I SEMESTER

S.No.	Course Code	Course Title	Course Category	Hours per week			Total Contact Hours	Credits
				L	T	P		
1	MA1001	Mathematics-I (Linear Algebra and Calculus)	BSC	4	0	0	4	4
2	PH1001	Engineering Physics	BSC	3	1	0	4	4
3	PH1601	Engineering Physics Lab	BSC	0	0	3	3	1.5
4	HS1001	English	HSMC	2	0	0	2	2
5	HS1601	English Language Lab	HSMC	0	0	2	2	1
6	CE1001	Engineering Graphics	ESC	1	0	4	5	3
7	EE1001	Basic Electrical Engineering	ESC	3	1	0	4	4
8	EE1601	Basic Electrical Engineering Lab	ESC	0	0	2	2	1
Total				13	2	11	26	20.5
Induction Programme (Non-Credit)								

MA1001 **MATHEMATICS – I**
(LINEARALGEBRA AND CALCULUS)

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-4**

Course Objectives:

- Types of matrices and their properties.
- Concept of a rank of the matrix and applying this concept to know the consistency and solving the system of linear equations.
- Concept of Eigen values and Eigen vectors and to reduce the quadratic form to canonical form.
- Concept of Sequence.
- Concept of nature of series.
- Geometrical approach to the mean values theorems and their application to the mathematical problems.
- Evaluation of surface areas and volumes of revolutions of curves.
- Evaluation of improper integrals using Beta and Gamma functions.
- Partial differentiation, concept of total derivative.
- Finding maxima and minima of function of two and three variables.

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

- Write the matrix representation of set of linear equations and to analyze the solution of the system of equations.
- Find the Eigen values and Eigen vectors.
- Reduce the quadratic form to canonical form using orthogonal transformations.
- Analyze the nature of sequence and series.
- Solve the applications on the mean value theorems.
- Evaluate the improper integrals using Beta and Gamma functions.
- Find the extreme values of functions of two variables with/without constraints.

UNIT-I: Matrix Theory

Types of Matrices, Symmetric, Hermitian, Skew-Symmetry, Skew-Hermitian, Orthogonal matrices, Unitary matrices; Elementary row and column operations on a matrix, Rank of a matrix by Echelon form and Normal form, Inverse of a Non-singular matrix by Gauss-Jordan method; Consistency and solutions of system of linear equations using elementary operations, Gauss elimination method; Gauss Seidel Iteration method.

UNIT-II: Eigen values and Eigen vectors

Linear Transformation and Orthogonal Transformation; Characteristic roots and vectors of a matrix; Diagonalization of a matrix; Cayley-Hamilton theorem(without proof) ; finding inverse and power of a matrix by Caylay-Hamilton Theorem; Quadratic forms and Nature of the Quadratic forms; Reduction of quadratic form to canonical form by Orthogonal transformation.

UNIT-III: Sequences & Series:

Definition of a sequence, limit; Convergent, Divergent and Oscillatory sequences. Convergent, Divergent and Oscillatory Series; Series of positive terms; Comparison test, p-test, D-Alembert's ratio test; Raabe's test; Cauchy's Integral test; Cauchy's root test; Logarithmic test. Alternating series; Leibnitz test; Alternating Convergent series; Absolute and conditionally convergence.

UNIT-IV: Calculus:

Mean value theorems: Roll's theorem, Lagrange's Mean value theorem, Cauchy's Mean value theorem; Taylor's and Macaurin's series with remainders, Expansions; Applications of definite integrals to evaluate surface area and volumes of revolutions of curves (Only in Cartesian coordinates): Definition of Improper Integrals and their convergence, Beta and Gamma functions and their applications.

UNIT-V: Multivariable Calculus (Partial Differentiation and applications):

Definitions of Limits and continuity. Partial Differentiation; Euler's theorem; Total Derivative; Jacobian; Functional dependence and independence; Maxima and minima of functions of several variables (two and three variables) using Lagrange Multipliers.

Textbooks:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition,
2. R.K.Jain and S.R.K.Iyengar Advanced Engineering Mathematics, Narosa Publications House.2008
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2009.

References:

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson,Reprint,2002.
2. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11thReprint, 2010.
3. N.P. bail and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint,2008.

PH1001 **ENGINEERING PHYSICS – I**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-1-0-4**

UNIT I : Vectors and Mathematical Physics (5 hours)

Gradient, Divergence, Curl and its applications .Line, surface and volume integrals, Stokes and Gauss theorem, Curvilinear Coordinates: Polar, Cylindrical and spherical polar co-ordinates, Problems

UNIT II : Electromagnetic Theory (18 hours)

Electrostatics in linear medium

Physical Interpretation of Bound charges & Electric displacements, Boundary conditions of displacements and Linear dielectrics ,Potential at the centre of a metal sphere surrounded by linear dielectrics

Magneto statics in linear magnetic linear medium

Magnetization and associated bound currents, auxiliary magnetic fields, Boundary conditions on B and H

UNIT – III: Maxwell's Equations

Continuity equation for current density; modifying equation for curl of magnetic field to satisfy continuity equation, Displace current and magnetic field arising from time dependent electric field, Maxwell's equation in vacuum and non- conducting medium; Energy in an electromagnetic fields. Flow of energy and Poynting vector & Qualitative discussion of momentum in electromagnetic fields.

UNIT – IV: Electromagnetic waves

The wave Equation; Plane electromagnetic waves in vacuum. Polarization; relation between electric and magnetic fields of electromagnetic waves. Energy carried by electromagnetic waves and examples. Momentum carried by electromagnetic waves and pressure. EM waves in vacuum: propagation in linear media, boundary conditions , Reflection and transmission co-efficient of electromagnetic waves from a non conducting medium- vacuum interface for normal incidence. Problems

UNIT V: Quantum Mechanics (5 hours)

Introduction to Quantum Mechanics, De-Brogile waves and uncertainity principle, Time dependant Schrodinger wave equation, Significance of Wave Function, Time independent Schrodinger wave equation and solution of generalized potential, Particle in a box, Problems.

UNIT VI: Electron Structure of solids (6 hours)

Introduction to Crystallography, Bravais Lattices, Miller Indices, Free electron Theory, Kronig Penny model (E vs K), Band theory of solids

UNIT VII: Semiconductor Physics (6)

Intrinsic and extrinsic semiconductors, Fermi level and carrier-concentration, Effect of temperature on Fermi level.Mobility of charge carriers and effect of temperature on mobility, Hall Effect, Energy band gap determination of semiconductors by four probe method, Direct and Indirect Bandgap semiconductors .

Reference books:

1. Arfken, Mathematical Physics
2. David Griffiths, Introduction to Electrodynamics &W Saslow, Electricity, Magnetism and Light
3. David Griffiths, Quantum Mechanics
4. Wahab, Solid State Physics
5. S M Sze, Semiconductor Devices: Physics and Technology, Wiley (2008)

PH1601 **Engineering Physics Lab**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-1.5**

List of Experiments:

1. Four Probe Method
2. Hall Effect
3. Dielectric Constant
4. Frank Hertz Experiment
5. Diffraction Grating
6. Ultrasonic Interfeometer
7. Energy Bandgap of a semiconductor
8. Photoelectric Effect
9. Torsional Pendulum
10. Magnetic Hysterisis Curve

CE1001 **ENGINEERING GRAPHICS**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **1-0-4-3**

Course Objectives:

- To introduce the students to the "Universal Language of Engineers" for effective communication through drawing.
- To understand the basic concepts of drawing through modern techniques.
- To impart knowledge about standard principles of projection of objects.
- To provide the visual aspects of Engineering drawing using Auto-CAD.

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

- Use Engineering principles and techniques to understand and interpret engineering drawings.
- Understand the concepts of Auto-CAD.
- Draw orthographic projections of lines, planes and solids using Auto-CAD.
- Use the techniques, skills and modern engineering tools necessary for engineering practices.

UNIT-I:Introduction to Engineering Drawing:

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, types of lines and Dimensioning. *Over view of Auto-CAD:* Theory of CAD software (The Menu System, Tool Bars, Drawing area, Dialogue boxes, Shortcut Menu, the command lines, Select and erase objects, Introduction to layers etc.), Drawing simple figures- lines, planes, solids.

UNIT-II:

Geometrical constructions: Construction of regular polygons.
Conic sections: Construction of Ellipse, Parabola, Hyperbola (General method only), Cycloid, Epicycloid, Hypocycloid and Involutes.
Scales: Construction of Plain, Diagonal and Vernier scales.
UNIT-III

Orthographic projections: Principles of Orthographic Projections
Projections of Points: Projections of Points placed in different quadrants,
Projection of lines: lines parallel and inclined to both the planes (Determination of true lengths and true inclinations and traces)
Projection of planes: Planes inclined to both the reference planes

UNIT-V

Development of surfaces: .Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone ,
Isometric Projections: Principles of Isometric projection – Isometric Scale, Isometric Views of planes and simple solids,
Perspective projections: Basic concepts of perspective views.

Text/Reference Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
3. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
4. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age publications
5. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
6. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
7. (Corresponding set of) CAD Software Theory and User Manuals

EE1001	Basic Electrical Engineering	
Externals: 60Marks		**L-T-P-C**
Internals: 40		**3-1-0-4**

Course Objectives: This course introduces

- DC and AC electrical circuit steady state analysis
- Construction and working of DC and AC electrical machines
- The components of low-voltage electrical installations

Course Outcomes: At the end of this course, students will demonstrate the ability

- To understand and analyse basic electric and magnetic
- To study the working principles of electrical machines and power converters.
- To introduce the components of low-voltage electrical installations.

Unit I : Circuits Analysis (16 hours)

DC Circuits:

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

AC Circuits:

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.

UNIT II: Transformers(6hours)

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

UNIT III: Electrical Machines (8 hours)

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and

speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.

UNIT IV: Power Converters (6 hours)

DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.

UNIT V: Electrical Installations (6 hours)

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries.

Elementary calculations for energy consumption, power factor improvement and battery backup.

Text / References:

1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
3. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
4. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
5. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

EE1601	BASIC ELECTRICAL ENGINEERING LAB	
Externals: 60Marks		**L-T-P-C**
Internals: 40		**0-0-2-1**

Course objective: To provide practical exposure

- Common electrical components and their ratings.
- Common electrical measuring instruments.
- Transformers, electrical machines and power electronic converters.

Laboratory Outcomes: The students are expected to

- Get an exposure to common electrical components and their ratings.
- Make electrical connections by wires of appropriate ratings.
- Understand the usage of common electrical measuring instruments.
- Understand the basic characteristics of transformers and electrical machines.
- Get an exposure to the working of power electronic converters.

List of Laboratory Experiments/Demonstrations (any 10 of the following):

1. Introduction to Lab:

(a) Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.

(b) ***Demonstration of cut-out sections of machines:*** dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field

winging - slip ring arrangement) and single-phase induction machine.

(c) ***Demonstration of Components of LT switchgear.***

2. Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope).Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification.

Observation of phase differences between current and voltage. Resonance in R-L-C circuits.

3. Transformers: Observation of the no-load current waveform on an oscilloscope (non sinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonics). Loading of a transformer: measurement of primary and secondary voltages and currents, and power.
4. Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents). Phase-shifts between the primary and secondary side. Cumulative three-phase power in balanced three-phase circuits.
5. Torque Speed Characteristic of separately excited dc motor.
6. Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections.
7. Torque-Slip Characteristic of an induction motor.
8. Synchronous Machine operating as a generator: stand-alone operation with a load. Control of voltage through field excitation.
9. Power electronics (a) dc-dc converters (b) dc-ac converters – PWM waveform (c) the use of dc-ac converter for speed control of an induction motor and
10. Calibration of Energy Meter
11. 3-phase power measurement using two wattmeter method
12. Characteristic of the lamps (Tungsten, Fluorescent and Compact Fluorescent Lamps)

II SEMESTER

S.No.	Course Code	Course Title	Course Category	Hours per week			Total Contact Hours	Credits
				L	T	P		
1	EE1201	Electrical Circuit Analysis	PCC	4	1	0	5	5
2	EE1801	Electrical Circuit Analysis Lab	PCC	0	0	2	2	1
3	MA1201	Mathematics-II (Laplace Transforms and Ordinary Differential Equations)	BSC	3	1	0	4	4
4	CY1001	Chemistry	BSC	3	1	0	3	4
5	CY1601	Chemistry Lab	BSC	0	0	3	3	1.5
6	ME1601	Workshop/Manufacturing Practices	ESC	1	0	4	5	3
7	MC1001	Constitution of India	MC	0	0	0	0	0
8	MC1002	Environmental Science	MC	0	0	0	0	0
Total				11	3	9	22	18.5

19EE1201 **ELECTRICAL CIRCUIT ANALYSIS**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-1-0-5**

Course Objectives:

- To introduce the basic concepts of circuit analysis which is the foundation for all subjects of the Electrical Engineering discipline.
- To introduce the various techniques/tools used in the transient and steady-state response of electrical circuits.

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

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

UNIT I : Circuits Analysis (12 hours)

DC Circuits: Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation, Network reduction techniques (Series, Parallel connection, Star-delta transformation), Analysis with dependent current and voltage sources. Nodal and Mesh Analysis.
Network Theorems: Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem, Tellegen's Theorem, Milliman's Theorem

UNIT II: Sinusoidal steady state analysis (12 Hours)

Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, effective or RMS values, reactive power, apparent power, power factor average power and complex power. . Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance: series and parallel resonances, Superposition theorem, Thevenin's theorem, Norton theorem, Maximum power transfer theorem
Three phase balanced circuits, voltage and current relations in star and delta connection, Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer.

UNIT III: Solution of First and Second order networks (10 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 IV: Electrical Circuit Analysis Using Laplace Transforms (10 Hours)

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

UNIT V: Two Port Network and Network Functions (12 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,
Network Topology: Definitions – Graph – Tree, Basic Cutset and Basic Tieset Matrices for Planar Networks – Loop and Nodal Methods of Analysis of Networks with Dependent & Independent Voltage and Current Sources – Duality & Dual Networks.

Text Books:

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. Network Theory by N.C.Jagan & C.Lakshminarayana, B.S. Publications.
5. Network Theory by Sudhakar, Shyam Mohan Palli, TMH.

Reference Books:

1. C. K. Alexander and M. N. O. Sadiku, " Electric Circuits", McGraw Hill Education, 2004.
2. K. V. V. Murthy and M. S. Kamath, " Basic Circuit Analysis" , Jaico Publishers, 1999.
3. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.

19EE1801 ELECTRICAL CIRCUIT ANALYSIS LAB

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-2-1**

Course Objective:

- To expose the students to the concepts of electrical and electronics circuits and give them experimental skills.

Course Outcomes: Upon completion of this course

- The student will be able to perform experiments to verify network theorems
- Understand the usage of common electrical measuring instruments.
- The student will be able to perform experiments to study transient and steady state behavior of electrical circuits for DC and Sinusoidal excitation
- The student will be able to perform experiments to determine the two port network parameters

List of Experiments:

1. Introduction Lab
   (i) Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
   (ii) Verification of Ohm's Law, KCL and KVL
2. Measuring the steady-state and transient time-response of R-L and R-C to a step change in voltage (transient may be observed on a storage oscilloscope).
3. Measuring the steady-state and transient time-response of R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope).
4. Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage.
5. Resonance in R-L-C circuits.
6. Verification of Superposition theorem and Reciprocity theorem
7. Verification of Thevenin's theorem and Maximum power transfer theorem
8. Determination of 2-port parameters for a given network: Z,Y, ABCD parameters

Any two of the following simulation experiments

1. Simulation of DC Circuits
2. DC Transient response
3. Mesh Analysis
4. Nodal Analysis

MA1201	**Mathematics-II** (Vector Calculus and Ordinary Differential Equations)	

Externals: 60Marks		**L-T-P-C**
Internals: 40Marks		**3-1-0-4**

Course Objectives:

- Methods of solving the differential equations of first and higher order.
- To study the methods of solving improper integrals and the concepts of multiple integrals
- The basic properties of vector valued functions and their applications to line, surface an volume integrals
- To study numerical methods to analyze an experimental data.

Course Outcomes: At the end of the course student will be able to

- Solve first order linear differential equations and special non linear first order equations like Bernouli , Riccati & Clairaut's equations
- Compute double integrals over rectangles and type I and II" regions in the plane
- Explain the concept of a vector field and make sketches of simple vector fields in the plane.
- Explain concept of a conservative vector field, state and apply theorems that give necessary and sufficient conditions for when a vector field is conservative, and describe applications to physics.
- Recognize the statements of Stokes' Theorem and the Divergence Theorem and understand how they are generalizations of the Fundamental Theorem of Calculus.
- Able to solve the problems in diverse fields in engineering science using numerical methods.

UNIT-I: Ordinary Differential Equations of first order

Exact first order differential equation, finding integrating factors, linear differential equations, Bernoulli's , Riccati , Clairaut's differential equations, finding orthogonal trajectory of family of curves, Newton's Law of Cooling, Law of Natural growth or decay

UNIT-II: Ordinary Differential Equations of higher order

Linear dependence and independence of functions, Wronskian of n- functions to determine Linear Independence and dependence of functions, Solutions of Second and higher order differential equations (homogeneous & non-homogeneous) with constant coefficients, Method of variation of parameters, Euler-Cauchy equation.

UNIT-III: Laplace Transform –I:

Definition of Laplace Transform, linearity property, conditions for existence of Laplace

Transform. First and second shifting properties, Laplace Transform of derivatives and integrals, unit step functions, Dirac delta-function, error function. Differentiation and integration of transforms, convolution theorem.

UNIT-IV Laplace Transform –II:

Finding Inverse Laplace Transform using various methods, Evaluation of integrals by Laplace Transform. Solving initial and boundary value problems, Differential Equations & Partial differential equations, Integral Equations using Laplace Transforms.

UNIT-V: Integral Calculus

Convergence of improper integrals, tests of convergence, Beta and Gamma functions

1. elementary properties, differentiation under integral sign, differentiation of integrals with variable limits
2. Leibnitz rule. Rectification, double and triple integrals, computations of surface and volumes, change of variables in double integrals - Jacobians of transformations, integrals dependent on parameters – applications.

Text Books:

1. Advanced Engineering Mathematics (3rd Edition) by R. K. Jain and S. R. K. Iyengar, Narosa Publishing House, New Delhi

References Books:

1. Advanced Engineering Mathematics (8th Edition) by Erwin Kreyszig, Wiley-India.
2. Dr. M.D. Raisinghania,Ordinary andPartialdifferentialequations,S.CHAND,17thEdition2014.

CY1001 **ENGINEERING CHEMISTRY**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-1-0-4**

Course Objectives

- To understand the importance of the spectroscopy in determining the structures of chemical compounds
- To understand the importance of electrochemistry in technical field
- To understand the application of polymers in the technical field
- To understand the basics of chemistry involved in the synthesis of nanomaterials
- To understand the application of nanomaterials as sensors

Unit I: Spectroscopy (12 classes)

Introduction to spectroscopy, electromagnetic radiations, different types of spectroscopy, principle of spectroscopy, spectrophotometer Microwave spectroscopy: principle, microwave spectra of diatomic molecules, selection rules for microwave spectra, applications of microwave spectroscopy: determination of bond length, dipole moment measurement, determination of isotopic mass of an element. Infrared spectroscopy: introduction and principles of IR, types of vibrations: bending and stretching, Hooke's law for stretching vibrations, characteristic frequencies of common functional groups, IR instrumentation, interpretation and applications of IR spectrum with examples.

Ultra-violet spectroscopy: Introduction and principle of UV spectroscopy, color interpretation with VBT and MOT, types of electronic transitions, selection rules, chromophores and auxochromes with examples, conjugation effect, absorption and intensity shifts, applications of UV spectroscopy.

Unit II: Electrochemistry (10 classes)

Types of electrodes: introduction, metal-metal ion electrodes, metal-insoluble salt-anion electrodes, calomel electrode, gas-ion electrodes, hydrogen and chlorine electrodes, oxidation-reduction electrodes, amalgam electrodes.

Types of cells: classification into chemical and concentration cells, chemical cells with transference and without transference, classification of concentration cells into electrolyte and

electrode concentration cells, electrolyte concentration cells with and without transference, amalgam and gas concentration cells, examples for these cells.
EMF and applications of EMF: determination of pH, determination of the valency of the ions, potentiometric titrations. pH: definition of pH and determination of pH by various methods, acid-base titrations.
Thermodynamic data: enthalpy and entropy of cell reactions, Gibbs-Helmholtz equation and applications.

Unit III: Polymers (5 classes)

Polymers: Introduction to polymers, types of polymerization (Chain & Step growth). Plastics: Thermoplastic &Thermo setting resins; Preparation, properties, engineering applications of PE, PVC, Teflon and Bakelite.

Unit IV: Nano Chemistry (8 classes)

Introduction to nanomaterials, synthetic approaches: Top-Down (Lithography, spray pyrolysis, FIB, ball milling) and Bottom-Up (Self assembly of nanostructures, core shell nanostructures, nanocomposites), properties at nanoscale, brief overview on characterization of nanomaterials

Unit V: Sensors (5 classes)

Nano Sensors: Introduction, biosensors, chemical sensors, gas sensors, optical nano sensors, magnetic nano sensors with examples. CNT and metal oxide based nano sensors with examples.

Refer Books

1. Engineering Chemistry, Jain & Jain
2. Engineering Chemistry, Shashi Chawla
3. Nanomaterials and Nanochemistry, C. Brhignac P. Houdy M. Lahmani
4. Nanochemistry: Achemical approach to nanomaterials, Geoffrey aln Ozin

	CHEMISTRY LAB	
Externals: 60Marks		**L-T-P-C**
Internals: 40Marks		**0-0-2-1**

1. Preparation of Thiokol rubber.
2. Colorimeter: Estimation of Ferric Iron in cement by colorimetrically.
3. pH meter: Estimation of the strength of an Acetic acid by pH metry
4. Polarimeter: Determination of specific rotation of Sucrose by Polarimeter
5. Conductometry: Conductometric titration of strong acid Vs strong base
6. Syntheis of iron oxide nanoparticles by coprecipitation process.
7. Preparation of Aspirin
8. FT-IR spectral analysis of synthesized Aspirin- demonstration

ME1601 WORKSHOP/MANUFACTURING PRACTICES

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **1-0-4-3**

(i)Theory

Course Objectives:

- To understand basic concepts of fitting, carpentry and House wiring.
- To understand the basic manufacturing process of producing a component by casting, plastic molding and joining processes.
- To understand machining of a component either by conventional or by unconventional processes.
- To understand the concepts of plastic deformation and the processes involved in manufacturing through forming process.
- To understand the advanced manufacturing process of additive manufacturing process.

Course Outcome:

- Students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

UNIT – 1: Fitting operations and tools.

UNIT – 2: Carpentry and tools

UNIT – 3: Electrical House wiring.

UNIT – 4: Metal Casting

Introduction, Tools, Types of Patterns, Pattern Materials, Types of casting – Sand, Die and other casting processes and Applications

UNIT – 5: Plastic molding and Glass cutting

UNIT – 6: Joining

Types of Joining, Introduction to Welding, Brazing and soldering, Arc and gas welding.

UNIT – 7: Conventional Machining processes: Introduction to machining operations; Lathe operations, Drilling, Milling and Grinding.

UNIT – 8: Unconventional Machining processes: ECM, EDM, AJM and USM.

UNIT – 9: Metal Forming: Introduction, Classification, Types of Bulk and sheet metal forming and Applications.

UNIT – 10: Additive manufacturing

Text Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.

Reference Books:

1. Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson Education, 2008.
2. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
3. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGrawHill House, 2017.

(ii) Workshop Practice
Course Outcomes:

- Upon completion of this laboratory course, students will be able to fabricate components with their own hands.
- They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
- By assembling different components, they will be able to produce small devices of their interest.

Practical's (30 Hrs):

1. Fitting shop (6 hours)
2. Carpentry (4 hours)
3. Electrical & Electronics (4 hours)
4. Smithy (2 hours)
5. Welding shop (4 hours) (Arc welding 2 hrs + gas welding 2 hrs)
6. Casting (2 hours)

7. Machine shop (6 hours)
8. Plastic molding & Glass Cutting (2 hours)

III SEMESTER

S.No.	Course Code	Course Title	Course Category	Hours per week			Total Contact Hours	Credits
				L	T	P		
1	EE2101	Electrical Machines-I	PCC	3	0	0	3	3
2	EE2102	Analog Electronic Circuits	PCC	4	1	0	5	5
3	EE2103	Electromagnetic Fields	PCC	3	1	0	4	4
4	EE2701	Analog Electronic Circuits Lab	PCC	0	0	2	2	1
5	CS2103	Pragramming for Problem Solving	ESC	3	0	0	3	3
6	CS2703	Pragramming for Problem Solving Lab	ESC	0	0	4	4	2
7	MA2105	Vector Calculus and Complex analysis	BSC	3	1	0	4	4
8	ME2104	Engineering Mechanics	ESC	3	1	0	4	4
Total				19	4	6	29	26

19EE2101 **ELECTRICAL MACHINES-I**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-0-0-3**

Course Objectives:

This course introduces the concept of

- Construction operational features of energy conversion devices i.e., DC machines and transformers.
- Characteristics of DC machines and transformers and their applications

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

- Understand the operation of dc machines.
- Analyze the differences in operation of different dc machine configurations.
- Analyze single phase and three phase transformers circuits

UNIT I: Magnetic fields, magnetic circuits and Magnetic Forces (10 Hours)

Review of magnetic circuits - MMF, flux, reluctance, inductance; review of Ampere Law and Biot Savart Law; B-H curve of magnetic materials, hysteresis and eddy current losses, Concept of statically and dynamically induced emf, Lorentz's Equation of Force
Energy stored in the magnetic circuits; Field energy and mechanical energy, determination of mechanical force; flow of energy in electromechanical devices.

UNIT II: DC machines (8 Hours)

Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or

shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation - Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

UNIT III: DC machine - motoring and generation (8 Hours)

Armature circuit equation for motoring and generation, Types of field excitations - separately excited, shunt, series and compound. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed, Characteristics of generators and motors: separately excited, shunt ,series and compound. Speed control of DC motors, Losses, load testing and back-to-back testing of DC machines, Starting of DC motor

UNIT IV: Transformers-1 (8 Hours)

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, 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

UNIT V: Transformers-2 (8 Hours)

Three-phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, 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.

Text books:

1. P. S. Bimbhra, " Electrical Machinery", Khanna Publishers, 2011.
2. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

Reference Books:

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.

19EE2102 **ANALOG ELECTRONIC CIRCUITS**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-1-0-5**

Course Outcomes:

- To introduce the semiconductor devices like Diode, BJT, MOSFET and their applications
- To know the linear and non-linear applications of operational amplifiers.

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

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

UNIT I: Diode circuits (10 Hours)

P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits.

UNIT II: BJT circuits (10 Hours)

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 III: MOSFET circuits (12 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 IV: Operational amplifiers (8 Hours)

Ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

UNIT V: Applications of op-amp (14 Hours)

Linear applications of op-amp: 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 (Wein bridge and phase shift).Analog to Digital Conversion.
Nonlinear applications of op-amp: Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators. Precision rectifier, peak detector. Monoshot, 555 timer.

Text Books:

1. A. S. Sedra and K. C. Smith, " Microelectronic Circuits", New York, Oxford University Press, 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.

Reference Books

1. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1989.
2. P. R. Gray, R. G. Meyer and S. Lewis, " Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.

19EE2103 **ELECTROMAGNETIC FIELDS**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-1-0-4**

Course Objectives: To provide the basic knowledge

- To find electric and magnetic fields for symmetrical charge and current configurations.
- To deduce EM wave propagation in free space and in dielectric medium
- To analyze electromagnetic wave propagation in guiding structures under various matching conditions
- To understand the power flow mechanism in the losssy and lossless transmission lines.

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

- To understand the basic laws of electromagnetism.
- To obtain the electric and magnetic fields for simple configurations under static conditions.
- To analyse time varying electric and magnetic fields.
- To understand Maxwell's equation in different forms and different media.
- 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. Conversions of a vector from one coordinate system to another.

UNIT II: Electrostatics (8 Hrs)

Coulomb's Law, Electric Field Intensity due to different Charge Distributions, Electric Flux Density, Gauss Law and Applications, Electric Potential due to different Charge Distributions, Relations Between E and V, Equipotential Surfaces, Energy Density in the Electrostatic Field.

UNIT III: Conductor, Dielectric and Boundary conditions (8 Hrs)

Convection and Conduction Currents, current density, continuity Equation, conductor, Dielectric materials and their properties. Boundary conditions between conductor-dielectrics, dielectric-dielectric and conductor-free space. Poisson's and Laplace's equations, General procedure for solving Poisson's and Laplace's equation.

UNIT IV: Magneto statics (10 Hrs)

Biot-Savart's Law, Ampere's Circuital Law and Applications, Magnetic Flux Density, Magnetic Scalar and Vector Potentials, Forces due to Magnetic Fields, Magnetisation in material,Magnetic torque and moments, Inductances and Magnetic Energy,
Maxwell's Equations (Time Varying Fields): Faraday's Law, General Field Relation for Time Varying Electric And Magnetic Field, Maxwell's Equations in Different Forms, Conditions at a Boundary Surface : Dielectric-Dielectric and Dielectric-Conductor Interfaces. Poynting Vector and Poynting Theorem.

UNIT V: Electromagnetic waves (10 Hrs)

Wave Equations for Conducting Media, Uniform Plane Waves – Definition, Relations Between E & H, plane wave in good conductor, skin effect, skin depth.
Transmission Lines: Types, Parameters, Transmission Line Equations, Expressions for Characteristic Impedance, Input Impedance Relations, SC and OC Lines, Reflection Coefficient, UHF Lines as Circuit Elements : λ/4, λ/2, λ/8 Lines – Impedance Transformations, Single Stub Matching.

Text Books:

1. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.
2. A. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009.
3. A. Pramanik, "Electromagnetism-Problems with solution", Prentice Hall India, 2012.

Reference Books:

1. G. W. Carter, "The electromagnetic field in its engineering aspects", Longmans, 1954.
2. W. J. Duffin, " Electricity and Magnetism" , McGraw Hill Publication, 1980.
3. W. J. Duffin, " Advanced Electricity and Magnetism" , McGraw Hill, 1968.

19EE2701 **ANALOG ELECTRONIC CIRCUITS LAB**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-2-1**

Course Objective:

- To provide practical Exposure for the students of semiconductor devices, operation
  amplifiers and their application

Course Outcome: At the end of this course, students will be able to

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

LIST OF EXPERIMENTS:

1. Verification of Network Theorems
2. Familiarization with electronic components and usage of multimeter (measurement of resistance, classification of capacitors, diode testing)
3. Familiarization with Oscilloscope, signal generator and further usage of multimeters
4. Frequency response and square wave resting of R-C, C-R and R-L networks
5. Half-wave and full-wave rectifiers, rectification with capacitive filters, zener diode and IC regulation
6. Studies on CE amplifiers
7. Studies on Analog Circuits using OP-AMP
8. Studies on logic gates
9. Studies on 555 circuits, J-K flip-flop, counters and shift registers

ME2001 **ENGINEERING MECHANICS**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-1-0-4**

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

- Understand the concepts of co-ordinate systems.
- Analyse the three-dimensional motion.
- Understand the concepts of rigid bodies.
- Analyse the free-body diagrams of different arrangements.
- Analyse torsional motion and bending moment.

UNIT I: Introduction to vectors and tensors and co-ordinate systems

Vector and tensor algebra; Indical notation; Symmetric and anti-symmetric tensors; Eigenvalues and Principal axes. Three-dimensional Rotation: Three-dimensional rotation: Euler's theorem, Axis-angle formulation and Euler angles; Coordinate transformation of vectors and tensors.

UNIT II: Kinematics of Rigid Body

Dentition and motion of a rigid body; Rigid bodies as coordinate systems; Angular velocity of a rigid body, and its rate of change; Distinction between two- and three-dimensional rotational motion; Integration of angular velocity to find orientation; Motion relative to a rotating rigid body: Five term acceleration formula.

UNIT III: Kinetics of Rigid Bodies

Angular momentum about a point; Inertia tensor: Dentition and computation, Principal moments and axes of inertia, Parallel and perpendicular axes theorems; Mass moment of inertia of symmetrical bodies, cylinder, sphere, cone etc., Area moment of inertia and Polar moment of inertia, Forces and moments; Newton-Euler's laws of rigid body motion.

UNIT IV: Free Body Diagram

Examples on modelling of typical supports and joints and discussion on the kinematic and kinetic constraints that they impose. General Motion: Examples and problems. General planar

motions. General 3-D motions. Free precession, Gyroscopes, Rolling coin. Friction: Concept of Friction; Laws of Coulomb friction; Angle of Repose; Coefficient of friction.

UNIT V: Bending Moment

Transverse loading on beams, shear force and bending moment in beams, analysis of cantilevers, simply supported beams and overhanging beams, relationships between loading, shear force and bending moment, shear force and bending moment diagrams. Torsional Motion: Torsion of circular shafts, derivation of torsion equation, stress and deformation in circular and hollow shafts.

Text Books:

1. F. P. Beer and E. R. Johnson (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill
2. R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.

Reference Books

1. J. L. Meriam and L. G. Kraige (2013) Engineering Mechanics: Statics and Dynamics by Wiley Publication
2. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
3. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press
4. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
5. Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education
6. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications
7. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

IV SEMESTER

S.No.	Course Code	Course Title	Course Category	Hours per week			Total Contact Hours	Credits
				L	T	P		
1	EE2201	Electrical Machines-II	PCC	3	0	0	3	3
2	EE2202	Power Electronics	PCC	3	0	0	3	3
3	EE2203	Digital Electronics	PCC	3	0	0	3	3
4	EE2204	Power Systems-I	PCC	3	0	0	3	3
5	EE2205	Signals and Systems	PCC	2	1	0	3	3
6	EE2801	Electrical Machines-I Lab	PCC	0	0	3	3	1.5
7	EE2802	Power Electronics Lab	PCC	0	0	3	3	1.5
8	EE2803	Digital Electronics Lab	PCC	0	0	2	2	1
9		Delvlopement of Socities and Communication Skills)	HSS	2	0	0	2	2
Total				16	1	8	25	21

19EE2201 **ELECTRICAL MACHINES-II**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-0-0-3**

Course Objectives: This course introduces the concept of

- The concepts of rotating magnetic fields.
- Construction and principle of operation of ac machines (Induction and Synchronous Machines)

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

- Understand the concepts of rotating magnetic fields.
- Understand the operation of ac machines
- Analyze performance characteristics of ac machines.

UNIT I : Fundamentals of AC machine windings (6 Hours)

Physical arrangement of windings in stator and cylindrical rotor; slots for windings; concentrated winding, distributed winding, single- layer winding, full-pitch coils, pitch factor, distribution factor, elimination of harmonics, Air-gap MMF distribution with fixed current through winding - concentrated and distributed.

UNITII: Pulsating and revolving magnetic fields (6 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 III: Three Phase Induction Machines (12 Hours)

Construction, Types (squirrel cage and slip-ring). Equivalent circuit. Phasor Diagram, Torque Slip Characteristics, Starting and Maximum Torque, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors, Concept of Cogging and Crawling, Double cage rotor induction motor , Testing of induction motor: Circle diagrams. Generator operation. Self-excitation. Doubly-Fed Induction Machines.

UNITIV: Single-phase induction motors (6 Hours)

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

UNIT V: Synchronous machines (12 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, V-curves. Salient pole machine - two reaction theory,analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

Text Books:

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.

Reference Books:

1. A. S. Langsdorf, " Alternating current machines", McGraw Hill Education, 1984.
2. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007

19EE2202 **POWER ELECTRONICS**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-0-0-3**

Course Objectives: This course will develop students' knowledge in/on

- Characteristics and applications of basic power semiconductor switches
- Controlled rectifier circuits, DC-DC converter, inverter, AC voltage controller and cycloconverters

Course Outcomes: At the end of this course students will demonstrate the ability to

- Understand the differences between signal level and power level devices.
- Analyze controlled rectifier circuits.
- Analyze the operation of DC-DC choppers.
- Analyze the operation of voltage source inverters

UNIT I: Power switching devices (8 Hours)

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

UNIT II: Thyristor rectifiers (12 Hours)

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R, RL and RLE loads; Three-phase full-bridge thyristor rectifier with R, RL loads; Input current wave shape and power factor, effect of source impedance and dual converter.

UNIT III: DC-DC converter (8 Hours)

Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, boost converter and buck-boost converter analysis and waveforms at steady state, relation between duty ratio and average output voltage, Voltage ripple and current ripple, introduction to isolated DC-DC converters.

UNIT IV: Inverters (10Hours)

Single-phase voltage source inverter, three-phase voltage source inverter (180 & 120 degree conduction modes), modulation techniques (PWM, SPWM), current source inverter

UNIT V: AC voltage controller and cycloconverters (5 hours)

Principle of phase control, principle of integral cycle control, single phase voltage controllers; principle of cyclo-converter operation, single phase to single phase cyclo-converter and single phase to three phase cyclo-converter.
Applications: Battery Charger, UPS and SMPS

Text Books:

1. M. H. Rashid, "Power Electronic Devices, Circuits and Applications" Pearson Education India, 2009.
2. N. Mohan and T. M. Undeland, "Power Electronics: Converters, applications and Design", John Wiley & Sons, 2007.

Reference Books:

1. R. W. Erickson and D. Maksimovic, " Fundamentals of Power electronics", Springer Science & Business Media, 2007.
2. L. Umanand, " Power Electronics: Essentials and Applications", Wileey India, 2009.

19EE2203 **DIGITAL ELECTRONICS**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-0-0-3**

Course Objectives: This course introduces

- Concept of logic families and logic gates
- The concepts of various combinational and sequential circuits.
- Analog to Digital conversion and Digital to Analog conversion.

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

- Understand working of logic families and logic gates.
- Design and implement Combinational and Sequential logic circuits.
- Understand the process of Analog to Digital conversion and Digital to Analog conversion.

UNIT I: Fundamentals of Digital Systems and logic families (10 Hours)

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 ICs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic

UNIT II : Combinational Digital Circuits (10 Hours)

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, digital comparator, parity checker/generator, code converters, priority encoders, decoders

UNIT III: Sequential circuits and systems (10 Hours)

1-bit memory, the circuit properties of Bistable 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 , 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 ICs, 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, dual slope 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. (5 Hours)

Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM)

Text Books:

1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.

Reference Books:

1. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.

19EE2204 **POWER SYSTEMS-I**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-0-0-3**

Course Objectives: This course introduce

- The concepts generation and distribution of electrical power
- Economics aspects of power systems
- Overhead Line Insulators and underground cables

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

- Describe the operation of conventional generating stations
- Describe about the different types of substations available
- Determine Different Types of Tariff's in power system
- Design Distribution of voltage along the string insulators & Solve Problems
- Discuss underground cables & Solve Problems

UNIT- I: Conventional and Non-conventional Energy Sources (8 Hours)

Introduction: Typical Layout of an Electrical Power System–Present Power Scenario in India.
Generation of Electric Power: Conventional Sources (Qualitative): Hydro station, Steam Power Plant, Nuclear Power Plant and Gas Turbine Plant.
Non Conventional Sources (Qualitative): Ocean Energy, Tidal Energy, Wave Energy, wind Energy, Fuel Cells, and Solar Energy, Cogeneration and energy conservation and storage.

UNIT-II: Substations (6 Hours)

Air insulated substations - Indoor & Outdoor substations: Substations layout showing the location of all the substation equipment. Bus bar arrangements in the Sub-Stations: Simple arrangements like single bus bar, sectionalized single bus bar, main and transfer bus bar system with relevant diagrams.
Gas insulated substations (GIS) – Advantages of Gas insulated substations, different types of gas insulated substations, single line diagram of gas insulated substations, bus bar, construction aspects of GIS, Installation and maintenance of GIS, Comparison of Air insulated substations and Gas insulated substations.

UNIT- III: Overhead Line Insulators and Insulated Cables (10 Hours)

Overhead Line Insulators: Introduction, types of insulators, Potential distribution over a string of suspension insulators, Methods of equalizing the potential, testing of insulators.
Insulated Cables: Introduction, insulation, insulating materials, Extra high voltage cables,

grading of cables, insulation resistance of a cable, Capacitance of a single core and three core cables, Overhead lines versus underground cables, types of cables.

UNIT- IV: Corona and Sag (10 Hours)

Corona: Introduction, disruptive critical voltage, corona loss, Factors affecting corona loss and methods of reducing corona loss, Disadvantages of corona, interference between power and Communication lines.

Mechanical design of transmission lines: The Catenary curve, Sag Tension calculations, Stringing chart, Sag template, Equivalent span, Stringing of conductors, Vibration and Vibration dampers

UNIT- V: Economics of Generation and Distribution (8 Hours)

Economics of Generation: Introduction, definitions of connected load, maximum demand, demand factor, load factor, diversity factor, Load duration curve, number and size of generator units. Base load and peak load plants. Cost of electrical energy-fixed cost, running cost, Tariff on charge to customer.

A.C. Distribution: Introduction, AC distribution, Single phase, 3-phase, 3 phase 4 wire system, bus bar arrangement, Selection of site for substation.

D.C. Distribution: Calculations, uniformly loaded distributor fed at one end, distributor fed at both ends, distributor with both concentrated and uniform loading, rind and with inter connect

Text books:

1. W.D.Stevenson –"Elements of Power System Analysis", Fourth Edition, McGraw Hill, 1984.
2. C.L. Wadhwa –"Generation, Distribution and Utilization of Electrical Energy", Second Edition, New Age International, 2009
3. C.L. Wadhwa –"Electrical Power Systems", Fifth Edition, New Age International, 2009

Reference Books:

1. M.V. Deshpande –"Elements of Electrical Power Station Design", Third Edition, Wheeler Pub. 1998
2. H.Cotton & H. Barber-"The Transmission and Distribution of Electrical Energy", Third Edition, ELBS, B.I.Pub., 1985
3. Syed A Nasar, "Electric Power Systems" ,Mcgraw-Hill, 1/e, 2006.

19EE2205 **SIGNALS AND SYSTEMS**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **2-1-0-3**

Course Objectives: This course introduces

- Concepts of signals and systems and their characteristics
- Various mathematical tools like Fourier, Laplace and z- transforms to analyze an LTI systems

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

- Understand the concepts of continuous time and discrete time systems.
- Analyse systems in complex frequency domain.
- Understand sampling theorem and its implications.

UNIT I: Introduction to Signals and Systems (6 hours):

Signals and systems as seen in everyday life, and in various branches of engineering and science. continuous and discrete time signals, continuous and discrete amplitude signals, properties of signal, Power and energy of a signal, some special signals of importance: unit step, unit impulse, ramp, parabolic sinusoid, complex exponential,. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. Examples.

UNIT II: Behavior of continuous and discrete-time LTI systems (8 hours)

Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

UNIT III: Fourier Transforms(8 hours)

Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Properties of Fourier series, Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Properties of Fourier Transforms, Fourier domain duality. The Discrete- Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem.

UNIT IV: Laplace and z-Transforms (10 Hrs)

Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

UNIT V: Sampling and Reconstruction (6 hours)

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.

Text Books:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, " Signals and systems", Prentice Hall India, 1997.
2. B. P. Lathi, " Linear Systems and Signals" , Oxford University Press, 2009.
3. M. J. Robert " Fundamentals of Signals and Systems", McGraw Hill Education, 2007.

Reference Books:

1. J. G. Proakis and D. G. Manolakis, " Digital Signal Processing: Principles, Algorithms, and Applications", Pearson, 2006.
2. H. P. Hsu, " Signals and systems" , Schaum's series, McGraw Hill Education, 2010.
3. S. Haykin and B. V. Veen, " Signals and Systems" , John Wiley and Sons, 2007.
4. A. V. Oppenheim and R. W. Schafer, " Discrete-Time Signal Processing" , Prentice Hall, 2009.

19EE2801 **ELECTRICAL MACHINES-I LAB**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-1.5**

Course Objective:

- To expose the students to the operation of DC machines, transformers and give them experimental skills.

Course Outcomes: Upon completion of the course the student will be able to

- Analyze the characteristics of DC machines and transformers
- Perform tests on DC Machines and transformer and evaluate their performance

Any ten of the following experiments

1. To obtain magnetization characteristics of a d.c. shunt generator.
2. Polarity and ratio test of single phase transformers.
3. To obtain load characteristics of a d.c. shunt generator and compound generator
4. To obtain efficiency of a dc shunt machine using Swinburn's test.
5. To perform Hopkinson's test and determine losses and efficiency of DC machine.
6. To obtain speed-torque characteristics of a dc shunt motor.
7. To obtain speed control of dc shunt motor using
   (a) armature resistance control (b) field control
8. To obtain equivalent circuit, efficiency and voltage regulation of a single phase transformer using O.C. and S.C. tests.
9. To obtain efficiency and voltage regulation of a single phase transformer by Sumpner's test.
10. Load test on dc series generator
11. Field's test

19EE2802 **POWER ELECTRONICS LAB**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-1.5**

Course Objectives: To provide practical exposure on

- Characteristics of basic power semiconductor switches
- Applications of basic power semiconductor switches like controlled rectifier circuits, DC-DC converter, inverter, AC voltage controller etc.

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

- Determine the power semiconductor switches characteristics and their applications.
- Design gate firing & commutation circuits for SCRs.
- Analyze the operation of converters, inverters and choppers.
- Design and simulate power electronic circuits and plot their characteristics.

Any eight experiments should be conducted

1. (a) Study of Characteristics of SCR, MOSFET & IGBT
   (b) Gate firing circuits for SCR's
2. (a) Single Phase Semi-converter with R and RL load
   (b) Single Phase fully controlled bridge converter with R and RL loads
   (c) Single Phase dual converter with RL loads
3. (a) Three Phase Semi-converter with R-load
   (b)Three Phase Bridge converter with R and RL loads
4. Isolated DC-DC converter
5. Single phase half bridge and full bridge inverter
6. Single Phase series inverter with R and RL loads
7. Single Phase Parallel inverter with R and RL loads
8. Single Phase AC Voltage Controller with R and RL Loads
9. Single Phase Cycloconverter with R and RL loads

Reference books:

1. M.H.Rashid, Simulation of Electric and Electronic circuits using PSPICE – by M/s PHI Publications.

19EE2803 **DIGITAL ELECTRONICS LAB**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-2-1**

Course Objectives: To provide practical exposure on

- Various combinational and sequential circuits and filters.
- Applications of Operational Amplifier as adder, integrator and voltage to current converters.

Course Outcomes: Upon completion of this course the student will be able to

- Design counters, NAND gate and adders.
- Design multiplexer, 7-segment LED display and LPF, HPF, BPF
- Analyze the application of Operational Amplifier as adder, integrator and voltage to current converters.

LIST OF EXPERIMENTS: Any TEN of the following experiments

1. Design of a counter asynchronous and synchronous
2. I/O characteristics of a NAND gate
3. Design of a full adder circuit
4. Design of a digital comparator
5. Simplification Boolean function using K-map
6. Design of a multiplexer
7. Design of a 7-segment LED display
8. To study application of Operational Amplifier as adder, integrator and voltage to current converters.
9. Design of filters
    a. To design a low pass filter Second order filters using operational amplifier for cutoff frequency 1 KHz.
    b. To design a high pass filter Second order filters using operational amplifier for frequency 12 KHz.
    c. To design a band pass filter with unit gain of pass band from 1 KHz to 12 KHz.
10. To study application of Operational Amplifier as voltage comparator.
11. To generate triangular & square wave using operational amplifier.
12. To study regulation of unregulated power supply using IC 7805/7812 voltage regulator and measure the load and line regulations

V SEMESTER

S.No.	Course Code	Course Title	Course Category	Hours per week			Total Contact Hours	Credits
				L	T	P		
1	EE3101	Power Systems-II	PCC	3	0	0	3	3
2	EE3102	Control Systems	PCC	3	0	0	3	3
3	EE3103	Electrical Measurements and Instrumentation	PCC	3	0	0	3	3
4	EE3104	Micro Processors	PCC	3	0	0	3	3
5	EE3701	Electrical Machines-II Lab	PCC	0	0	3	3	1.5
6	EE3702	Electrical Measurements and Instrumentation Lab	PCC	0	0	2	2	1
7	EE3703	Micro Processors Lab	PCC	0	0	2	2	1
8		Open Elective-I (Oops)	OEC	3	0	0	3	3
9		Essence of Indian Traditional Knowledge	MC	2	0	0	2	0
10		Seminar-I (Technical)	Seminar	0	0	0	0	0
Total				17	0	7	24	18.5

19EE3101 **POWER SYSTEMS-II**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-0-0-3**

Course Objective: To provide the knowledge to

- Analyze transmission line performance
- Apply load compensation techniques to control reactive power
- Understand the application of per unit quantities
- Determine the fault currents for symmetrical and unbalanced faults

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

- Analyze circuit parameters of transmission lines & transmission line performance & Solve Problems.
- Describe the voltage control methods and different compensation methods available
- Explain the significance of per unit quantities.
- Determine the fault currents for symmetrical and unbalanced faults

UNIT I: Transmission Line Parameters (10 Hours)

Inductance and Capacitance Calculations of Transmission Lines: Line conductors, inductance and capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing, Composite conductors-transposition, bundled conductors, and effect of earth on capacitance, Skin and Proximity effect

UNIT II: Performance of Transmission Lines (8 Hours)

Representation of lines, short transmission lines, medium length lines, nominal T and PI-representations, long transmission lines. The equivalent circuit representation of a long Line, A, B, C, D constants, Ferranti Effect, Power flow through a transmission line, receiving end power circle diagram.

UNIT III: Voltage Control and Compensation In Power Systems (8 Hours)

Voltage Control : Introduction – methods of voltage control, shunt and series capacitors / Inductors, tap changing transformers, synchronous phase modifiers.
Introduction to compensation in power systems: Load ability characteristics of overhead lines – Uncompensated transmission line – Symmetrical line – Radial line with asynchronous load – Compensation of lines.

UNIT IV: Travelling Waves on Transmission Lines and Per Unit Representation (10

Hours)

Travelling Waves on Transmission Lines: Production of traveling waves, open circuited line, short circuited line, line terminated through a resistance, line connected to a cable, reflection and refraction at T-junction line terminated through a capacitance, capacitor connection at a T-junction, Attenuation of travelling waves.

Per Unit Representation of Power Systems : The one line diagram, impedance and reactance diagrams, per unit quantities, changing the base of per unit quantities, advantages of per unit system.

UNIT V: Symmetrical Components and Fault Analysis (8 Hours)

Significance of positive, negative and zero sequence components, Average 3-phase power in terms of symmetrical components, sequence impedances and sequence networks, fault calculations, sequence network equations, single line to ground fault, line to line fault, double line to ground fault, three phase fault, faults on power systems, faults with fault impedance, reactors and their location, short circuit capacity of a bus.

Text Books:

1. John J. Grainger & W.D. Stevenson: Power System Analysis – Mc Graw Hill International 1994.
2. C.L. Wadhwa: Electrical Power Systems – New Age International Pub. Co.Third Edition, 2001.
3. D.P. Kothari and I.J. Nagrath, Modern Power System Analysis - Tata Mc Graw Hill Pub. Co., New Delhi, Fourth edition, 2011

Reference Books:

1. Hadi Scadat: Power System Analysis – Tata Mc Graw Hill Pub. Co. 2002
2. W.D. Stevenson : Elements of Power system Analysis – McGraw Hill International Student Edition.
3. Miller “Reactive power control in Electric systems “Wiley , 2/e ,2011

19EE3102 **CONTROL SYSTEMS**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-0-0-3**

Course Objectives:

- To introduce the principles and applications of control systems in everyday life.
- The emphasis of this course is laid on stability analysis and design aspects of control systems using classical control theory approaches

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

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

UNIT I: Introduction to control problem (10 hours)

Industrial Control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra, Signal Flow Graph.

UNIT II: Time Response 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. Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique construction of Root-loci.

UNIT III: Frequency-response analysis (10 hours)

Design specifications in frequency-domain, Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.

UNIT IV: Introduction to Controller Design (10 hours)

Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems. Root-loci method of feedback controller design.. Frequency-

domain methods of design. Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs. Analog and Digital implementation of controllers.

UNIT V: State variable Analysis (10 hours)

Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability. Pole-placement by state feedback.
Introduction to Optimal Control and Nonlinear Control: Performance Indices. Regulator problem, Tracking Problem. Nonlinear system–Basic concepts and analysis.

Text Books:

1. M. Gopal, " Control Systems: Principles and Design", McGraw Hill Education, 1997.
2. B. C. Kuo, " Automatic Control System", Prentice Hall, 1995.

Reference Books:

1. K. Ogata, " Modern Control Engineering", Prentice Hall, 1991.
2. J. Nagrath and M. Gopal, " Control Systems Engineering", New Age International, 2009

19EE3103 **ELECTRICAL MEASUREMENTS AND INSTRUMENTATION**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-0-0-3**

Course Objectives:

- To understand the operating principle of various types of analog instruments for measuring voltage, current, power, phase, frequency and energy.
- To determine the circuit parameters using AC and DC bridges.
- To understand operating principles of electronic measuring instruments

Course Outcomes: Upon competition of the course students will be able to

- Compare performance of MC, MI and Dynamometer types of measuring instruments, Energy meters and CRO
- Compute the errors in CTs and PTs.
- Selection of transducers for the measurement of temperature, displacement and strain .

UNIT I : Measurement of Voltage and Current (8 Hours)

Introduction: Methods of measurement, Measurement system, Classification of instrument systems, Characteristics of instruments & measurement systems, Definition of accuracy, precision, resolution. Speed of response. Errors in measurement& its analysis. Loading effect due to shunt and series connected instruments.

Measurement of Voltage and Current: General features, Construction, principle of operation and torque equation of Permanent magnet moving coil(PMMC), Moving Iron(MI), electrodynamometer, Induction, Thermoelectric and rectifier type instruments. Extension of instrument ranges using shunt, multipliers.

UNIT II: Measurement of Electrical Power and Energy (10 Hours)

Measurement of power: Construction and principle of operation of Electrodynamometer type wattmeter. Errors in Electrodynamometer type wattmeter. Low power factor wattmeter. Measurement of power in single phase system.

Measurement of phase, frequency and energy: Single phase and three phase electro dynamometer power factor meter, moving iron power factor meter. Construction and operation of different types of frequency meters. Construction and principle of operation of Single phase induction type energy meters, errors in energy meter and their compensation methods. Testing of energy meter by phantom loading method.

Instrument Transformers: CT and PT; their errors, Applications of CT and PT in the extension of instrument range.

UNIT III: Measurement of Electrical Parameters (8 Hrs)

Measurement of resistance: Measurement of low resistance by kelvin's double bridge, measurement of medium resistance by wheatstone bridge, voltmeter and ammeter method,substitution method and ohmmeter method.measurement of high resistance by loss of charge method, direct deflection method and Meggar.

Measurement of inductance and capacitance: Measurement of inductance with the help of AC Bridges(Maxwell's Inductance, Anderson, Hay's and owen's bridges)Measurement of capacitance with the help of AC Bridges (De Sauty's, Schering Bridge) their Applications and Limitations. Q meter.

UNIT IV: Potentiometers, Sensors & Transducers (8 Hours)

Principle of operation and application of Crompton's DC potentiometer, Polar and co-ordinate type of AC potentiometers. Magnetic Measurement- Ballistic galvanometer, Flux meter, Determination of hysteresis loop, measurement of iron losses.

Introduction to sensors & transducers, RTD, Thermistors, LVDT, Strain Gauge, Piezoelectric Transducers, Hall effect sensors. Flow measurement using magnetic flow measurement.

UNIT V: Digital Measurement of Electrical Quantities (8 Hours)

Advantages of digital instruments. Concept of digital measurement. Block diagram and theory of digital voltmeter, digital Frequency meter, Spectrum analyzer and harmonic distortion analyzers. Block diagram and working of Cathode Ray Oscilloscope, Cathode Ray Tube (CRT) & its components, Applications of CRO in measurement, Lissajous Pattern, Dual trace & dual beam oscilloscopes

Text Books:

1. A. K. Sawhney, "Electrical & Electronic Measurement & Instrument", Dhanpat Rai & Sons, India
2. J. B. Gupta, "Electrical Measurement & Measuring Instrument", S. K. Kataria & Sons

Reference Books:

1. E. W. Golding & F. C. Widdis, "Electrical Measurement &Measuring Instrument", A. W. Wheeler & Co. Pvt. Ltd. India
2. Forest K. Harris, "Electrical Measurement", Willey Eastern Pvt. Ltd. India

19EE3104 **MICRO PROCESSORS**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-0-0-3**

Course Objective:

- To familiarize with the architecture of 8085 processor, assembling language programming and interfacing with various modules.
- To understand 8051 Microcontroller concepts, architecture, programming and application of Microcontrollers.

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

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

UNIT I: Fundamentals of Microprocessors: (8 Hours)

Fundamentals of Microprocessor, Architecture 8-bit Microprocessor (8085) 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: 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. 8085 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 III: Memory and I/O Interfacing (6 Hours):

Memory and I/O expression busses, control signals, memory wait states. Interfacing of peripheral devices such as General purpose I/O, ADC, DAC, timers, counters and memory devices.

UNIT IV: External Communication Interface (6 Hours)

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

UNIT V : Introduction to Advanced micro controllers (10 Hours)

Arduino programming and applications

Text 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. S. Gaonkar, “, Microprocessor Architecture: Programming and Applications with the 8085”, Penram International Publishing, 1996

Reference Books:

1. D. A. Patterson and J. H. Hennessy, "Computer Organization and Design: The Hardware/Software interface”, Morgan Kaufman Publishers, 2013.
2. R. Kamal, “Embedded System”, McGraw Hill Education,2009.

19EE3701 **ELECTRICAL MACHINES-II LAB**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-1.5**

Course Objectives:

- To provide practical exposure to ac machines (Induction and Synchronous machines)

Course Outcomes: Upon completion of the course the student will be able to

- Analyze the characteristics of synchronous machines and Induction motors
- Perform tests on synchronous machines and Induction motors and evaluate their performance

LIST OF EXPERIMENTS:

1. To perform no load and blocked rotor tests on a three phase squirrel cage induction motor and determine equivalent circuit.
2. To perform load test on a three phase induction motor and draw Torque -speed characteristics.
3. To determine speed-torque characteristics of three phase slip ring induction motor and study the effect of including resistance in the rotor circuit.
4. To determine speed-torque characteristics of single phase induction motor and study the effect of voltage variation.
5. To perform no load and blocked rotor tests on a single phase induction motor and determine equivalent circuit.
6. Determine voltage regulation at full load and at unity, 0.8 lagging and leading power factors by
   (i) EMF method
   (ii) MMF method.
7. To study synchronization of an alternator with the infinite bus by using:
   (i) dark lamp method
   (ii) two bright and one dark lamp method.
8. To determine V-curves and inverted V-curves of a three phase synchronous motor.
9. To determine Xd and Xq of a three phase salient pole synchronous machine using the slip test and to draw the power-angle curve.
10. Scott connection

19EE3702 **ELECTRICAL MEASUREMENTS AND INSTRUMENTATION LAB**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-2-1**

Course Objectives:

- To provide students with good depth of knowledge of electrical and electronic measuring instruments.
- To understand measurement errors and non ideal electrical devices.

Course Outcomes: At the end of the course the student will be able to:

- Calibrate single phase energy meters
- Measure Resistance, Inductance and capacitance using AC and DC bridges
- Measure frequency, voltage peaks, phase difference with an oscilloscope.
- Compare performance of MC, MI and Dynamometer types of measuring instruments, Energy meters and CRO

LIST OF EXPERIMENTS

1. Introduction to Lab
   a. Measurement of phase difference and frequency of a sinusoidal ac voltage using C.R.O.
   b. Usage of DSO for steady state periodic waveforms produced by a function generator.
   c. Selection of trigger source and trigger level, selection of time-scale and voltage scale.
   d. Bandwidth of measurement and sampling rate.
   e. Download of one-cycle data of a periodic waveform from a DSO and use values to compute the RMS values using a C program.
   f. Usage of DSO to capture transients like a step change in R-L-C circuit.
2. Calibration of voltmeter and ammeter.
3. Calibration of Single phase Energy Meter
4. Measurement of power and power factor of a single phase inductive load and to study effect of capacitance connected across the load on the power factor.
5. Measurement of Reactive power using one wattmeter method
6. Measurement of low resistance by Kelvin's double bridge.
7. Measurement of L using a bridge technique as well as LCR meter.
8. Measurement of C using a bridge technique as well as LCR meter.
9. Measurement of High resistance and Insulation resistance using Megger.
10. Measurement of voltage, current and resistance using dc potentiometer

19EE3703 **MICROPROCESSORS LAB**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-2-1**

Course Objective:

- To familiarize with arduino board and micro controller.
- To understand the interfacing with interfacing with various modules.

Course Outcome:

- The student will be able to interface Keyboard, stepper motor and DC motor.
- The student will be able to interface traffic light, ADC and DAC.
- The student will be able to understand 8051 Microcontroller concepts, architecture, programming and application of Microcontrollers

LIST OF EXPERIMENTS:

1. Interface simple seven segment LED display with arduino and controller.
2. To Display "DEPT OF EEE" on LCD in 8-bit as well as 4-bit mode
3. Interface Keyboard and LCD with controller.
4. Interface Stepper Motor by controlling its direction and make it spin faster or slower arduino and controller..
5. Interface DC motor and control its speed using PWM technique. arduino and controller.
6. Interface Elevator to arduino and controller..
7. Interface Traffic Light with arduino and controller..
8. Interfacing ADC to Microcontroller.
9. Interface DAC with Microcontroller and generate multiple waveforms.
10. Interface Temperature Sensor to ADC and measure it on LCD with arduino and controller.

VI SEMESTER

S.No.	Course Code	Course Title	Course Category	Hours per week			Total Contact Hours	Credits
				L	T	P		
1	EE3201	Power Systems Protection	PCC	3	0	0	3	3
2	EE3202	Power Systems Operation and Control	PCC	3	0	0	3	3
3	EE3801	Power Systems Lab	PCC	0	0	3	3	1.5
4	EE3802	Control Systems Lab	PCC	0	0	2	2	1
5	EE3803	Electrical Simulation Lab	PCC	0	0	2	2	1
6		Program Elective-I	PEC	3	0	0	3	3
7		Program Elective-II	PEC	3	0	0	3	3
8		Open Elective-II	OEC	3	0	0	3	3
9	HS3202	Human Values and Soft skills	HSMC	2	0	2	4	3
10		Mini Project	PROJ	0	0	2	2	1
11		Comprehensive Viva	PCC	0	0	0	0	0
12		Summer Intership	PCC	0	0	0	0	0
Total				17	0	11	28	22.5

19EE3201 **POWER SYSTEMS PROTECTION**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-0-0-3**

Course Objective:

- To compare and contrast electromagnetic, static and microprocessor based relays
- To apply technology to protect power system components
- To select relay settings of over current and distance relays.
- To analyze quenching mechanisms used in air, oil and vacuum circuit breakers

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

- Compare electromagnetic with static relays
- Evaluate the of performance of Various Relays
- Understand about the concept of over voltage protection and insulation coordination
- Analyze Fundamental principles of circuit breakers & fuses

UNIT I: Relays (8 Hours)

Electromagnetic Relays - Basic Requirements of Relays – Primary and Backup Protection – Construction, Details of – Attracted Armature, Balanced Beam, Inductor Type and Differential Relays – Universal Torque Equation – Characteristics of Over Current, Direction and Distance Relays. Static Relays –Introduction to static relays, Advantages and Disadvantages over electromagnetic relays

UNIT II: Protection of Generators and Transformers (10 Hours)

Protection of Generators against Stator Faults, Rotor Faults, and Abnormal Conditions. Restricted Earth Fault and Inter-Turn Fault Protection. Numerical Problems On percentage Winding Unprotected. Protection of Transformers: Percentage Differential Protection, Numerical Problem on Design of CT s Ratio, Buchholtz Relay Protection, Numerical Problems.

UNIT III: Protection of Transmission Lines (8 Hours)

Protection of Feeder (Radial & Ring Main) Using Over Current Relays. Protection of transmission Line– 3 Zone Protection Using Distance Relays. Carrier Current Protection. Protection of Bus Bars.

UNIT IV: Overvoltage Protection and Insulation Coordination (8 Hours)

Over voltage due to arcing ground and Peterson coil, lightning, horngaps, surge diverters, rod gaps, expulsion type lightning arrester, valve type lightning arrester, ground wires, ground rods, counter poise, surge absorbers, insulation coordination, volt-time curves**.**

UNIT V: Circuit Breakers (10 Hours)

Introduction, arcing in circuit breakers, arc interruption theories, re-striking and recovery voltage, resistance switching, current chopping, interruption of capacitive current, oil circuit breaker, air blast circuit breakers, Vacuum Circuit Breaker, SF6 circuit breaker, operating mechanism, selection of circuit breakers, high voltage d.c. breakers, ratings of circuit breakers, testing of circuit breakers. Fuses : Introduction, fuse characteristics, types of fuses, application of HRC fuses, discrimination

Text Books:

1. Badriram and D.N. Vishwakarma, Power System Protection and Switchgear, TMH 2001
2. U.A.Bakshi, M.V.Bakshi: Switchgear and Protection, Technical Publications, 2009.
3. Switchgear and Protection – by Sunil S Rao, Khanna Publishers, 1992.

Reference

1. L.P.Singh ―Protective relaying from Electromechanical to Microprocessors‖, New Age International
2. "Electrical Power", by S. L. Uppal, Khanna pulishers,1988.
   Ravindranath & Chander, "Switch Gear & Protection" New Age International , 2/e, 2014

19EE3202 **POWER SYSTEMS OPERATION AND CONTROL**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-0-0-3**

Course Objective: At the end of the course the student will be able to:

- To understand the computation of load flows in a power systems
- To study the various methods of reactive power control in power systems and economic load scheduling
- To study load frequency control and its analysis in an isolated power system
- To study stability, stability limits and the dynamics of synchronous machines

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

- Compute the bus variables and the power flows in the system using various iterative methods
- Determine the optimal economic load scheduling.
- Determine the static and dynamic frequency response of a power system for a single area and two area system
- Predict the stability of power systems and determine the transient stability limits

UNIT I: Load flow studies (8 hours)

Introduction, Bus classification, Nodal admittance matrix, Transmission Network Representations: Bus Admittance frame and Bus Impedance frame. Formation of Ybus: Direct and Singular Transformation Methods, Load flow equations, Iterative methods – Gauss, Gauss Seidel and Newton Raphson methods. Newton decoupled and fast decoupled. Merits and Demerits of these methods, system data for load flow study.

UNIT II : Economic Operation of Power Systems (6 hours)

Distribution of load between units within a plant, transmission loss as a function of plant generation, calculation of loss coefficients, distribution of load between plants. Unit commitment: Introduction, constraints in unit commitment problems.

UNIT III: Load Frequency control (11 hours)

Introduction, Load frequency problem, Megawatt frequency (or P-F) control channel, Megavar voltage (or Q – V) control channel. Dynamic interaction between P-F and Q-V loops, Mathematical model of speed governing system, turbine models division of power system into

control areas, P-F control of single control area (the uncontrolled and controlled cases) P-F control of two area systems (the uncontrolled and controlled cases).

UNIT IV: Power System Stability (8 hours)

The stability problem, steady state stability limit, Expression using ABCD parameters, steady state stability of synchronous machine. transient stability, swing equation, equal area criterion of stability and its further applications, step by step solution swing equation, some factors affecting transient stability & Methods of improving stability . Concept of Dynamic stability – effect of excitation on generator power limits.

UNIT V: Reactive Power–Voltage Control (9 hours)

Basics of reactive power control. Excitation systems – modeling. Static and dynamic analysis - stability compensation - generation and absorption of reactive power. Relation between voltage, power and reactive power at a node - method of voltage control - tap-changing transformer.
System level control using generator voltage magnitude setting, tap setting of OLTC transformer and MVAR injection of switched capacitors to maintain acceptable voltage profile and to minimize transmission loss.

Textbooks:

1. John Grainger & William Stevenson Jr., "Power Systems Analysis", McGraw Hill, 1/e,
2. D.P.Kothari and I.J.Nagrath, Modern Power System Analysis, 4th Edn, Tata McGraw Hill Education Private Limited 2011.
3. C.L.Wadhwa, Electrical Power Systems, 3rd Edn, New Age International Publishing Co., 2001.

Reference Books:

1. Olle I Elgerd " Electric Energy Systems Theory", Tata McGraw Hill ,2/e ,2011
2. Chakrabarthi, Abhijit halder, "Power system analysis: Operation and Control", Prentice hall of India, 3/e, 2010**.**

19EE3801 **POWER SYSTEMS LAB**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-1.5**

Course Objective:

- Performance of long transmission lines and reactive power control
- Characteristics of protective relays
- Short circuit analysis and sequence components of power system elements
- Study of different faults on Transmission lines

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

- Determine the performance characteristics of a long transmission line and reactive power control
- Determine the operating characteristics of protective relays
- Compute fault currents and determine the sequence components of power system elements

List of experiments

1. Determination of Sequence Impedances of a cylindrical rotor Synchronous Machine.
2. Determination of Positive, Negative and zero sequence reactance of 3 phase Transformers
3. Fault analysis of 3 phase Alternator, (LG, LL, LLG, LLLG faults).
4. Determination of Sub transient reactance's of a Salient Pole Synchronous Machine.
5. To obtain the operating characteristics of IDMT over current relay
6. Characteristics of Percentage biased of Static Differential Relay
7. Performance and Testing of Generator Protection System.
8. To obtain the performance characteristics of long transmission line
9. To determine the breakdown strength of oil.
10. Reactive power control of long Transmission line

Any two simulation experiments listed below should be conducted using two electrical related soft wares

1. Distribution System Reliability Analysis.
2. Power System Fault Analysis.
3. Transmission Line Fault Analysis.

19EE3802 **CONTROL SYSTEMS LAB**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-2-1**

Course Objectives: To provide the practical exposure

- To strengthen the knowledge of Feedback control
- To inculcate the controller design concepts
- To familiarize with control systems components like servomotor, synchros and Magnetic amplifier.
- To familiarize programmable logic controller

Course Outcomes: At end of this course student will be able to

- Demonstrate time response of second order system
- Understand characteristics of control system components like servomotor, synchros and Magnetic amplifier.
- Design and understand PID control for temperature control application
- Design controller and compensators using simulation tools

Any Eight of the following experiments are to be conducted:

1. Time response of Second order system
2. Characteristics of Synchros
3. Programmable logic controller – Study and verification of truth tables of logic gates, simple Boolean expressions and application of speed control of motor.
4. Effect of feedback on DC servo motor
5. Transfer function of DC motor
6. Effect of P, PD, PI, PID Controller on a second order systems
7. Lag and lead compensation – Magnitude and phase plot
8. Temperature controller using PID
9. Characteristics of magnetic amplifiers
10. Characteristics of AC servo motor

Any two simulation experiments are to be conducted:-

1. Simulation of Op-Amp based Integrator and Differentiator circuits.
2. Linear system analysis (Time domain analysis, Error analysis) .
3. Stability analysis (Bode, Root Locus, Nyquist) of Linear Time Invariant system
4. State space model for classical transfer function – Verification.

REFERENCE BOOKS:

1. Simulation of Electrical and electronics Circuits using PSPICE – by M.H.Rashid, M/s PHI Publications.
2. PSPICE A/D user's manual – Microsim, USA.
3. PSPICE reference guide – Microsim, USA.
4. MATLAB and its Tool Books user's manual and – Mathworks, USA.

19EE3803 **ELECTRICAL SIMULATION LAB**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-2-1**

Course Objective:

- To impart hands on experience in verification of circuit laws and theorems, measurement of circuit parameters, study of circuit characteristics and the simulation of power electronics circuits using PSPICE.
- Gives practical exposure to the usage of different circuits with different condition.
- Acquire skills of using computer packages MATLAB coding and SIMULINK in power Electronics and power system studies.

Course Outcome: Upon the successful completion of this course, the student is expected to gain the following skills:

- Understand the fundamentals and programming Knowledge in PSPICE.
- Able to understand the Transient & Steady State Performance of a system.
- Able to generate plots and export this for use in reports and presentations.
- Able to give practical experience with simulating physical systems

List of Experiments:

Any TEN of the following Experiments

1. Stability analysis(Bode, Root locus, Nyquist) of linear time invariant system
2. Effect P, PD, PI, PID controllers on a second order system
3. Simulation of Half wave & Full wave bridge rectifier .
4. Simulation of single phase bridge inverter
5. Simulation of Boost Converter
6. Performance evaluation of medium and long transmission lines .
7. Symmetrical component analysis
8. Load frequency control of single area and two area power system
9. Performance of FC-TCR compensator
10. Permanent Magnet DC motor simulation
11. Newton Raphson method of load flow analysis.
12. Gauss seidal method of load flow analysis.
13. Fault analysis

Reading:

1. C.L. Wadhwa: Electrical Power Systems –Third Edition, New Age International Pub. Co., 2001.
2. Hadi Sadat: Power System Analysis –Tata Mc Graw Hill Pub. Co. 2002.
3. Control Systems Engineering-I.J. Nagrath & M.Gopal- New Age International Pub. Co
4. A.E. Clayton & C.I. Hancock Performance and Design of DC Machines**.**

VII SEMESTER

S.No.	Course Code	Course Title	Course Category	Hours per week			Total Contact Hours	Credits
				L	T	P		
1	EE4101	Utilization of Electrical Energy	PCC	3	0	0	3	3
2	EE4701	Energy Systems Lab	PCC	0	0	2	2	1
3		Program Elective-III	PEC	3	0	0	3	3
4		Program Elective-IV	PEC	3	0	0	3	3
5		Open Elective-III	OEC	3	0	0	3	3
6		Slot for HSS (frnagement Studies)	HSMC	3	0	0	3	3
7		Project-I	PROJ	0	0	6	6	3
Total				15		8	23	19

19EE4101 **UTILIZATION OF ELECTRICAL ENERGY**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **3-0-0-3**

Course Objective:
This course will develop students' knowledge in/on

1. Various electric traction systems with their performance.
2. Selection of motor for different industrial drives.
3. Electric heating and welding techniques.
4. Designing and selection of lamps for proper illumination

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

- Choose the motor for different types of Electric traction systems.
- Evaluate the selection of a motor for different types of loads.
- Use various heating and welding techniques for different applications.
- Select and design the lamps for proper illumination. & Solve Problems

UNIT – I: INDUSTRIAL UTILIZATION (8 hours)

Introduction, Factors governing selection of Electric Motors, Nature of electric supply, Types of drives, Nature of loads, Standard Ratings of Motors, Choice of ratings of Motors, Types of Motors used in industrial Drives, Motors for particular service, speed control.

UNIT – II : ELECTRIC HEATING and WELDING (8 Hours)

Advantages and methods of electric heating, resistance heating induction heating and dielectric heating. Electric welding, resistance and arc welding, electric welding equipment, comparison between A.C. and D.C. Welding.

UNIT III: Illumination Systems (10 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. Discharge lamps

UNIT –IV: ELECTRIC TRACTION (10 Hours)

System of electric traction and track electrification. Review of existing electric traction systems in India. Special features of traction motor, methods of electric braking-plugging rheostat braking and regenerative braking. Mechanics of train movement. Speed-time curves for different services – trapezoidal and quadrilateral speed time curves. Calculations of tractive effort, power, specific energy consumption for given run, effect of varying acceleration and braking retardation, adhesive weight and coefficient of adhesion.

UNIT V: Residential Electrical Systems (8 Hours)

Types of residential 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

Introduction to Electric Vechicles: Historical Journey of Hybrids and Electric Vehicle, Economic and Environmental Impact of Electric Hybrid Vehicle

Text Books:

1. E. Openshaw Taylor, Utilisation of Electric Energy – by University press.
2. C.L. Wadhwa, Generation, Distribution and Utilization of electrical Energy, New Age International (P) Limited, Publishers, 1997

Reference Books

1. N.V.Suryanarayana, Utilization of Electrical Power including Electric drives and Electric traction, New Age International (P) Limited, Publishers, 1996.
2. Partab, Art & Science of Utilization of electrical Energy –Dhanpat Rai & Sons.

19EE4701 **ENERGY SYSTEMS LAB**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-2-1**

Course Objective:

- To introduce the basic renewable energy systems

Course Outcome:

- The student will be able to understand PV cell characteristics
- The student will be able understand to interface with power converters and MPPT concept

1. V-I characteristics of solar panel at various levels of isolation.
2. Study of wind turbine generator.
3. Performance Study of Solar Flat Plate Thermal Collector Operation with Variation in Mass Flow Rate and Level of Radiation
4. Characterization of Various PV Modules Using large area Sun Simulator
5. Study of micro-hydel pumped storage system
6. Fuel Cell Experiment
7. Study of 100 kW solar PV plant
8. Simulation of PV and DC-DC converter interface
9. Simulation of MPPT for PV cell or module
10. Simulation of PV cells in parallel and series

VIII SEMESTER

S.No.	Course Code	Course Title	Course Category	Hours per week			Total Contact Hours	Credits
				L	T	P		
1		Program Elective-V	PEC	3	0	0	3	3
2		Open Elective-IV	OEC	3	0	0	3	3
3		Project-II	PROJ	0	0	16	16	8
4		Comprehensive Viva	PCC	0	0	0	0	0
Total				6	0	16	22	14