.

UNIT-III

Multi-Pulse converter (8 HOURS)

Review of transformer phase shifting, generation of 6-phase ac voltage from 3-phase ac, 6-pulse converter and 12-pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation.

UNIT-IV

Single-phase ac-dc single-switch boost converter(8 HOURS)

Review of dc-dc boost converter, power circuit of single-switch ac-dc converter, steady state analysis, unity power factor operation, closed-loop control structure. Dc-dc fly back converter, output voltage as a function of duty ratio and transformer turns ratio. Power circuit of ac-dc fly back converter, steady state analysis, unity power factor operation, closed loop control structure.

UNIT-V

Ac-dc bidirectional boost converter (8 HOURS)

Reviewof1-phase inverter and 3-phase inverter, power circuits of 1-phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors. Rectification and regenerating modes. Phasor diagrams, closed-loop control structure.

Text/Reference Books:

1. G.De,“PrinciplesofThyristorisedConverters”,Oxford&IBHPublishingCo,1988.
2. J.G. Kassakian, M. F. Schlecht and G.C. Verghese,“Principles of Power Electronics”, Addison-Wesley,1991.
3. L.Umanand, “Power Electronics: Essentials andApplications”,WileyIndia,2009.
4. N.MohanandT.M.Undeland,“PowerElectronics:Converters,Applications and Design”, John Wiley & Sons,2007.
5. R.W.Erickson and D.Maksimovic, “Fundamentals of Power Electronics”, Springer Science & Business Media,2001.

EEPET 702.1	Electrical Drives	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes:

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

1. Understand the characteristics of dc motors and induction motors.
2. Understand the principles of speed-control of dc motors and induction motors.
3. Understand the power electronic converters used for dc motor and induction motor speed control.

UNIT-I

DC motor characteristics (5 hours)

Review of emf and torque equations of DC machine, review of torque-speed characteristics of separately excited dc motor, change in torque-speed curve with armature voltage, example load torque-speed characteristics, operating point, armature voltage control for varying motor speed, flux weakening for high speed operation.

Chopper fed DC drive (5 hours)

Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper, efficiency of dc drive, smooth starting.

UNIT-II

Multi-quadrant DC drive (6 hours)

Review of motoring and generating modes operation of a separately excited dc machine, four quadrant operation of dc machine; single-quadrant, two-quadrant and four-quadrant choppers; steady-state operation of multi-quadrant chopper fed dc drive, regenerative braking.

UNIT-III

Closed-loop control of DC Drive (6 hours)

Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor – dynamic equations and transfer functions, modeling of chopper as gain with switching delay, plant transfer function, for controller design, current controller specification and design, speed controller specification and design.

UNIT-IV

Induction motor characteristics (6 hours)

Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency, typical torque-speed curves of fan and pump loads, operating point, constant flux operation, flux weakening operation.

UNIT-V

Scalar control or constant V/f control of induction motor (6 hours)

Review of three-phase voltage source inverter, generation of three-phase PWM signals, sinusoidal modulation, space vector theory, conventional space vector modulation; constant V/f control of induction motor, steady-state performance analysis based on equivalent circuit, speed drop with loading, slip regulation.

Control of slip ring induction motor (6 hours)

Impact of rotor resistance of the induction motor torque-speed curve, operation of slip-ring induction motor with external rotor resistance, starting torque, power electronic based rotor side control of slip ring motor, slip power recovery.

Text / References:

1. G. K. Dubey, “Power Semiconductor Controlled Drives”, Prentice Hall, 1989.
2. R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, Prentice Hall, 2001.
3. G. K. Dubey, “Fundamentals of Electrical Drives”, CRC Press, 2002.
4. W. Leonhard, “Control of Electric Drives”, Springer Science & Business Media, 2001

EEPET 702.2	Power System Dynamics and Control	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objectives: Students will be able to

1. Understand the problem of power system stability and its impact on the system.
2. Analyzelineardynamicalsystemsanduseofnumericalintegrationmethods.
3. Model different power system components for the study of stability.
4. Understand the methods to improve stability.

UNIT-I

Introduction to Power System Operations (8 HOURS)

Introduction to power system stability. Power System Operations and Control. Stability problems in Power System. Impact on Power System Operations and control.

UNIT-II

Analysis of Linear Dynamical System and Numerical Methods(8 HOURS)

Analysis of dynamical System, Concept of Equilibrium, Small and Large Disturbance Stability. Modal Analysis of Linear System. Analysis using Numerical Integration Techniques. Issues in Modeling: Slow and Fast Transients, Stiff System.

UNIT-III

Modeling of Synchronous Machines and Associated Controllers(8 HOURS)

Modeling of synchronous machine: Physical Characteristics. Rotor position dependent model. D-Transformation. Model with Standard Parameters. Steady State Analysis of Synchronous Machine. Short Circuit Transient Analysis of a Synchronous Machine. Synchronization of Synchronous Machine to an Infinite Bus. Modeling of Excitation and Prime Mover Systems. Physical Characteristics and Models. Excitation System Control. Automatic Voltage Regulator. Prime Mover Control Systems. Speed Governors.

UNIT-IV

Modeling of other Power System Components(8 HOURS)

Modeling of Transmission Lines and Loads. Transmission Line Physical Characteristics. Transmission Line Modeling. Load Models- induction machine model. Frequency and Voltage Dependence of Loads. Other Subsystems–HVDC and FACTS controllers, Wind Energy Systems.

UNIT-V

Stability Analysis(8 HOURS)

Angular stability analysis in Single Machine Infinite Bus System. Angular Stability in multi-machine systems–Intra- plant, Local and Inter-area modes. Frequency Stability: Centre of Inertia Motion. Load Sharing: Governor droop. Single Machine Load Bus System: Voltage Stability. Introduction to Torsional Oscillations and the SSR phenomenon. Stability Analysis Tools: Transient Stability Programs, Small Signal Analysis Programs.

Enhancing System Stability

Planning Measures. Stabilizing Controllers(Power System Stabilizers). Operational Measures-Preventive Control. Emergency Control.

Text/Reference Books:

1. K.R.Padiyar,"PowerSystemDynamics,StabilityandControl",B.S.Publications,200
2. P.Kundur, "Power System Stability and Control", McGrawHill,1995.
3. P. Sauerand M. A.Pai, "Power System Dynamics and Stability", Prentice Hall, 1997.

EEPET 702.3	High Voltage Engineering	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objectives:

At the end of the course, the student will demonstrate

1. Understand the basic physics related to various breakdown processes in solid, liquid and gaseous insulating materials.
2. Knowledge of generation and measurement of D. C., A.C., & Impulse voltages. Knowledge of tests on H. V. equipment and on insulating materials, as per the standards.
3. Knowledge of how over-voltages arise in a power system, and protection against these over-voltages.

UNIT-I

Breakdown in solid, liquid and gas insulating materials (12 Hours)

Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend's theory, Streamer mechanism, Corona discharge Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials.

UNIT-II

Generation of High Voltages (7 Hours)

Generation of high voltages, generation of high D. C. and A.C. voltages - Van de Graff Generator, Cockcroft Walton Voltage multipliers, Cascade transformer circuits, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.

UNIT-III

Measurements of High Voltages and Currents (7 Hours)

Peak voltage, impulse voltage and high direct current measurement method, cathode ray oscillo graphs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.

UNIT-IV

Lightning and Switching Over-voltages (7 Hours)

Charge formation in clouds, Stepped leader, Dart leader, Lightning Surges. Switching over-voltages, Protection against over-voltages, Surge diverters, and Surge modifiers.

UNIT-V

High Voltage Testing of Electrical Apparatus and High Voltage Laboratories (7 Hours)

Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers and some high voltage equipment, High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H. V. Labs.

Text/Reference Books:

1. M.S.Naidu and V.Kamaraju, “High Voltage Engineering”,McGrawHill
2. Education, 2013.
3. C. Wadhwa,“High Voltage Engineering”, New Age International Publishers, 2007.
4. D.V.Razevig (Translated by Dr. M. P. Chourasia), “High Voltage EngineeringFundamentals”,KhannaPublishers,1993.
5. E.Kuffel, W.S.Zaengl and J.Kuffel, “High Voltage Engineering Fundamentals”, Newnes Publication, 2000.
6. R.Arora and W.Mosch “High Voltage and Electrical Insulation Engineering”, JohnWiley & Sons,2011.
7. Various IS standards for HV Laboratory Techniques and Testing

EEPET 703.1	Energy Management And Auditing	3L:0T:0P	3 Credits
Sessional Marks : **40**	End Semester Examination Marks: **60**		

Course Objectives: Students will be able

1. To understand the Principles and organization of energy management.
2. To understand the Particulars of different types of energy auditing methods, load profiles and energy conservation
3. To acquaintance with electrical energy management like energy saving opportunities and Power factor improvement.
4. To understand the Qualities and functions of an energy management
5. To get Familiarity with methods of economic analysis.

UNIT-I

Principles of energy management – Organising an energy management program – Initiating and managing an energy management program - Planning - Leading – Controlling – Promoting – Monitoring and reporting.

UNIT-II

Energy Auditing – Definitions and concepts – Types of plant energy studies – Energy index – Cost index – Pie charts – Sankey diagrams – Load profiles – Energy conservation –Energy conservation schemes – Energy Audit – Energy saving potential.

UNIT-III

Electrical energy management – Energy efficient motors – Power factor improvement – Lighting and lighting system control – Energy saving opportunities.

UNIT-IV

Qualities and functions of energy managers – Language of an energy manager – questionnaire - Check list for top management.

UNIT-V

Economic Analysis – Depreciation methods - Time value of money – Evaluation methods of projects – Replacement analysis – Special problems – Inflation – Risk analysis.

<u>**Text Books**</u> :

1. “Energy Management” - W.R.Murphy&G.MckeyButterworths.
2. “Energy Conservation” - Pa ulO’ Callagan - Pergamon press.
3. “Energy Management Hand Book” - W.C.Turner, John Wiley and Sons.
4. “Energy Management Principles” – Craig B Smith – Pergamon press

EEPET 703.2	Electrical and Hybrid Vehicles	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objectives: Students will be able to

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

UNIT-I (8 HOURS)

Introduction

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT-II (8 HOURS)

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

Electric Trains

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

UNIT-III (8 HOURS)

Energy Storage

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

UNIT-IV (8 HOURS)

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

UNIT-V (8 HOURS)

Energy Management Strategies

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text / References:

1. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and
2. Applications with Practical Perspectives”, John Wiley & Sons, 2011.
3. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.
4. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
5. T. Denton, “Electric and Hybrid Vehicles”, Routledge, 2016.

EEPET 703.3	Wind and Solar Energy Systems	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objectives: Students will be able

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

UNITI

Physics of Wind Power (8 HOURS)

Historyofwindpower,IndianandGlobalstatistics,Windphysics,Betzlimit,Tipspeedratio,stallandpitchcontrol,Windspeedstatistics-probabilitydistributions,Windspeedandpower-cumulativedistributionfunctions.

UNITII

Wind generator topologies(8 HOURS)

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

UNIT III

The Solar Resource(8 HOURS)

Introduction, solar radiation spectra, solar geometry, Earth Sunangles, observer Sunangles, solar day length, Estimation of solar energy availability.

UNIT IV

Solar photovoltaic(8 HOURS)

Technologies-Amorphous, mono crystalline, polycrystalline; V-I characteristics of a PVcell, PV UNIT, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control. Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

UNITV

Network Integration Issues(8 HOURS):

Overview of grid code technical requirements. Faultride- through for wind farms- real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system inter connection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

Text/References:

1. T.Ackermann,“WindPowerinPowerSystems”,JohnWileyandSonsLtd.,2005.
2. G.M. Masters,“Renewable and Efficient Electric Power Systems**”**, John Wiley and Sons, 2004.
3. S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGrawHill,1984.
4. H.SiegfriedandR.Waddington,“Gridintegrationofwindenergyconversionsystems”JohnWiley andSonsLtd.,2006.
5. G.N.TiwariandM.K.Ghosal,“RenewableEnergyApplications”,NarosaPublications,2004
6. J.A.DuffieandW.A.Beckman,“SolarEngineeringofThermalProcesses”,JohnWiley& Sons, 1991.

EEOET 704	Open Elective-III	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

The Open Elective-III courses offered by other Departments

(Chemical, Civil, CSE, ECE and Mechanical Engineering)

EEPCP705	**Power System –II Lab**	**0L:0T:2P**	**1 Credits**
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Hands-on experiments related to the course contents of **Power Systems-II**.

EEPCX 706	Project stage-I	0L:0T:6P	3 Credits
Sessional Marks : **40**	End Semester Examination Marks: **60**		

The object of Project Work I is to enable the student to take up investigative study in the broad field of Electrical and Electronics Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work.

The assignment to normally include:

1. Survey and study of published literature on the assigned topic.
2. Working out a preliminary Approach to the Problem relating to the assigned topic.
3. Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/Feasibility.
4. Preparing a Written Report on the Study conducted for presentation to the Department.
5. Final Seminar, as oral Presentation before a departmental committee.

EEPCI 707	Summer Internship / Mini Project	3 Credits
Sessional Marks : **40**	End Semester Examination Marks: **60**	

Minimum of Six weeks in an Industry in the area of Electrical & Electronics Engineering.

The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report.

EEPET 801	**Professional Elective-VII**	**3L:0T:0P**	**3 Credits**
EEPET 802	**Professional Elective-VIII**	**3L:0T:0P**	**3 Credits**
Sessional Marks : **40**		End Semester Examination Marks: **60**	

List of subjects- Professional Elective-VII& VIII

1. EEPET 801.1 **HVDC Transmission System**
2. EEPET 801.2 **Power Quality and FACTS**
3. EEPET801.3 **Advanced Electrical Drives**

4. EEPET 802.1 **Electrical Energy Conservation and Auditing**
5. EEPET 802.2**ARM Architecture and Programming**
6. EEPET 802.3 **Principles of Communication Systems**

EEPET 801.1	HVDC Transmission Systems	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objectives: Students will be able to

1. Understand the advantages of dc transmission over ac transmission.
2. Understand the operation of Line Commutated Converters and Voltage Source Converters.
3. Understand the control strategies used in HVDC transmission system.
4. Understand the improvement of power system stability using an HVDC System.

UNIT-I

DC Transmission Technology (8 HOURS)

Comparison of AC and dc Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission. Types of HVDC Systems. Components of a HVDC system. Line Commutated Converter and Voltage Source Converter based systems.

UNIT-II

Analysis of Line Commutated and Voltage Source Converters (8 HOURS)

Line Commutated Converters (LCCs):Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters. Inverter Operation. Effect of Commutation Overlap. Expressions for averaged voltage, AC current and reactive power absorbed by the converters. Effect of Commutation Failure, Misfire and Current Extinction in LCC links.

Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six pulse converter. Equations in the rotating frame. Real and Reactive power control using a VSC.

UNIT-III

Control of HVDC Converters:(8 HOURS)

Principles of Link Controlina LCCHVDC system. Control Hierarchy, Firing Angle Controls– Phase- Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link. Higher level Controllers Power control, Frequency Control, Stability Controllers. Reactive Power Control. Principles of Link Controlina VSC HVDC system: Power flow and dc Voltage Control .Reactive Power Control/AC voltage regulation.

UNIT-IV

Components of HVDC Systems:(8 HOURS)

Smoothing Reactors, Reactive Power Sources and Filters in LCCHVdc systems DCline: Corona Effects. Insulators, Transient Over-voltages. Dc line faults in LCC systems. Dc line faults in VSC systems. Dc breakers. Monopolar Operation. Ground Electrodes.

Stability Enhancement using HVDC Control

Basic Concepts: Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles– synchronous and asynchronous links. Voltage Stability Problem in AC/dc systems.

UNIT -V

MTdc Links Multi-Terminal and Multi-Infeed Systems. Series and Parallel MTdc systems using LCCs. MTdc systems using VSCs. Modern Trends in HVdc Technology. Introduction to Modular Multi-level Converters.

Text/References:

1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers,2011.
2. J.Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd.,1983.
3. E.W.Kimbark, "Direct Current Transmission", Vol.1, Wiley-Interscience,1971.

EEPET 801.2	Power Quality and FACTS	3L:0T:0P	3 Credits
Sessional Marks : **40**	End Semester Examination Marks: **60**		

Course Outcomes:

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

1. Understand the characteristics of ac transmission and the effect of shunt and series reactive compensation.
2. Understand the working principles of FACTS devices and their operating characteristics.
3. Understand the basic concepts of power quality.
4. Understand the working principles of devices to improve power quality.

UNIT-I

Power Quality Problems in Distribution Systems (4 hours)

Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment:

UNIT-II

DSTATCOM, Dynamic Voltage Restorer and Unified Power Quality Conditioner (8 hours)

Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution Systems using DSTATCOM, Voltage Sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies. Series Active Filtering. Unified Power Quality Conditioner (UPQC): Working Principle. Capabilities and Control Strategies.

UNIT-III

Transmission Lines and Series/Shunt Reactive Power Compensation (4 hours)
Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation. Shunt and series compensation at the mid-point of an AC line. Comparison of Series and Shunt Compensation.

UNIT-IV
Thyristor-based Flexible AC Transmission Controllers (FACTS) (10 hours)

Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor, SVC and TCSC. Fault Current Limiter.

Voltage Source Converters (VSC): Principle of Operation of STATCOM:, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Interphase Power Flow Controller. Other Devices: GTO Controlled Series Compensator.

UNIT-V

Application of FACTS (4 hours)

Application of FACTS devices for power-flow control and stability improvement. Simulation example of power swing damping in a single-machine infinite bus system using a TCSC. Simulation example of voltage regulation of transmission mid-point voltage using a STATCOM.

Text/References

1. N. G. Hingorani and L. Gyugyi, "Understanding FACTS: Concepts and Technology of FACTS Systems", Wiley-IEEE Press, 1999.
2. K. R. Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International (P) Ltd. 2007.
3. T. J. E. Miller, "Reactive Power Control in Electric Systems", John Wiley and Sons, New York, 1983.
4. R. C. Dugan, "Electrical Power Systems Quality", McGraw Hill Education, 2012.
5. G. T. Heydt, "Electric Power Quality", Stars in a Circle Publications, 1991

EEPECT 801.3	Advanced Electrical Drives	3L:0T:0P	3 Credits
Sessional Marks : **40**	End Semester Examination Marks: **60**		

Course Objectives: Students will be able

1. To understand the operation of power electronic converters and their control Strategies.
2. To understand the vector control strategies for ac motor drives
3. To understand the implementation of the control strategies using digital Signal processors.

UNIT-I

Power Converters for AC drives (8 HOURS)

PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self-commutated devices. Control of CSI, H bridge as a 4-Q drive.

UNIT-II

Induction motor drives (8 HOURS)

Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control(DTC).

UNIT-III

Synchronous motor drives (8 HOURS)

Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.

Permanent magnet motor drives

Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM.

UNIT-IV

Switched reluctance motor drives (8 HOURS)

Evolution of switched reluctance motors, various topologies for SRM drives, comparison, Closed loop speed and torque control of SRM.

UNIT-V

DSP based motion control (8 HOURS)

Use of DSPs in motion control, various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control.

Text / Reference Books :

1. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.
2. P. C. Krause, O. Wasynczuk and S. D. Sudhoff, "Analysis of Electric Machinery and Drive
3. Systems", John Wiley & Sons, 2013.
4. H. A. Taliyat and S. G. Campbell, "DSP based Electromechanical Motion Control", CRC press, 2003.
5. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press, 2009.

EEOET-802.1	Electrical Energy Conservation and Auditing	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objectives:
Students will be able to

1. Understand the current energy scenario and importance of energy conservation.
2. Understand the concepts of energy management.
3. Understand the methods of improving energy efficiency in different electrical systems.
4. Understand the concepts of different energy efficient devices.

UNIT-I

Energy Scenario (6 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, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

UNIT-II

Basics of Energy and its various forms (7 Hours)

Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

UNIT-III

Energy Management & Audit (6 Hours)

Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel& energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

UNIT-IV

Energy Efficiency in Electrical Systems (7 Hours)

Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

UNIT-V

Energy Efficiency in Industrial Systems

Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.

Energy Efficient Technologies in Electrical Systems (8Hours)

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.

Text/Reference Books

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)
3. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.
4. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

EEPET 802.2	**ARM Architecture and Programming**	**3L:0T:0P**	**3 Credits**
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objectives:

Student will be able to

1. Understand architecture and addressing modes of ARM processor
2. Write assembly programs for ARM processor
3. Learn coprocessor instructions and memory management
4. Use different tools for programming ARM processor with its peripherals

UNIT-I

ARM Introduction and Pipeline structures

Types of computer Architectures, ISA's and ARM History. Embedded System Software and Hardware, stack implementation in ARM, Endianness, condition codes. Processor core VS CPU core, ARM7TDMI Interface signals, Memory Interface, Bus Cycle types, Register set, Operational Modes. Instruction Format, ARM Core Data Flow Model, ARM 3 stage Pipeline, ARM family attribute comparison. ARM 5 stage Pipeline, Pipeline Hazards, Data forwarding - a hardware solution.

UNIT-II

ARM7TDMI assembly instructions and modes

ARM ISA and Processor Variants, Different Types of Instructions, ARM Instruction set, data processing instructions. Shift Operations, shift Operations using RS lower byte, Immediate value encoding. Data processing Instructions. AddressingMode-1, Addressing Mode -2. Addressing Mode -2, LDR/STR, Addressing mode -3 with examples. Instruction Timing, Addressing Mode - 4 with Examples. Swap Instructions, Swap Register related Instructions, Loading Constants. Program Control Flow, Control Flow Instructions, B & BL instructions, BX instruction. Interrupts and Exceptions, Exception Handlers, Reset Handling. Aborts, software Interrupt Instruction, undefined instruction exception. Interrupt Latency, Multiply Instructions, Instruction set examples. Thumb state, Thumb Programmers model, Thumb Implementation, Thumb Applications. Thumb Instructions, Interrupt processing. Interrupt Handling schemes, Examples of Interrupt Handlers.

UNIT-III

ARM Coprocessor Interface and VFP

ARM coprocessor interface and Instructions, Coprocessor Instructions, data Processing Instruction, data transfers, register transfers. Number representations, floating point representation (IEEE754). Flynn's Taxonomy, SIMD and Vector Processors, Vector Floating Point Processor (VFP), VFP and ARM interactions, An example vector operation

UNIT-IV

Cache and Memory Management and Protection

Memory Technologies, Need for memory Hierarchy, Hierarchical Memory Organization, Virtual Memory. Cache Memory, Mapping Functions. Cache Design, Unified or split cache, multiple level of caches, ARM cache features, coprocessor 15 for system control. Processes, Memory Map, Protected Systems, ARM systems with MPU, memory Protection Unit (MPU). Physical Vs Virtual Memory, Paging, Segmentation. MMU Advantage, virtual memory translation, Multitasking with MMU, MMU organization, Tightly coupled Memory (TCM).

UNIT-V

ARM tools and Peripherals

ARM Development Environment, Arm Procedure Call Standard (APCS), Example C program. Embedded software Development, Image structure, linker inputs and outputs, memory map, application startup. AMBA Overview, Typical AMAB Based Microcontroller, AHB bus features, AHB Bus transfers, APB bus transfers, APB bridge. DMA, Peripherals, Programming Peripherals in ARM. ARM ISAs, ARMv5, ARMv6, ARM v7, big. little technology, ARMv8. ARM ISAs, ARMv5, ARMv6, ARM v7, big. little technology, ARMv8.

Text Books:

1. ARM System Developers Guide, Designing and Optimizing System Software, by Andrew N.SLOSS, Dominic SYMES and Chris WRIGHT, ELSEVIER, 3004
2. ARM System-on-Chip Architecture, Second Edition, by Steve Furber, PEARSON, 2013 Operating Systems, 5th Edition, By William Stallings
3. Manuals and Technical Documents from the ARM Inc, web site.

EEPET 802.3	Principles of Communication Systems	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Outcomes: By completing this subject, the student can

1. Work on various types of modulations. Should be able to use these communication modules in implementation.
2. Will have a basic understanding of various wireless and cellular, mobile and telephone communication systems.

UNIT - I

Introduction: Need for Modulation, Frequency translation, Electromagnetic spectrum, Gain, Attenuation and decibels.

UNIT -II

Simple description on Modulation: Analog Modulation-AM, FM, Pulse Modulation-PAM, PWM, PCM, Digital Modulation Techniques-ASK, FSK, PSK, QPSK modulation and demodulation schemes.

UNIT- III

Telecommunication Systems: Telephones Telephone system, Paging systems, Internet Telephony. Networking and Local Area Networks: Network fundamentals, LAN hardware, Ethernet LANs, Token Ring LAN.

UNIT -IV

Satellite Communication: Satellite Orbits, satellite communication systems, satellite subsystems, Ground Stations Satellite Applications, Global Positioning systems. Optical Communication: Optical Principles, Optical Communication Systems, Fiber – Optic Cables, Optical Transmitters & Receivers, Wavelength Division Multiplexing.

UNIT -V

Cellular and Mobile Communications: Cellular telephone systems, AMPS, GSM, CDMA, and WCDMA. Wireless Technologies: Wireless LAN, PANs and Bluetooth, Zig Bee and Mesh Wireless networks, Wimax and MANs, Infrared wireless, RFID communication, UWB.

Text Books:

1. Principles of Electronic Communication Systems, Louis E. Frenzel, 3e, McGraw Hill publications, 2008.
2. Electronic Communications systems, Kennedy, Davis 4e, MC GRAW HILL EDUCATION, 1999

Reference Books:

1. Theodore Rapp port, Wireless Communications – Principles and practice, Prentice Hall, 2002.
2. Roger L. Freeman, Fundamentals of Telecommunications, 2e, Wiley publications.
3. Introduction to data communications and networking, Wayne Tomasi, Pearson Education, 2005.

EEOET 803	Open Elective-IV	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

The Open Elective-IV courses offered by other departments

(Chemical, Civil, CSE, ECE and Mechanical Engineering)

EEPCX 803	Project stage-II	0L:0T:18P	9 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

The object of Project Work-II Dissertation is to enable the student to extend further the investigative study taken up under EEPCX- Project Work-I, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership.

The assignment to normally include:

1. In depth study of the topic assigned in the light of the Report prepared under **EEPCX 706.**
2. Review and finalization of the Approach to the Problem relating to the assigned topic.
3. Preparing an Action Plan for conducting the investigation, including team work.
4. Detailed Analysis/ Modelling/ Simulation/ Design/ Problem Solving/ Experiment as needed.
5. Final development of product/process, testing, results, conclusions and future directions.
6. Preparing a paper for Conference presentation/Publication in Journals, if possible.
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar Presentation before a Departmental Committee.

OPEN ELECTIVE COURSES OFFERED BY THE DEPARTMENT OF EEE

S.No	Code No.	Subject	Preferred semester	Credits
1.	EEOET 01	Power Plant Engineering	V	3
2.	EEOET02	MOOCs	VI	3
3.	EEOET03	Neural Network and Fuzzy Logic	VII	3
4.	EEOET04	Renewable Energy Systems	VIII	3
5.	EEOET05	Industrial Electrical Systems	VIII	3

EEOET01	Power Plant Engineering	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

COURSE OBJECTIVES:

1. To provide an overview of coal based thermal power plants and gas turbine and combined cycle power plants.
2. To provide an overview of nuclear power plants and hydro electric power plants and the associated energy conversion issues.

UNIT-I

Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems

UNIT-II

Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.

UNIT-III

Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.

UNIT-IV

Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems.

UNIT-V

Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.

Text Books:

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.
3. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

Course Outcomes:

Upon completion of the course,

1. the students can understand the principles of operation for coal based thermal power plants and gas turbine and combined cycle power plants.
2. the students can understand the principles of operation for nuclear and hydro electric power plants and heir economics.

EEOET 02	MOOCS	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Moocs Course Selected by the Students

EEOET 03	Neural Network And Fuzzy Logic	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objectives: Students will be able

1. To provide students basic knowledge on Artificial Neural Networks and learning rules.
2. To provide students basic knowledge on supervised learning.
3. To make students understand fundamentals of fuzzy logic and fuzzy sets.
4. To provide students basic knowledge on design of fuzzy systems.
5. To provide students good knowledge on Neuro-fuzzy modelling.

UNIT-I

Artificial Neural Networks: Introduction to neural networks, biological neurons, artificial neurons, McCulloch-Pitt's neuron model, neuron modeling for artificial neural systems, feed forward network, perceptron network , Supervised and un-supervised learning.

Learning Rules: Hebbian learning Rule, Perceptron learning Rule, Delta learning Rule, Winner-take-all learning rule, Out-star learning rule.

UNIT-II

Supervised Learning: Perceptrons, exclusive OR problem, single layer perceptron network, multi-layer feed forward networks: linearly non separable patter classification, delta learning rule for multi perceptron layer, error back propagation algorithm, training errors. Un-Supervised Learning**:** Hamming net, Max net,. Winner –take –all learning, counter propagation network, feature mapping, self-organising feature maps

UNIT-III

Fundamentals of fuzzy logic and fuzzy sets: Definition of fuzzy set , a-level fuzzy set , cardinality, operations on fuzzy sets: union, intersection, complement, Cartesian product, algebraic sum, definition of fuzzy relation, properties of fuzzy relations, fuzzy composition.

UNIT-IV

Design of Fuzzy Systems: Components of fuzzy systems, functions of fuzzification, Rule base patterns, Inference mechanisms, methods of de-fuzzification: COG,COA, MOM, Weighted average, height methods. Fuzzy control applications, Case studies

UNIT-V

Neuro-Fuzzy Modeling: Adaptive networks based Fuzzy interface systems – classification and regression trees – data clustering algorithms – rule based structure identification – Neuro-Fuzzy controls – simulated annealing – evolutionary computation. Introduction to Genetic Algorithms.

Text Books:

1. Jacek M Zurada, " Introduction to artificial Neural Systems", Jaico Publications
2. Zimmerman, " Fuzzy Set Theory and its Applications" , Kluwer Academic Publishers.
3. Timothy Ross, " Fuzzy Logic with Engineering Applications" ,(McGrawHill) S.Rajasekaran, G.A. VijayalakshmiPai,"Neural Networks, Fuzzy logic & Genetic Algorithms", PHI, New Delhi

EEOET04	Renewable Energy Systems	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objectives:

Students will be able to

1. Introduce aspects of different Energy Sources and Energy scenario in India.
2. Understand the Particulars of solar energy and collectors.
3. Understand the Essentials of the solar energy storage and application of solar energy.
4. Understand the Fundamentals of Biomass energy systems, analysis and testing.
5. Know the Details of wind energy, wind turbines and their controls.

UNIT-I

Introduction to Energy Sources(8 HOURS): Energy sources and their availability, Non-renewable reserves and resources; renewable resources, Transformation of Energy, Energy scenario in India.

UNIT II

Solar energy(8 HOURS)**:** -Basic characteristics of sunlight – solar energy resource – Solar processes and spectral composition of solar radiation; Radiation flux at the Earth's surface. Solar collectors, Types and performance characteristics.

UNIT III

Solar energy storage :Solar energy storage systems,Solar pond

Applications of Solar energy: Photovoltaic cell-characteristics -equivalent circuit-Photovoltaic effect – photo voltaic for battery charging-applications.(8 HOURS)

UNIT-IV

Biomass Energy Systems(8 HOURS)- Biomass sources-production processes-Gasification, Anaerobic Digestion, Pyrolysis, Boigas- Performance analysis and testing

UNIT-V

Wind energy(8 HOURS)- Wind Distribution – principles of wind energy conversion –basic components of wind energy conversion-advantages and disadvantages-Principles of Operation of wind turbines, types of wind turbines and characteristics, Generators for Wind Turbines, Control strategies.

References :

1. **G.D.Rai** "Non Conventional Energy sources", Khanna Publishers, New Delhi,1999.
2. **G.N.Tiwari and M.K.Ghosal** , "Renewable energy resources, Basic Principles and applications", Narosa Publishing house, New Delhi.
3. **S.N.Badra, D.Kastha and S.Banerjee** "Wind electrical Systems", Oxford University Press, New Delhi.
4. **M.V.R.koteswara Rao** "Energy resources Conventional &Non conventional" BS publications-Hyderabad,2004
5. **GilbertM. Masters** "Renewable and Efficient electric power systems" Wiley Inter Science Publications,2004.

EEOET 05	Industrial Electrical Systems	3L:0T:0P	3 Credits
Sessional Marks : **40**		End Semester Examination Marks: **60**	

Course Objective:

Students will be able to

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

UNIT-I

Electrical System Components (8 Hours)

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

UNIT-II

Residential and Commercial Electrical Systems (8 Hours)

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

UNIT-III

Illumination Systems (6 Hours)

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

UNIT-IV

Industrial Electrical Systems I (8 Hours)

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

UNIT-V

Industrial Electrical Systems II (6 Hours)

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

Industrial Electrical System Automation (6 Hours)

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

Text/Reference Books:

1. S. L. Uppal and G. C. Garg, “Electrical Wiring, Estimating & Costing”, Khanna Publishers, 2008.
2. K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2007.
3. S. Singh and R. D. Singh, “Electrical estimating and costing”, DhanpatRai and Co.,1997.
4. Web site for IS Standards.
5. H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2008.