NATIONAL INSTITUTE OF TECHNOLOGY, AGARTALA

DEPARTMENT OF ELECTRICAL ENGINEERING

SYLLABII FOR UG 1st, 2nd, 3rd, 4th, 5th, 6th, 7th & 8th SEMESTERS

		HOUR			CREDIT			
Semester		Lecture	Tutorial	Practical	Lecture	Tutorial	Practical	Total
	First Year (1st Semester+2nd Semester) [already implemented by the academic section in 2018-19 session.]							**43**
3rd Semester								
1	Engineering Mathematics III	3	1	0	3	1	0	4
2	Electrical Measurement and Measuring Instruments	3	1	2	3	1	1	5
3	Network Analysis	3	1	2	3	1	1	5
4	Digital Electronics	3	0	2	3	0	1	4
5	Object Oriented Programming	2	0	3	2	0	2	4
6	Signals & Systems	3	1	0	3	1	0	4
7	Seminar (Soft Skilled based)	0	0	0	0	0	0	0
								26
4th Semester								
1	Electrical Machine-I	3	1	3	3	1	2	6
2	Power System I	3	1	0	3	1	0	4
3	Data Structure & Algorithm	3	1	0	3	1	0	4
4	Numerical Methods and Analysis	3	1	2	3	1	1	5
5	Analog Electronics	3	1	2	3	1	1	5
6	Elective-I	3	0	0	3	0	0	3
7	Seminar (Soft Skilled based)	0	0	0	0	0	0	0
								27
5th Semester								
1	Electrical Machine-II	3	1	3	3	1	2	6
2	Power Electronics	3	1	3	3	1	2	6
3	Microprocessors and Microcontroller	3	0	2	3	0	1	4
4	Control System-I	3	1	2	3	1	1	5
5	Electromagnetic Field Theory	3	0	0	3	0	0	3
6	Seminar	0	0	2	0	0	1	1
								25
6th semester								
1	Power System II	3	1	3	3	1	2	6
2	Digital Signal Processing	3	0	2	3	0	1	4
3	Industrial Instrumentation	3	1	2	3	1	1	5
4	Principle of Communication	3	0	2	3	0	1	4
5	Industrial Visit/ internship							**audit**
6	Seminar	0	0	2	0	0	1	1
								20
7th Semester								
1	Electrical Drives	3	0	3	3	0	2	5
2	Engineering Economics	3	0	0	3	0	0	3
3	Elective II	3	1/0	0/2	3	1/0	0/1	4
4	Elective III	3	1/0	0/2	3	1/0	0/1	4
5	Project –I	0	0	4	0	0	2	2
6	Seminar	0	0	2	0	0	1	1
								19
8th semester	**(If a students does not participates project in Industry)**							
1	Industrial Management	3	0	0	3	0	0	3
2	Elective IV	3	0	0	3	0	0	3
3	Elective V	3	0	0	3	0	0	3
4	Grand Viva							2
5	Project –II	0	0	8	0	0	4	4
								15
8th semester	**(If a students participates project in Industry)**							
1	Industrial Project							10
2	Project Seminar							3
3	Comprehensive Viva							2
								15
TOTAL								**(43+132) =175**

1st Semester

1. Language (Communication in Engish)

Pronunciation, Vocabulary Extension, basic aspects of language skills, modes of writing, comprehension, composition, word-order, structure of words etc.
The fundamentals of Grammar, textual pieces for literary appreciation, non-traditional materials, newspaper articles, advertisements, notice writing, Soft Skills Development etc. The following textual pieces from "English for All" by Nilanjana Gupta, published by Mac Millan :

Text/Reference Books :-

1. Shakespeare's Sister by Virginia Woolf
2. Scientific Research for Amateurs by J.B.S. Haldane
3. When I Have Seen by William Shakespeare
4. Lines Written in Early Spring by William Wordsworth
5. On His Blindness by John Milton
6. Prospice by Robert Browning
7. After Twenty Years by O' Henry
8. The Adventures of the Blue Carbuncle by Arthur Conan Doyle

2. Engineering Chemistry I

a) Chemical Bonding:-

Ionic and Covalent bonds; Valence Bond Theory (V.B.T) of covalency- atomic orbital and their overlap, hybridization of orbitals definition types and associated geometries, VSEPR theory, shapes of simple molecules like-H2O, CO2, NH3, CH4,C2H6, C2H2 BF3, PCl5, SF6 in the light of the hybridization state of the central atom and VSEPR effects; Molecular Orbital Theory (M.O.T)- concept of molecular orbital, molecular orbital energy level diagrams of homonuclear diatomic molecules-He2,O2, N2 and molecular ions, determination of bond order, bond length and magnetic properties from M.O diagrams; Noncovalent interactions- van der Waals and hydrogen bonding and their effect over physical properties of different substances, metallic bonds-Electron sea model.

b) Fuels:-

Definition and classification of fuels; Characteristics of a good fuel, comparison between solid, liquid and gaseous fuel; Calorific value of fuels- definition, units, higher and lower calorific value, determination of the calorific value of a solid fuel by bomb calorimeter; Solid fuel- coal, origin, types, proximate and ultimate analysis of coal; Liquid fuel- petroleum, origin, refining of crude, cracking, synthetic petrol, Fischer-Tropsch and Bergius method for the synthesis of gasoline, knocking

c) Water:-

Introduction; Hardness of Water- cause, types, units, disadvantages of using hard water for domestic and industrial purposes (e.g., scale and sludge formation in boilers, causticembitterment, boiler corrosion etc.), softening of hard water (lime-soda, permutit and ion exchange processes); Chemical analysis of Water- estimation of free chlorine, total alkalinity, hardness and dissolved oxygen, numerical based on determination of hardness.

d) Pollution and its control:-

Pollution- introduction, air pollutants, particulates, smog, photochemical smog, acid rain, green house effects, depletion of ozone layer, analysis of gaseous effluents-oxides of nitrogen, oxides of sulphur and H2S, control of air pollution- particulate emission, gaseous pollutants, water pollution- arsenic pollution and its remedies. Chemical analysis of effluent liquid streams, BOD, COD.

e) Electrochemistry:-

Arrhenius theory of electrolytic dissociation, classification of electrolytes; degree of dissociation of acids, dissociation constant of weak acids, Debye-Huckel theory, concept of pH and pOH, buffer solutions, solubility product, common ion effect, conductance of solutions- specific, molar and equivalent conductance, variation of molar conductance with dilution for strong and weak

electrolytes; Migration of ions- Kohlrausch's law of independent migration of ions, Ostwald's dilution law; transport number, Nernst equation for single electrode, electrochemical cells.

f) Polymer Chemistry**:-**

Introduction, types of polymerization, classification of polymers based on chain characteristics, source, method of synthesis and molecular forces involved, mechanism of polymerization reaction: cationic, anionic and catalytic polymerization; glass transition and crystalline melting point temperatures, Factors influencing glass transition and crystalline melting point temperatures. Preparation, properties and uses of the following- Polyethylene, PVC, Polystyrene, PAN, Teflon, Nylon- 6:6, polyester ; Rubber- monomer, structure, compounding of rubber, vulcanization, synthetic rubbers- Buna-S, Buna-N, neoprene, butyl rubber and polyurethanes.

ENGINEERING CHEMISTRY I LABORATORY:

List of experiments:

1. Determinations of hardness of water.
2. Determinations of percentage purity of lime stone sample.
3. Determinations of dissolved oxygen in water.
4. Determinations of sodium carbonate & sodium bicarbonate in a mixture.
5. Determinations of iron content in a sample.
6. Determinations of chloride content of water.
7. Determinations of proximate analysis of coal.
8. Determinations of flash point of anoil by penskymartein's closed cup flash point Apparatus.
9. Determinations of viscosity of oil by redwood viscometer.
10. Determination of Dissociation constant of weak acids by conductometric Titration.
11. Determinations of carbon residue of oil by Conrad son's apparatus.
12. Determination of pH of an electrolyte by potentiometer Titration.

Text/Reference books:

1. Jain & Jain , Engineering Chemistry; 15th Edition,
2. Engineering Chemistry; Wiley - India.
3. S.S Dara, S chand Publisher , A Text Book of Engineering Practical Chemistry .
4. Sashi Chawla, A text book of Engineering Chemistry;
5. S.S Dara, S chand Publisher, A Text Book of Engineering Chemistry;
6. A.K Dey, Environmental Chemistry, John Wiley.
7. Ashim K das , Environmental chemistry with Green chemistry, Books and Allied Pvy. Ltd.
8. Vanloon/Duffy, Environmental Chemistry ,2/E, Oxford University Press.
9. O. G. Palanna, Engineering Chemistry, Tata Mc.Graw Hill Education Private Ltd. New Delhi.

3. Engineering Physics I

1. Vector and Vector Differential Calculus:

Types of Vectors, Orthogonal Representation of a Vector, Product of Vectors,Scalar TripleProduct, Vector Triple Product. Vector Differentiation, Scalar and Vector Fields,Directional Derivatives, Vector Differential Operator, Gradient, Divergence, Curl, Line, Surface & Volume integrals and their applications, Green's theorem.

2. Mechanics:

Newton's Laws of motion, Mechanics of a Particle, Limitations of Newtonian mechanics, Newton's laws of motion for a system of particles, Constraints, D'Alembert's Principle, Generalized Coordinates, Generalized velocity and momentum, Lagrangian formulation, Hamiltonian formulation. Streamline and turbulent motion, Stokes law, terminal velocity, Poiseuille's Equation, Bernouli's theorem, Venturimeter and other applications of Bernouli's principle. Reference frames, Lorentz transformation, postulates of relativity, relativistic mass and mass-energy relation.

3. Vibration and Waves:

Simple Harmonic Motion, superposition of two linear SHMs, Lissajous figures, Damped Vibration:- differential equation and solution, critical damping, logarithmic decrement, analogy with electrical circuit. Progressive waves, Forced Vibration, Amplitude and Velocity Resonance, Sharpness of resonance and quality factor.

4. Time Varying Field and Maxwell's Equation:

Laws of Electromagnetic Induction, Self and Mutual induction, Concept of Displacement Current, Difference between Conduction Current and Displacement Current, Eddy Current, Maxwell's Equations, Derivation of Maxwell's Equations, Propagation of Electromagnetic Waves in free space/ dielectrics/conductors, Solution of propagation of Plane Electromagnetic Wave in free space/dielectrics/conductors.

5. Optics: Interference, Diffraction, Polarization

Interference: Coherence (temporal and spatial), Interference of Light due to division of wave front (Young's double slit and Fresnel's Bi-prism), Interference of Light due to division of amplitude (Newton's Ring), colour of thin film.

Diffraction: Different Types of Diffraction, Difference between Interference and Diffraction, Fraunhofer Diffraction at a Single Slit and Double slit, Plane transmission diffraction grating spectra, Comparison between Grating and Prism Spectra, Resolving Power of an optical instrument and limit of resolution.

Polarization: Plane of Vibration and Plane of Polarization, Classification of Polarized Light.

ENGINEERING PHYSICS-I LAB

Laboratory experiment based on syllabus of Physics - I

Text/Reference Books :-

1. H. K. Dass, Mathematical Physics.
2. Rana & Joag, Classical Mechanics, Tata McGraw- Hill Education, India.
3. D.S. Mathur, Elements of Properties of Matter,S. Chand publication
4. Dattu Prasad Joshi, Engineering Physics, Tata Mc Graw Hill
5. D. J. Griffith, Introduction to Electrodynamics, Pearson
6. Brijlal & Subramaniyam, A Text Book of Optics, S.Chand Publication
7. Relativity, R. Resnick, Wiley Eastern Pvt. Ltd.
8. L.A. Pipes and L.R. Harvill, Applied Mathematics for Engineers and Physicists, McGraw-Hill
9. A. Ghatak, Optics, Tata Mc Graw Hill

4. Engineering Mathematics I

1. Infinite series: Convergence of Sequence, Bounded Sequence, Monotonic Sequence, Convergent, Divergent and Oscillatory Series, Geometric Series, Positive term series, p-series, Comparison Test, D'Alembert's Ratio tests, Raabe's Test, Gauss's Test, Cauchy's Integral Test, Cauchy's Root test, Logarithmic Test.

2. Calculus of function of one variable: Limit and continuity of functions, Uniform continuity and differentiability, successive differentiation, Leibnitz's theorem, Rolle's theorem, Mean Value theorems and Taylor's theorem, expansion of functions into Taylor's and Maclaurin's series, Indeterminate forms, Curvature, Asymptotes, Concavity, Convexity and point of inflexion.

3. Function of Several Variables: Limit, Continuity, Partial Derivatives, Chain Rule, Differentiation of Implicit functions, Exact Differentials, Euler's theorem on homogeneous function and its converse, Tangent planes and Normal planes, Maxima, Minima and Saddle points, Simple problems in extrema of functions with constraints, Method of Lagrangian Multipliers.

4. Ordinary Differential Equation: First order ordinary differential equation, Linear equations and Bernoulli's equation, Ordinary linear differential equation of nth order, Solution of homogeneous and nonhomogeneous equations, Operator method, method of undetermined coefficients and variation of parameters, Solution of simple simultaneous ordinary differential equation. Series solution of differential equation.

5. Laplace Transform: Transforms of elementary functions, Inverse transforms, properties of laplace transform, Convolutions, Transforms of periodic functions, unit step functions, shifting theorems, Solution of ODE's using transforms.

Text/Reference Books :-

1. M.D. Raisinghania. Ordinary Differential Equation
2. Malik & Arora. Mathematical Analysis
3. H.K. Dass, Advanced Engineering Mathematics
4. B.V.Ramana, Higher Engg. Mathematics
5. E. Kreyszig, Advanced Engineering Mathematics

5. Engineering Mechanics I

Force Systems and Equilibrium

Force moment and couple, principle of transmissibility, Varignon's theorem. Resultant of force system- concurrent and nonconcurrent coplanar forces, free body diagram, equilibrium equations and their uses in solving elementary engineering problems.

Plane trusses

Analysis of plane trusses and plane frames (Analytical and graphical methods). Method of joints, methods of sections, graphical method.

Friction

Coulumb's laws of fraction, belt fraction problems involving fraction related to practical application.

Moment of Inertia and plane figure:-

Moment of Inertia of a plane figure with respect to an axis in its plane, Moment of Inertia with respect to an axis perpendicular to the plane of the figure. Parallel axis theorem, perpendicular axis theorem. Polar moment of inertia

Moment of inertia of material bodies:

Mass moment of inertia in case of disc cone cylinder sphere slender rod

Centre of gravity of rigid body

Centre of gravity of right circular cone, cylinder,hemisphere and composite rigid body.

Virtual work :

Work of a force principle of virtual work & itsapplication, Constriction of force polygon, Raydiagram, Funicular polygon, Maxwelldiagrams. Mass moment of inertia in case of disc, cone,cylinder, sphere slender rod.

ENGINEERING MECHANICS LAB

Syllabus based on Engineering Mechanics.

Text/Reference Books:

1. Timoshenko and Young, *Engineering Mechanics.*
2. R.S. Khurmi , *A text Book of Engineering Mechanics*.
3. R.K. Bansal , *A text Book of Engineering Mechanics*.

6. Basic Electrical Engineering

Basic circuit analysis methods: Kirchhoff's laws, mesh and nodal analysis.

Network Theorems: Superposition theorem, Thevenin-Norton theorem, maximum power-transfer theorem, star-delta transformation.

AC circuit analysis: AC fundamentals, phasor diagrams, Power in ac circuits, Series AC circuit and parallel AC circuit, Resonance, Network analysis methods, Poly-phase circuit.

Basics of Electrical Machines: Basic principle of generator and motor, emf induced in a coil, concept of rotating magnetic field, introduction to transformer.

BASIC ELECTRICAL ENGINEERING LABORATORY

List of experiments

1) Study of different Electrical sources.
2) Verification of Thevenin's theorem.
3) Verification of Norton's theorem.
4) Verification of Maximum power transfer theorem.
5) Verification of Superposition theorem.
6) Extension of meter range.
7) Study of characteristics of Fluorescent lamp and Incandescent lamp**.**
8) Characteristics of R-L circuit, R-C circuit, R-L-C series circuit with AC source.
9) Determination of insulation resistance by using Megger.
10) Study of different transformer connections.
11) Transformer testing
12) Starting of induction motor

Text/Reference Books:

1. Vincent Del Toro, 'Electrical Engineering Fundamentals', Phi Learning, 2nd Edition, 2014.
2. D. P. Kothari and I. J. Nagrath, 'Basic Electrical Engineering', McGraw Higher Ed., 3rd Edition, 2009.
3. K.V.V. Murthy and M.S.Kamath, 'Basic Circuit Analysis', 1st edition (reprinted with corrections) Jaico publishing, 1998.
4. W.H. Hayt and J.E. Kemmerley, 'Engineering Circuit Analysis', Int. St. Ed.(4th) McGraw Hill, 1986.
5. S.K.Bhattacharya, 'Electrical Machines', Tata McGraw Hill Publishing company Ltd., second edition, 2007
6. I. J. Nagrath and D. P. Kothari, 'Electric Machines', Tata McGraw Hill, 1985.

7. Engineering Graphics I

Drawing instruments and their uses, lines, lettering and dimensioning, scales, plains and diagonal scale, curves used in engineering practice, ellipse, parabola, hyperbola, cycloid, involutes orthographic projection, planes of projection, four quadrant, first angle projection, reference line, convention employed. Projection of points and lines, true length, true inclinations with reference plane, traces of a line, end view, and illustrative problems. Projection of planes, traces, end view planes perpendicular to one inclined to other reference planes. Projections of solid such as prism, pyramid, cone, cylinder, cube etc.

Text/Reference Books:

1. N.D. Bhatt , *Elementary Engineering Drawing (Plane and solid geometry).*
2. R.B Gupta , *A text Book of Engineering Drawing*.
3. K.Venugopal , *A text Book of Engineering Drawing*.
4. N.D. Bhatt, *Machine Drawing*.
5. R. K. Dhawan , A text Book of Machine Drawing (In first angle projection)

8. Workshop Practice I

1. Fitting Shop
i) Introduction of hand Tools.
ii) Job No. 01:- Making of Square bar from round bar of mild steel by metal wearing process.
iii) Job No.02:- Making of V-Groove on Mild Steel Flat by metal cutting process.
2. Carpentry Shop
i) Introduction of Hand Tools.
ii) Job No.01:- Making of wooden End half lap joint.
iii) Job No.02:- Making of wooden T-Joint.
3. Smithy Shop
i) Introduction of Hand Tools
ii) Job No.01:- To make square bar from round bar of Mild Steel by heating& hammering.
iii) Job No.02:- To make Hexagonal bar from round bar of Mild Steel by heating & hammering.

2nd Semester

1. Introduction to Programming

BASIC OF COMPUTERS:
Computer fundamentals: Bits and Bytes , CPU, Memory, Input and output devices, I/O devices, operating system, Application software's , Number system- Decimal, Binary, Octal, Hexadecimal.Need for high level languages, Program design using flow charts

C LANGUAGE PRELIMINARIES:
C character set, Identifier and keywords, data types, declaration, expression, statements and symbolic constants.

Pre-processor commands: #include, #define, #ifdef
Input-Output: getchar, putchar, scanf, printf, gets,puts.
Operators and expressions: Arithmetic, unary,assignment, logical, conditional, and bit wise operators.
Control statements: if else, for, while, do-while, switch, break, continue, nested loops.
Storage types: Automatic, external, register andstatic variables.
Functions : Definiting and accessing , Passing arguments, Function prototypes, Recursion, Libraryfunctions, Static functions.
Arrays: Definiting and processing, Passing arrays to a function, Multi-dimension arrays.
Pointers: Basic concepts, malloc, pointer and arrays, simple single linked list example.

INTRODUCTION TO PROGRAMMING LABORATORY
Programming simple problems exercising different features of C

Text/Reference Books:

1. Introduction to Computer Science- ITL Education Solutions Limited , Pearson Education
2. *Paul Deitel* , C How to Program -5th Edition, PHI.
3. *Dennis Ritchie and Brian Kernighan*, The C Programming Language, PHI.
4. *Behrouz A. Forouzan, Richard F. Gilberg*, Computer Science: A Structured Programming Approach Using C , Course Technology
5. *Gottfried, Byron S*, Programming with C , TMH
6. *E. Balagurusamy*, C Programming By, TMH

2. Engineering Physics –II

1. Modern Physics:
Particle properties of wave: Planck's hypothesis, Photoelectric effect, Compton Effect. Wave properties of particle: De Broglie wave as mater waves, Davison-Germer experiment, Heisenberg's uncertainty principle and its application. Quantum Mechanics: Interpretation of wave function, Schrödinger equation (time dependent and time independent), particle in a box, Eigen values and Eigen function. Nuclear structure, atomic masses, mass spectrograph, particle accelerator (Betatron, Cyclotron, Synchrocyclotron), Nuclear reactors.

2. Solid State Physics and Nanotechnology:
Crystallography: Crystalline and amorphous solids, crystal structure, Bravais Lattice, Packing Fraction, Crystallographic planes and miller indices, Inter-planer spacing (cubic system only), Bragg's diffraction, Crystal structure analysis, Defects and disorders. Nanotechnology: Nanoscience: Nanomaterials and types: Quantum Dots, Quantum wires, Quantum wells, Nanocomposites, Properties.

3. Statistical Mechanics:
Concept of phase space, macro and micro states, ensembles, statistical distributions MB, B-E & F-D statistics (No derivations), Planck's law of radiation, Fermi energy, electron distribution in metal.

4. Plasma Physics
Definition of plasma & Collective behaviour, Concept of temperature, Quasineutrality & Debye shielding, Criteria for plasmas, Plasma Oscillations; Single particle motions in - uniform and

nonuniform electric and magnetic fields, time varying electric and magnetic fields,applications of plasma physics (Fusion, Industrial), Confinement of plasma (magneticand LASER).

5. Laser and Optical Fiber:

Spontaneous and stimulated emission, Einstein's A-B coefficient, meta-stable state, population inversion, basic principle of laser (three and four level), optical cavity and resonator, Ruby and He- Ne laser. Propagation of light in fiber, step and graded index fiber, numerical aperture, attenuation in optical fiber, introduction of optical window, application of laser and optical fiber.

Text/Reference Books:

1. Francis F. Chen , Plasma Physics and Controlled Fusion, Springer
2. A. Ghatak, K. Thyagrajan, Lasers: Fundamentals and Applications, Springer
3. K. Huang, Statistical Mechanics
4. D.C. Tayal, Nuclear Physics, Himalaya House, Bombay
5. Kittel, Introduction solid State Physics, Willy Eastern Limited
6. A.K.Ghatak and S.Lokanathan, Quantum Mechanics, Macmillan India Limited
7. Mark A. Ratner & Daniel Ratner, Nanotechnology: a gentle introduction to the next big idea, PHI
8. Dattu Prasad Joshi, Engineering Physics, Tata Mc Graw Hill
9. B.K. Agarwal, Elements of Statistical Mechanics
10. R. Eisberg and Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley India Pvt. Ltd.
11. Leonard I. Schiff, Quantum mechanics
12. Dekker, Solid State Physics, McMillan Student Ed.

3. Disaster Management

Elements of Engineering Seismology:- Earthquake occurrence in the world, causes of Earthquake, Plate tectonics, Earthquake mechanism, seismic zoning map of India and its use.

Earthquake phenomenon:- Focus, Epicenter, seismic waves, magnitude, intensity scale its co- relation assessment and Do's and Don's for protection of life and property during disaster.

Landslides:- Geo-technical aspects of landslides and control of Landslide Hazard. Flood:-

Flood control as a measure of Disaster Management and Mitigation

Cyclone and Fire:- Cyclone Disaster Mitigation and ensuring wind and fire hazard safety during disaster.

Text/Reference Books:

1. A.K.Mukhopadhay, Crisis and Disaster Management Turbulence and Aftermath, New Age International Publishers.
2. H.N.Srivastava, S.N. Bhattacharya. G.D.Gupta, Earthquake Geography and Management, New Age International Publishers.
3. Thomas D. Schneid, Larry Collins, Disaster Management and Preparedness, Lewis Publishers, 2001.
4. C. V. R. Murty, IITK-BMTPC Earthquake Tips: Learning Seismic Design and Construction, National Information Centre of Earthquake Engineering.

4. Engineering mathematics II

1. Matrices : Algebra of matrices, Vector spaceslinear dependence of vectors, basis, Linear Transformations, Rank and inverse of a matrix, Solution of algebraic equations, consistency conditions, Hermitian, skew-Hermitian and Unitary matrices, by-linear form, eigen value and eigen vectors. Cayley-Hamilton theorem.

2. Complex numbers : Exponential complex numbers and logarithm of a complex number, circular, hyperbolic and inverse circular functions of complex numbers.

3. Function of a Complex Variable : Limit, continuity and differentiation, Analytic function, Cauchy-Riemann equations, Conjugate functions, Application to two dimensional problems, Taylor's and Laurent's expansions, Branch points, zeros, poles, residues, Cauchy's Integral theorem, simple problems on Contour Integration.

4. Integral Calculus : Improper Integrals, Beta and Gamma function. Double and Triple Integrals, Jacobians and transformation of co-ordinates.

5. Vectors: Scalar and vector triple product, space curves, Seret-Frenet formula, velocity and acceleration- simple problems, moment of force, work done, angular velocity, relative velocity- imple applications. Vector function of one variable, vector differentiation and integration, gradient, divergence and curl ---Applications. Stoke's theorem, Green's theorem, Gauss divergence theorem - simple applications to areas, Volumes and centre of Pressure.

Text/Reference Books:

1. Malik & Arora, Mathematical Analysis:
2. H.K.Dass., Advanced Engineering Mathematics
3. B.V.Ramana. Higher Engg. Mathematics
4. E. Kreyszig , Advanced Engineering Mathematics.
5. G.B.Thomas and R.L.Finney, Calculus and Analytic Geometry:
6. M.L.Khanna , Vector Calculas

5. Engineering Chemistry –II

(a) Cement:-

Introduction, classification; Portland Cement definition, raw materials, manufacture, ideal composition and physical requirement according to I.S code, chemical constitution of the finished product, setting and hardening, heat of hydration; Special Cements- high-alumina, white portland, water-proof cements etc.

(b) Refractories:-

Definition, objective of using, classification based on chemical nature; Properties- refractoriness, strength, dimensional stability, chemical inertness, thermal expansion, thermal conductivity, porosity, spalling, electrical conductivity etc. and interrelations between them; selection of good refractory; Common Refractory Bricks- silica, fireclay, high alumina, magnesite and zirconia bricks, properties and uses.

(c) Corrosion:-

Introduction, definition, classification; Dry Corrosion factors effecting dry corrosion, mechanism, types, oxidation corrosion, Pilling-Bedworth rule, corrosion by other gases, hydrogen related corrosion, liquid metal corrosion; Wet Corrosion- types, chemical corrosion, factors affecting chemical corrosion, mechanism of wet corrosion- electrochemical mechanism, evolution of H2 and absorption of O2 types; Differential aeration theory, passivity, pitting, waterline and stress corrosion; Corrosion Control purification, alloying, application of protective coatings, cathodic protection etc.

(d) Lubricants:-

Introduction; Mechanism- thick-film, thin-film and extreme pressure lubrication; Classification of Lubricants- lubricating oils, greases and solid lubricants, their properties, use and additives required (e.g., anti-oxidants, corrosion preventers etc.); Properties of Lubricating Oils- viscosity, flash and fire-point, cloud and pour point, oiliness, carbon residue, aniline point etc. ; Cutting fluids.

(e) Thermochemistry:-

Different types of energy and other definitions; Endothermic/ Exothermic Reactions and Energy Diagrams; thermochemistry stoichiometry, enthalpy, standard enthalpy of formation and reaction, Hess's Law, heat of solution, heat of neutralization.

Text/Reference Books:

1. Jain & Jain , Engineering Chemistry; 15th Edition,
2. Engineering Chemistry; Wiley - India.
3. S.S Dara, S chand Publisher , A Text Book of Engineering Practical Chemistry .
4. Sashi Chawla, A text book of Engineering Chemistry;
5. S.S Dara, S chand Publisher, A Text Book of Engineering Chemistry;
6. A.K Dey, Environmental Chemistry, John Wiley.
7. Ashim K das , Environmental chemistry with Green chemistry, Books and Allied Pvy. Ltd.
8. Vanloon/Duffy, Environmental Chemistry ,2/E, Oxford University Press.
9. O. G. Palanna, Engineering Chemistry, Tata Mc.Graw Hill Education Private Ltd. New Delhi.

6. Engineering Mechanics II

Kinematics of a particle - simple relative motion:
Introduction, general notions, differentiation of a vector with respect to time, velocity and acceleration calculations, rectangular components, velocity and acceleration in terms of path variables, cylindrical coordinates, simple kinematical relations and applications, simple relative motion, motion of a particle relative to a pair of translating axes.

Particle dynamics:
Introduction, rectangular coordinates, rectilinear translation, Newton's law for rectangular coordinates, rectilinear translation, cylindrical coordinates, Newton's law for cylindrical coordinates, path variables, Newton's law for path variables, a system of particles, the general motion of a system of particles.

Energy methods for particles
Analysis for a single particle, power considerations, conservative force field, conservation of mechanical energy, alternative form of work-energy equation, systems of particles, work-energy equations, kinetic energy expression based on centre of mass, work kinetic energy expressions based on centre of mass.

Methods of momentum for particles
Linear momentum, impulse and momentum relations for a particle, linear momentum considerations for a system of particles, impulsive forces, impact, moment of momentum, moment of momentum equation for a single particle and for a system of particles.

Kinematics of rigid bodies: Relative motion
Introduction, translation and rotation of rigid bodies, Chasles' theorem, derivative of a vector fixed in a moving reference, applications of the fixed-vector concept, general relationship between time derivatives of a vector for different references, the relationship between velocities of a particle for different references, acceleration of a particle for different references.

Kinetics of rigid bodies
Moment-of-momentum equations for general motion of rigid bodies, Euler equations, Plane motions, Pure rotation of a body of revolution about its axis of revolution, General plane motion concept of a slab like body, Pure rotation of an arbitrary rigid body.

Text/Reference Books :-

1. F.P. Beer and E.R. Johnston, Vector Mechanics for Engineers - Dynamics, McGraw Hill Book Company, 2003.
2. J. L. Meriam and L.G. Kraige, Engineering Mechanics - Dynamics, John Wiley & Sons, 2002.
3. H. Shames, Engineering Mechanics – Statics and Dynamics, 4th Edition, Prentice Hall of India, 1996.

7. Basic Electronics

Elementary Physics of Semiconductor Material.
PN Junction Diode- Operation Characteristics and Modelling, Zener Diode- Operation and Application; Diode Rectifiers, Filters, Clipper, Clamper.
BJT Operation and Characteristic, NPN & PNP transistor, BJT biasing, Different circuit configurations with Circuit Models.
Introduction to JFET Operation, Main Carriers in BJT & FET and Characteristics.
Operational Amplifiers- Inverting & Non inverting Configuration and its Common Applications IC-555 Timer Circuit- Astable, Monostable & Bistable Operations.
Cathode Ray Oscilloscope. Elementary Construction, Connections for Viewing Signals, Measuring Voltage, Frequency and Time Period.
Elementary Physics of Opto electric Devices like LED,LCD Devices, Photo-Diode, Photo- Transistor, LDR,7-segment Display, Opto isolators.

BASIC ELECTRONICS LABORATORY

Selected experiments based on Basic Electronics.
1) Study of characteristics of transistor indifferent modes i.e. common a emitter, common base and common collector configuration.
2) Experiments on class-A, class-B and AB of transistor power amplifiers.
3) Experiment on uncontrolled Diode-Bridge rectifier.
4) Determination of hybrid parameters of a transistor.
5) Characteristics of JFET, MOSFET.
6) Study of characteristics of Mono-stable, Bistable and a-stable multi vibrators using bipolar transistors.
7) Experiment on Schmitt Trigger Circuit.
8) Study of LED, photo-Diodes, Photo-Transistors, Light Development Resistors and Opto- Isolators.

Text/Reference Books :-

1. Vladimir V.Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, Introduction to Nanoelectronics - Science, Nanotechnology,Engineering and Application, Cambridge University Press.
2. D. De and K. P. Ghatak , Basic Electronics, Pearson Education.
3. R.F. Pierret, Semiconductor Device Fundamentals, Pearson Education.
4. Robert F Pierret and Gerold W.Neudeck , Modular Services on Solid State Device, Addison Wesley Publishing Company
5. K. Sedra & Smith, Microelectronic Circuits , Oxford
6. D. Carlo & Lin , Linear Circuit Analysis, Oxford University Press

8. Engineering Graphics II

1) To draw sectional views, true shape of section of solid like Prism, Pyramid, cones cylinder with and without sections.
2) To draw views and Isometric projection of solids like Pyramid, Prism, cones, cylinder, sphere and hemisphere.
3) Development of surface prism, Pyramid, cones, cylinder with and without sections.
4) To draw sketch of bolts, nuts, rivets and riveted joints.
5) To draw plan, elevation, side view of machine parts with and without sections.

9. Workshop Practice II

1. Machine Shop

a) Introduction of operation of Machine Tools.
b) Job No. 01:- Facing and Turning operation by using Lathe machine.
c) Job No. 02:- Step turning operation by using Lathe machine.

2. Fitting Shop

Introduction of Precision Tools.
Job No. 01:- Making of an External Thread by using Die and Die Stock Job No.
02:- Making of an Internal Thread by using Tap and Tap wrench.

3. Welding Shop

a) Introduction to Welding Machines and related Tools.
b) Job No.01:- Lap joining of two metal plates by arc welding process.
c) Job no.02:- Butt joining of two metal plates by arc welding process.

4. Forging Shop

a) Introduction of forging process and related tools.
b) Job No.01:- Making of mild steel ring by forging process.
c) Job NO.02:- Making of Square punch from round Mild Steel Bar.

5. Pattern Shop

a) Introduction of wood working Machine Tools.
b) Job No.01:- Making of wooden Knuckle Joint.
c) Job No.02:- Making of wooden Halving Joint.

6. Sheet Metal Shop

a) Introduction of machine tools & hand tools.
b) Job No. 01:- Metal sheet single seam joining.
c) Job No. 02:- Metal sheet joining by riveting.

7. Casting Shop

a) Introduction of Casting process & related tools.
b) Job No. 01:- metal casting using a pattern of Knuckle Joint.

8. Automobile Shop

a) Introduction of working principle of IC Engine.
b) Demonstrations of different parts of an IC engine

3rd Semester

1. Engineering Mathematics III

Probability and statistics-classical and axiomatic definition of probability, conditional probability, independent events, random variables, probability mass function and probability density function, distribution function, function of random variables, standard univariate discrete and continuous distribution and their properties, mathematical expectation, moments, moments generating function, correlation and regression. Function of several variables-partial derivatives, chain rule, differentiation of implicit functions, exact differentials, tangent planes and normal planes, maxima, minima and saddle points, simple problems in extrema of functions with constraints, method of Lagrangian multipliers. Function of a complex variable-limit, continuity and differentiation, analytic function, Cauchy-Riemann equations, conjugate functions, application to two dimensional problems, Cauchy's integral theorem, Taylor's and Laurent's expansions, branch points, zeros, poles, residues, simple problems on contour integration.

Text Books:

1. E. Kreyszig, *Advanced Engineering Mathematics*, Wiley publication, 9th Edition,
2. B. S. Grewal, *Higher Engineering Mathematics*, Khanna Publication, Delhi.

Referrence Books:

1. H. Bauer, *Probability Theory and Elements of Measure Theory*, Academic Press, 1981.
2. P.E. Danko, A.G. Popov, T.YA. Koznevnikova, *Higher Mathematics in Problems and Exercises*, Part 2, Mir Publishers, 1983.

2. Electrical Measurement & Measuring Instruments

Sensitivity-reliability-accuracy-resolution, error analysis of measurements: Systematic and random errors, propagation of errors; Classification of analog and digital Instrument; Specific analog instruments to be covered: PMMC meter, moving iron type meter and Electrodynamometer type meter; Wattmeters; induction type energy meter; Extension of range for an instrument; instrument transformers: Principle of CT and PT and error; DC potentiometers; Measurement of low, medium and high resistances; Principles of ac bridges; Basics of digital measurements: A/D and D/A converters, programmable gain amplifier-auto-ranging; Introduction to DSO and its specifications; digital voltmeter, ammeter, frequency meter, digital multimeter, Block diagram of LCR meter; Hall effect sensor; clamp-on-meter; static energy meter; Sample and Hold circuit; Data Acquisition Systems

Text Books:

1. N. Kularatna: Digital and Analogue Instrumentation: Testing and Measurement, IET, 2003.
2. Helfrick and Cooper, *Modern Electronic Instrumentation and Measurement Techniques*, Prentice-Hall.
3. E.W. Golding & F.C.Widdis, *Electrical Measurements & Measuring Instruments*, A.H.Wheeler & Co.

Reference Books:

1. F. K. Harris , *Electrical Measurement*.
2. Ernest Frank , *Electrical Measurement Analysis*.

3. Electrical Networks

Introduction to circuit elements, types of network, network theorems, transient response. Transform of different signal wave forms, initial and final value. Concept of complex frequency, transform impedances, transform circuit and application of network theorem. Concept of poles and zeros, network functions for one port and two port network, restrictions of poles and zeros location for driving point function and transfer function. Time domain behaviour for the poles and zeros plots. Concept of two port network, impedance parameter, admittance parameter, transmission parameter, inverse transmission parameter, hybrid parameter, inverse hybrid parameter, relation between parameter set, interconnection of two networks, network functions for general networks. Graph of a network, trees, co-trees, loops, incidence matrix, cut-set, tie-set matrix, number of possible trees of a graph, mutual inductance, dot convention, co-efficient of coupling, series and parallel combination of coupled circuit. Classification of passive filters, characteristics, equation of filter networks, resonance, bandwidth and selectivity, quality factor, Introduction to networks synthesis.

Text Books:

1. Franklin Kuo, *Network Analysis And Synthesis*, Wiley international, 2nd edition.
2. M.E. Van Valkenburg, *Network Analysis* , PHI, 3rd edition.

Reference Books:

1. W.H.Hyatt and J.E.Kemmerly , *Engineering Circuit Analysis*, McGraw-Hill.

2. A.E Fitzgerald, David E. Higginbotham, Arvin Grabel, *Basic Electrical Engineering*, McGraw-Hill, 5th Edition.

4. Digital Electronics

Number systems and codes, Boolean algebra, Logic gates, Tristate logic, minimization using Karnaugh map and QM method. Code converters. Finite state machines. Combinational and Sequential logic circuits. Encoders, Decoders.Shift registers, Asynchronous and synchronous counters. Memory: ROM, PROM, EPROM, EEPROM, RAM, Flash memory. Design of ROM, PAL, PLA. MUX and DEMUX etc. Logic families: TTL, ECL, CMOS.

Text Books:

1. H. Taub and D. L. Schilling ,*Digital Integrated Electronics*, McGraw-Hill, 1977.
2. M. Morris Mano, *Digital Design*, Prentice Hall, 3rd Edition, 2002.

Reference Books:

1. W. I. Fletcher, *An Engineering Approach to Digital Design*, Prentice-Hall 1980.
2. T.M. Floyd , R.P. Jain, *Digital fundamentals*, Pearson Education

5. Object Oriented Programming

A look at procedure-oriented programming, object oriented programming paradigm, basic concepts of object oriented programming, benefits of OOP, object oriented languages. Tokens, keywords, identifiers and constants, basic data types, user-defined and derived data types, type compatibility, reference, variables, scope resolution operator, type casting, implicit conversion, operator precedence, control structures, structure, function. Class specification, class objects, accessing class members, data hiding, empty classes, pointers within a class, passing objects as arguments, returning objects from functions, friend functions and friend classes, constant parameters and member functions, structures and classes, static members, objects and memory resource, class design steps. Constructors, destructor, constructor overloading, order of construction and destruction, constructors with default arguments, nameless objects, dynamic initialization through constructors, constructors with dynamic operations, constant objects and constructor, static data members with constructors and destructors, nested classes. Defining operator overloading, overloading unary operators, overloading binary operators, overloading binary operators using friends, manipulation of strings using operators, rules for overloading operators, type conversions. Deriving derived classes, single, multilevel, multiple, hierarchical, hybrid inheritance, constructors & destructors in derived classes, constructors invocation and data members initialization, virtual base classes, abstract classes, delegation. Pointers to objects, this pointer, pointers to derived classes, virtual functions, implementation of run-time polymorphism, pure virtual functions. Classes for file stream operations, opening and closing a file, file pointers and their manipulations, sequential input and output operations, error handling during file operations, command line arguments. Class templates with multiple parameters, function templates, overloading of template functions, member function templates. Object-oriented analysis and design, procedure oriented development tools, prototyping paradigm.

Text Books:

1. Budd, *Object Oriented Programming*, Addison Wesley,
2. K.R Venugopal, Rajkumar, *Mastering C++*, TMH.

Reference Books:

1. Lip man and Lajole, *C++ Primer*, Addison Wesley.
2. B. Stroustrup, *The C++ Programming language*, Addison Wesley

6. Signals and systems

Different types of signals: continuous and discrete, impulse sequence, impulse functions and other singularity functions. Types of system: continuous and discrete linearity, time invariance and causality; convolution: convolution sum, convolution integral and their evaluation; time-domain representation and analysis of LTI systems based on convolution and differential equations and difference equation. Multi input-multi output discrete and continuous systems: transform domain considerations: Laplace transforms and Z-transforms; applications of transforms to discrete and continuous systems-analysis; transfer function, block diagram representation. Fourier series and Fourier transform, sampling theorem, discrete Fourier transform (DFT), estimating Fourier transform using DFT. DTFT, DFT, FFT.

Text Books:

1. A.V. Oppenheim, Schafer, R. W,A.S. Willsky and I.T. Young, Signals and Systems, Prentice Hall, 1983
2. R.F. Ziemer, W.H. Tranter and D.R. Fannin, Signals and Systems - Continuous and Discrete, 4th Edition, Prentice Hall, 1998.

Reference Books:

1. A. Papoulis, Circuits and Systems, Modern Approach, HRW, 1980
2. Kuo, B. C, Automatic Control System, Prentice Hall of India

7. Seminar (Soft Skilled Based)

4th Semester

1. Electrical Machine -I

Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three phase transformers: connections, parallel operation; Auto-transformer, Electromechanical energy conversion principles, DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, starting and speed control of dc motors; Three phase induction motors: principle of operation, types, performance, torque-speed characteristics, no-load and blocked rotor tests, equivalent circuit, starting and speed control.

Text Books:

1. I. J. Nagrath and D. P. Kothari, *Electric Machines*, Tata McGraw Hill, 1985.
2. S.K.Bhattacharya, *Electrical Machines*, Tata McGraw Hill. 2nd edition, 2007.
3. H. Cotton, A.H.Wheeler ,*Advanced Electrical Technology*
4. V.D Toro, *Electrical Engineering Fundamentals*, 2nd Edition, Prentice-Hall of India.

Reference Books:

1. M G Say, *Performance and Design of AC machines*, CBS Publishers.
2. A.E. Fitzgerald, C. Kingsley Jr. and S. D. Umans, *Electrical Machinery*, McGraw Hill, 1983.

2. Power System-I

Brief idea of different energy resources including renewables, Institutional arrangements & regulatory affairs of power system, Overhead lines and cables: main component of overhead line, line supports, overhead line insulators, insulating materials, types of insulator, corona, underground cable, load curves, power distribution system, primary and secondary distribution. Substations: classification of substations, major equipment in substation, bus bar configurations, line parameter- resistance, conductance, inductance, capacitance of short, medium and long single and three phase lines, proximity effect, skin effect, Ferranti effect, bundle conductors, effect of earth on the capacitance of the conductors, power factor improvement. Performance of lines: A, B, C, D parameters, short, medium, long lines, transmission efficiency, voltage regulation. Per unit system: per unit impedance, changing the base of per unit quantities, pu impedances of transformer, alternator, advantages of per unit system, Earthing techniques.

Text Books:

1. W.D. Stevenson, *Elements of Power Systems Analysis*, 4th edition, McGraw Hill, 1982.
2. I.J. Nagrath and D.P. Kothari, *Modern Power System Analysis*, Tata McGraw Hill, 2nd Edition, 1989.
3. C.L. Wadha

Reference Books:

1. J Duncan Glover, Mulukutala S. Sarma and Thomas J. Overbye, *Power System Analysis and Design*, Cengage Learning India Pvt. Ltd. 4th Edition.
2. Arthur R burgen and Vijay Vittal, *Power System Analysis*, Pearson Education.

3. Data Structures & Algorithm

INTRODUCTION: Definition, Interrelationship of Data structure and algorithms, Asymptotic complexity analysis, Abstract Data Types, Recursive programming and recurrence relations ARRAYS: Representation of arrays, Sparse Representation, Circular arrays STACKS AND QUEUES: Fundamental of stacks and queues, Representation with arrays, circular queue, Multiple stacks and queues dynamics, Dequeues.
LINK LISTS: Singly linked list and their manipulation, doubly linked list, storage pool, Dynamic storage management, Garbage collection, generalized list, Linked stacks and queues. TREES: Binary trees and its representation arrays, Tree traversals (preorder, inorder, and postorder), Threaded binary tree, Binary tree representation of tree, heaps, union-findSORTING AND SEARCHING: Searching – linear search, binary search, hashing; Binary search trees, Balanced binary search trees, Different algorithms for sorting – bubble sort, selection sort, insertion sort, merge sort, quicksort, heap sort, radix sort, counting sort, lower bounds for sorting

Recommended Books:

1. S. Lipschutz, "Data Structure" , Schaum's Outline Series, Tata McGraw-Hill
2. Tannenbaum, "Data Structures", PHI
3. An Introduction To Data Structures With Applications, Tremblay J.P. and Sorenson P.J, Tata Mcgraw Hill
4.'Fundamentals of Data Structures', Horowitz S. and Sahani S., Computer Science Press.

4. Numerical Methods and Analysis

Solution to algebraic and transcendental equations by regula-falsi method, iteration method, Newton-Raphson method, simultaneous linear algebraic equations by Gauss-Jordon method, Crout's method, factorization method, Gauss-Seidel iterative method, determination of eigen values. Numerical differentiation based on interpolation, numerical integration, a general quadrature formula for equidistant ordinates, the trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rules, Weddles rule, Method of undetermined coefficients, extrapolation method. Numerical solution of ordinary differential equations of first order by Euler's and Runge –Kutta's method. Introduction to interpolation, interpolation with equal intervals, different interpolation methods (Newton-Gregory forward and backward difference formulae), interpolation with unequal intervals, divided differences and table, Newton's divided difference formulae, central difference interpolation formulae (Gauss, Stirling, Bessel formulae), piecewise and spline interpolation, (cubic splines) least squares approximations.

Text Books:

1. Robert J. Schiling and Sandra L. Harris, *Applied Numerical Methods for Engineers using Matlab and C*, Thomsom Asea Pte. Ltd.
2. S.S. Sastry , *Introductory methods of numerical analysis*, 4^{th}edition, PHI Learning Pvt. Ltd., 2005

Reference Books:

1. E. Kreyszig, *Advanced Engineering Mathematics*, 9^{th} edition, Wiley publication
2. S. A. Mollah, *Numerical methods*, T.M.H. publication

5. Analog Electronics

Operation and characteristics of BJT and FET, Biasing circuits. Frequency response of different configurations. h-parameter model of BJT. Power amplifiers. Feedback amplifiers. Differential amplifiers. Tuned amplifiers. Simple active filters. Op-amp, ideal and non-ideal properties, high frequency effects on op-amp gain and phase. Linear and non-linear circuit applications of op-amp. Various Oscillators. Voltage regulators. VCOs and timers.

Text Books:

1. J. Millman and A. Grabel,, *Microelectronics*, McGraw Hill, International, 1987.
2. J. Millman and C. C. Halkias., *Electronic Devices and Circuits*, McGraw-Hill, New York.

Reference Books:

1. A.S. Sedra and K.C. Smith, *Microelectronic Circuits*, Saunder's College Publishing, 1991
2. R. *Boylestad* and L. Nashelsky, *Electronic Devices and Circuit Theory*, Prentice Hall Publishing Co.
3. L.S. Bobrow, *Fundamentals of Electrical Engineering*, Oxford University Press.

6. Elective-I

7. Seminar (Soft Skilled Based)

5th Semester

1. Electrical machine-II

Synchronous machine: construction, classification, application, non-salient pole synchronous machine: working principle, emf equation, distribution factor and pitch factor, armature reaction, equivalent circuit, phasor diagram, calculation of synchronous reactance, performance indices, isolated and parallel operation of synchronous generator, power angle characteristics, V-curve , load sharing, starting of synchronous motor, hunting, short circuit transient in synchronous machine. Salient pole synchronous machine: two reaction theory, determination of X_d and X_q, performance. Single phase motor: classification of single phase motor and their applications, single phase induction motor- double revolving field theory, equivalent circuit, torque- slip characteristics, performance.

Text Books:

1. I. J. Nagrath and D. P. Kothari, *Electric Machines*, Tata McGraw Hill, 1985.
2. E. Fitzgerald, C. Kingsley Jr. and S. D. Umars, *Electrical Machinery*, McGraw Hill, 1983.

Reference Books:

1. M G Say, *Performance and Design of AC machines*, CBS Publishers.
2. A.F Puschtein & T.C. Lloyd, *Alternating Current Machines*, John Wiley & Sons.

2. Power Electronics

Characteristics of power semiconductor switches: diodes, SCR, MOSFET and IGBT; their driving and switching aid circuits and cooling issues; Uncontrolled Rectifiers: single phase and three phase operation. Phase controlled rectifier- single-phase & three- phase converters, effects of source inductance, dual converters, issues of line current harmonics and power factor; cyclo-converter. Principles of switched mode dc to ac conversion: single-phase and three phase voltage source inverters and current source inverter. Various PWM techniques: SPWM, SVPWM. Basic principles of switched mode dc-dc power conversion: non-isolated and isolated converter-fly back, forward and push-pull.

Text Books:

1. Muhammad H Rashid, Power Electronics Circuits Devices and Applications.
2. N. Mohan, T. M. Undeland, W. P Robbins, *Power Electronics: Converter, Applications & Design*, 3rd edition, Wiley & Sons.
3. L. Umanand, *Power Electronics*, Wiley India Pvt. Ltd.

Reference Books:

1. B. W. Williams, *Power Electronics: Devices, Drivers and Applications*, Macmillan, London

3. Microprocessors and Microcontrollers

Block diagram view of a general purpose processor (Preferably 8085 or 8086): Elements of hardware and software architectures; introduction to concepts of data and control paths, registers and memory organization. Instruction set basics and assembly language programming: instruction structure and addressing modes, instruction encodingtiming diagrams, internal registers, interrupt mechanism (hardware/software). DMA mechanism - Detailed description of a typical microprocessor. Interfacing with support chips, signals and timing details along with hardware/software interfacing techniques. I/O interfaces with switch, multi-segment display, ADC/DAC, instruction cycle, machine cycle, T states. Instruction set, addressing modes, stack subroutine, and interrupt service routines.

8051 hardware and instruction set architecture, timers/counters, interrupts and serial interface (including multi-processor communication). Interfacing basics using examples of I/O devices: parallel port, serial ports, keypad, display, etc.

Introduction to PIC micro controllers -Advantage of PIC micro controllers – History, Types and products of PIC and features, CCS C Compiler and PIC18F Development System, PIC Architecture & Programming, PIC I/O Port Programming, PIC Programming in C, PIC18 Hardware Connection and ROM loaders, PIC18 Timers Programming, PIC18 Serial Port Programming, Interrupt Programming, LCD and Keypad Interface, External EEPROM and I2C, USB and HID Class, ADC and DAC, Sensor and other Applications, CCP and ECCP Programming.

Text Books:

1. Ramesh S. Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085A/8080A, Wiley Eastern Limited.
2.Muhammed Ali Mazidi and Janice Gillispie Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education Inc., Fifth Edition, 2003.

Reference Books:

1. I. Liu, G. A. Gibson, Microcomputer Systems: The 8086/8088 Family, 2nd Ed., Prentice Hall, 1986.
2. Douglas Hall, Microprocessors Interfacing, Tata McGraw Hill, 1991
3. Kenneth J. Ayala, The 8051 Microcontroller, Penram International Publishing, 1996

4. Control System-I

Introduction: Control systems, Physical elements of a control system, classification, examples, effects of feedback, concept of non-linearity.

Mathematical Model of Physical Systems: Introduction, Differential equation representation of physical systems, Transfer function concepts, Block diagram reduction, Signal flow graphs, Mason's Gain formula

Time Response Analysis: Introduction, Standard test signals, Time response of first and second order systems, steady state error and error coefficients, P, PI and PID type controllers.

Stability of linear systems-Routh-Hurwitz criterion, Nyquist criterion, root locus, Bode-plot, stability margins,

effects of system gain on stability.
Compensation: Design of Lag, lead and lag-lead compensator.
State Variable Analysis: Concept of state, state variables, state mode transfer function decomposition, State models of linear continuous-time systems. Basic concepts of state and output feedback controller. Controllability & Observability.

Texts/References

1. Nagrath I J & Gopal M : Control Systems Engineering, New Age International Pub.
2. K. Ogata: Modern Control Engineering, Prentice Hall publishers
3. S. Hasan Saeed: Automatic Control Systems, S.K. Kataria & Sons Publisher
4. F. Golnaraghi, B. C. Kuo: Automatic Control Systems, Wiley Pub.

5. Electromagnetic Field Theory

Electrostatic field: dielectric interface, Laplace and Poisson's equations, energy & force. Steady currents: continuity equations, Ohm's law, Joule heating, current flow in materials, Eddy current, skin effect, displacement current. Magnetostatic field: Ampere's circuital law, scalar & vector potentials, Laplace and Poissions equations. Electromagnetic induction: Maxwell's equations; power flow and Poynting vector. Solutions of field equations in rectangular, cylindrical and spherical coordinate system, radiation generation, propagation of electromagnetic waves, various boundary value problems, principle of electromagnetic radiation & interaction with matter; scientific and engineering applications of electromagnetic radiation.

Text Books:

1. W H Hayt & J A Buck, *Engineering Electromagnetic*, 7th Edition, Tata McGrawHill.
2. J D Krauss, *Electromagnetic with application*, 5th Edition, Tata McGrawHill.

Reference Books:

1. J. A. Edminister , *Schaum's outline of theory and problems of electromagnetics*, 2nd edition, McGraw- Hill Professional
2. A Pramanik, *Electromagnetism – Theory and Applications*, Prentice-Hall of India

6. Seminar

6th Semester

1. Power System II

Symmetrical fault and unsymmetrical faults: symmetrical components single line diagram for a balanced system, analysis of three phase fault, construction of sequence networks under fault conditions (L-G, L-L, and L-L-G). Analyses of unsymmetrical faults using symmetrical components. Load flow analysis: static load flow equation, system variables, bus admittance matrix, bus classification, Gauss Seidel, Newton-Raphson and fast-decoupled load flow methods, comparison of methods. Voltage and frequency control. Economic aspects of power system. Power System transient Stability: synchronous generator connected to an infinite bus, power angle curve, steady state, transient, swing equation, equal area and criteria of stability. Brief ideas about power system protection and circuit breakers: general requirements of circuit breakers. Different types of circuit breakers, their construction, operating principles and relative merits and demerits. Fundamental principles of protective relays, their properties and block diagrams. Introduction to HVDC Transmission, Basic configurations and its merit.

Text Books:

1. W.D. Stevenson, 'Elements of Power Systems Analysis', 4th Edition, McGraw Hill, 1982.
2. I.J. Nagrath and D.P. Kothari, 'Modern Power System Analysis', 2nd Edition. TMH, New Delhi, 1989.

Reference Books:

1. Power System Economics: Designing Markets for Electricity – Steven Stoft IEEE Press ' A John Wiley & Sons , INC., Publication.
2. J Duncan Glover, Mulukutala S. Sarma and Thomas J. Overbye, *Power System Analysis and Design*, Cengage Learning India Pvt. Ltd. 4th Edition.
3. Olle I. Elgerd, *Electric Energy Systems Theory-An Introduction*, Tata McGraw Hill.

2. Digital Signal Processing

Design of fir digital filters: window method, frequency sampling method, Park-McClellan's method. Design of IIR digital filters: bilinear transformation, butterworth, chebyshev and elliptic approximations; frequency transformation lowpass, bandpass, bandstop and high pass filters.

Structures of DSP: direct, parallel, cascade and lattice, effect of finite register length in FIR filter design, limit cycle in IIR filters. Introduction to multi-rate signal processing. Hardware implementation considerations in DSP, selected applications of digital signal processing.

Texts Books:

1. S. K. Mitra, *Digital signal processing: A computational approach*, Tata McGraw Hill
2. A.V. Oppenheim and R.W. Schafer, *Discrete Time Signal Processing*, Prentice Hall,

References Books:

1. L.R. Rabiner and B. Gold, *Theory and Application of Digital Signal Processing*, Prentice Hall,
2. J.R. Johnson, *Introduction to Digital Signal Processing*, Prentice Hall, 1992.

3. Industrial Instrumentation

Measurement of non-electrical quantities: Transducers: Definition and introduction, classification: Active/ passive, primary/secondary, etc. specific transducers: strain gauge, LVDTs and Signal conditioning circuit, Measurement of temperature, pressure, flow and level, Static and dynamic characteristics of sensors. Resistive, Inductive and Capacitive sensors, Piezo-electric and Ultrasonic sensors and its application in process and biomedical instrumentation, Measurement of viscosity, humidity, thermal conductivity, Nucleonic gauges: Sources and Detectors and its application. Interfacing Sensors and actuators: LabVIEW technique. Optical sensors including infrared, laser and optical fiber.

Text Books:

1. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill,
2. A.E. Fribrance, Industrial Instrumentation Fundamentals, McGraw Hill.
3. J. P. Bentley, Principle of measurement system, Pearson Education India, 1988.
4. R. P. Areny, J. G. Webster, Sensor and Signal Conditioning, John Wiley & Sons, Inc. 2001.

Reference Books:

1. Donald P. Eckman, Industrial Instrumentation
2. E.O. Doebeline & D.N Manik, Measurement systems Application and design, 5th edition, McGraw-Hill.

4. Principles of Communication

Analog communication : introduction to communication systems, communication channels and propagation characteristics, basics of amplitude modulation and angle modulation - spectra, circuits and systems, frequency division multiplexing, performance of analog communication systems in AWGN.

Digital communication: A-D conversion, quantization and companding, PCM, DPCM, ADPCM, DM, ADM, time division multiplexing, baseband transmission, data regenerators and clock recovery, inter-symbol interference, equalizers, digital modulation and demodulation: FSK & MSK, PSK & QPSK, QAM with their spectra, circuits and systems, Information theory: entropy, mutual information & channel capacity, basics of spread spectrum.

Text Books:

1. S.S. Haykin, *An Introduction to Analog and Digital Communication Systems*, Wiley Eastern 1989
2. R.B. Carlson, *Communication Systems*, 3rd international edition, McGraw Hill, 1986.

Reference Books:

1. B.P. Lathi, *Communication Systems*, John Wiley, 1987.
2. H. Taub and D.L. Shilling, *Principles of Communication Systems*, McGraw Hill international student edition,1971.

5. Seminar (Project Related)

7th Semester

1. Electrical Drives

Basic Electric drives and its components, Torque speed characteristics of different types of loads, Selection of motor power ratings, Torque speed characteristics and speed control of Separately excited and series DC motor drives: Armature resistance control, combined armature voltage and field control, four quadrant operation. Induction motor drive: toque speed characteristics and speed control of stator voltage controlled and v/f controlled IM drive, various performance like T/I ratio, Issues of efficiency, four quadrant operation, speed

control of slip ring IM: static Scherbius drive. Toque speed characteristics of v/f controlled IM drive. Torque speed characteristics and speed control of synchronous motor drive, principle of operation of BLDC motor and switched reluctance motor drives.

Text Books:

1. G. K. Dubey, *Fundamentals of Electrical Drives*, CRC Press, 2002
2. R.Krishnan, *Electric Motor Drives – Modeling, Analysis and Control*, Prentice-Hall of India Pvt Ltd., New Delhi,2003.

Reference Books:

1. Bimal K.Bose, *Modern Power Electronics and AC Drives*, Pearson Education Pvt. Ltd., 2003.
2. Paul C. Krause, Oleg Wasynczuk, Scott Sudhoff, Steven Pekarek, Analysis of Electric Machinery and Drive systems, Wiley publication, 3rd edition, 2013.

2. Engineering Economics:

Introduction – engineering economy and its important, want activity satisfaction of wants. Resources planning and distribution in economic system – Laissez Faire and socialism. Factors of production and concept of optimum. Laws of return. Demand - elasticity of demand, demand – estimation, market research, supply and industrial costs. Money – value of money, quantity theory; inflation and deflection. Neural network and its applications. Banking - role in commercial banks credit and its importance in industrial financing, sources of finance Reserve bank of India and its functions. Business management and organization, proprietorship, partnership and joint stock company – their formation, finance and management. Elements of taxation, insurance, business combinations. Basic principles of management. Industrial record keeping : double entry system – journal, ledger, trial balance, cash book, preparation of final accounts, trading and profit and loss account and balance sheet. Industrial costs and their classifications – material cost control, labour cost control and overhead cost control. Depreciation and replacement studies; financial control ratio analysis and their interpretation for industrial control. Budgetary control.

Text Books:

1. H L Ahuja, *Business Economics* , S Chand's & Company Ltd.
2. Sampat Mukherjee, *Managerial Economics*, New Age International (P) Ltd.

Reference Books:

O P Chhabra, *Managerial Economics*, Tata McGraw Hill

2. Elective-II
3. Elective-III
4. Project-I

8th Semester

1. Industrial Management

Introduction to management, evolution of scientific management, modern management. Principles. Elements of management; Planning, organizing, staffing, directing, coordinating, reporting, budgeting. Core concepts of marketing. Need, want, demand, product, value, satisfaction, marketing mix- product, price, place, promotion. Financial management, objectives, scope, techniques of investment analysis, pay- back period, accounting rate of return, working capital, cost of capital. Sources of financing. Technology management. Product design. Types of production system. Plant location-factors to be considered. Plant layout. Types of layout. Inventory management. Significance of HRM. HR planning job evaluation. Recruitment and selection. Placement and induction. Training. Performance appraisal. Compensation. Industrial relations. Microeconomics. Demand and supply. Forecasting techniques. Cost and revenues. Competitive nature of firms. Keynesian economics. Aggregate demand and supply. Employment determination. National income. Trade cycle. Inflation. Index numbers. Capital budgeting. Cash flow analysis. Balance sheet. Risk analysis and decision making. Impact of liberalization, privatization and globalization. Locating the firm in a global economy. Fiscal policy. Taxation-principles. Exchange rate determination. Monetary policy. Functions of banks. Credit creation by commercial banks.

Text Books:

1. P.Kotler, *Marketing Management*, 12th edition, Pearson
2. P.Chandra, *Financial Management Theory and Practice*, 3rd edition, Tata McGraw Hill,

Reference Books:

2. K.Ashwathappa, *Human Resources and Personnel Management*, 3rd edition, Tata McGraw Hill
3. E.S.Buffa & R.K.Sarin, *Modern Production/Operation Management* , 8th edition, Wiley.

2. Elective-IV
3. Elective-V
4. Grand Viva
5. Project- II

Elective-I

1. Applied Thermodynamics

Definition: Thermodynamic system, control volume, thermodynamic properties, processes, cycles, homogenous and heterogeneous system, thermodynamic equilibrium, quasi-static process, work transfer, pdv work, indicator diagram, free expansion, path function. First law of thermodynamics: quantity of energy and its measurement, first law energy equation for closed and open loop system under SSSF and USUF condition, application of first law energy equation to thermodynamic system components such as boiler, turbine, compressor, nozzle, expander, pump, condenser, first law efficiency, first law analysis of combustion process. Second law of thermodynamics, quality of energy and its measurements, reversible and irreversible processes, entropy and its significance, principle of increase of entropy of the universe, Carnot cycle, Clausius inequality, application of second law to various thermodynamic system, combination of first and second law, first and second law combined, reversible adiabatic work in a steady flow system, unsteady flow, control system analysis, control volume analysis, entropy and disorder, availability and irreversibility, second law analysis of combustion process, air standard cycles, Otto-cycle, Diesel cycle, limited pressure cycle, comparison of Otto and Diesel and dual cycle, Brayton cycle, Stirling cycle and Ericsson cycle. Simple vapour cycles, Rankine cycle, actual vapour cycle processes, comparison of Rankine and Carnot cycle, reheat cycle, regenerative cycle, binary vapour cycles

Text/Reference Books :-

1. Nag, P.K., *Engineering Thermodynamics*, 3rd edition, Tata McGraw-Hill, 2005
2. Cengal, Y.A and Boles, M.A, *Thermodynamics: An Engineering Approach*, 5th edition, McGraw Hill, 2006.
3. Rajput, R.K.,*Thermal Engineering*
4. Ballaney, P.L,*Thermal Engineering*, Khanna Publishers

2. Fluid Mechanics

Properties of fluid: Mass and weight density, specific gravity, specific volume, viscosity and Newton's law of viscosity, compressibility, types of fluid, surface tension and capillarity, pressure and its measurement: fluid pressure at a point and pascal's law, absolute, gauge and vacuum pressures, pressure variation in a fluid at rest, pressure measurement-manometers and mechanical gauges. Hydrostatics: Total pressure and centre of pressure for horizontal, vertical, inclined plane surfaces and curved surfaces submerged in liquid. Total pressure and centre of pressure on lock gates. Buoyancy and flotation: Buoyancy, centre of buoyancy , 23iamagneti and metacentric height and equilibrium of floating bodies, period of oscillation .Kinematics of flow: Types of fluid flow, continuity equation in three dimensions, velocity potential function and stream function, forced and free vortex flow. Dynamics of flow: Euler's equation and Bernoulli's equation , application of Bernoulli's equation-venturimeter, orifice-meter, and pitot tube. Orifice and notches: Flow through orifices, hydraulic coefficients, time of emptying hemispherical and horizontal cylindrical tank through an orifice at it's bottom, discharge over rectangular, triangular and trapezoidal notches, velocity of approach. Laminar flow : Flow of viscous fluid through circular pipe-velocity distribution and average velocity, Hagen Poiseiulle formula, kinetic energy correction and momentum correction factors , Navier-Stokes equation of motion. Turbulent Flow: Reynold's experiment, Loss of head due to friction in pipes, Reynold's expression and Prandtl mixing length theory for turbulent shear stress. Flow through Pipes: Major and minor losses of energies in pipes,

hydraulic gradient and total energy lines, flow through pipes in series, equivalent pipe, flow through parallel pipes, power transmission through pipes and nozzles, water hammer.

Text/Reference Books :-

1. Bansal, S.K., *Fluid Mechanics & Hydraulic Machines*, Laxmi Publications.
2. Cengel, Y.A., *Fluid Mechanics: Fundamentals & Applications (SI Units)*, Tata McGraw- Hill Publications
3. Jain, A.K., *Fluid Mechanics*, Khanna Publishers.
4. Rajput, R.K., *Fluid mechanics & Hydraulic machines* , S. Chand Publications.

3. Strength of Materials

Stress, strain, types of stresses, elastic limit, Hook's law, Analysis of bars of varying sections, law of superposition, composite bar, thermal stress, thermal stresses in composite bars, elongation of bar due to it's own weight, stress-strain diagram. Introduction , longitudinal & lateral strain, Poisson's ratio, volumetric strain for rectangular bar, bulk modulus , principle of complementary shear stress, relation between various elastic constants. Principle planes and principle stresses, methods for determining stresses on oblique section, analytical method, graphical method, Mohr's circle, use of Mohr's circle to find principle stresses. Types of beams and loads, S.F & BM diagram for a cantilever, uniformly distributed load, simply supported beam for various types of loading, relation between load, shear force and

bending moment diagram. Theory of simple bending, expression for bending stress, bending stresses in symmetrical sections, section modulus, section modulus for various shapes of beam sections, bending stress in unsymmetrical sections, deflection of various types of beams. Basic assumptions and derivation of shear stress produced in a circular shaft subjected to torsion, torque transmitted by a circular and hollow circular shaft, polar modulus, strength of a shaft and tensional rigidity, composite shafts, combined bending and torsion, strength of a shaft of varying cross section.

Text/Reference Books :-

1. Ramamurtham, S., "Strength of Materials", Dhanpat Rai & Sons, 1974.
2. Bansal, R.K., "*Strength of Materials",* Laxmi publications.
3. Beer, Johnston., "*Mechanics of Materials"*, Tata McGraw-Hill Publications

4. Electrical Engineering Materials

Crystallography: Crystalline and amorphous solids, periodic structures – Lattice, basis, unit cell, bravais lattice, crystal structure and symbols, millar indices reciprocal lattice. X- ray crystallography: X- ray diffraction , Bragg's law , determination of lattice constant, atomic form factor, closest packing of spheres, packing efficiency , crystal defects, band theory of solids, Kronig – Penny model, Brillouin zones, electronic distinction between conductors , insulators and semiconductors, dielectric properties of materials: 24iamagnetism and dielectric constant, frequency and temperature dependence of relative permittivity 24iamagne of dielectric under alternating fields, dielectric losses. Conductors: Electrical conductivity of metals, Lorentz theory, free electron theory, electron scattering, resistivities of conductors including alloys. Semiconductors: Intrinsic and Extrinsic semiconductors, Fermi-Dirac distribution, dependence of carrier concentration on temperature, measurement of resistivity, four probe method, Hall effect, measurement of carrier concentration, Zener breakdown phenomenon, photo-electric effect in semiconductors. Magnetic properties of materials: 24iamagnetism, paramagnatism, ferromagnetism, exchange interaction, antiferromagnatism, ferrimagnetism, and ferrites, magnetic resonance, magnetotriction , Curie-Weiss law , Curie law, Curie temperature of ferromagnetic material, soft and hard magnetic material. Ni-Fe alloy and applications, Alnic, Alcomax and application. Special materials, ceramics, polymers, XLPE, nanostructures and nanomaterials, biomaterials and bioceramics. Superconductivity: Superconductivity phenomena, meissner effect, type I and type II, superconductors, high TC Superconductors, Josephson junction, SQUID.

Text/Reference Books :-

1. A.J. Dekker, *Solid State Physics*, Tata McGraw-Hill Publications
2. C. Kittel, *Introduction to Solid State Physics*, Wiley & sons
3. R L Singhal , *Solid State Physics,* Macmillan *Publishing* Co .
4. S.O. Pillai ,*Solid State Physics*, McGraw Hill Publisher

Electives II, III, IV& V

S.No.	Title	Lecture	Tutorial	Practical	Credit
1	Special Topics in Electrical Engineering I				
2	Special Topics in Electrical Engineering II				
3	Analysis and Control of Electrical Machines	4	0	0	4
4	Power Plant Engineering	3	1	0	4
5	Advanced Power Systems	3	0	1	4
6	Process Control & Automation	3	0	1	4
7	Opto-electronics Instrumentation	3	0	1	4
8	High Voltage Engineering	3	0	1	4
9	Electrical Machine Design	3	0	1	4
10	Advanced Power Electronics	3	0	1	4
11	Optical Engineering and Laser Instrumentation	3	0	1	4
12	Renewable Energy Technology	3	1	0	4
13	Solar Photovoltaic Systems	3	0	1	4
14	Network Synthesis	3	1	0	4
15	Embedded Systems	4	0	0	4
16	Pulse Width Modulation Technique	3	0	1	4
17	Power System Protection	3	0	1	4
18	Smart Grid Fundamentals with Renewable Integration	3	1	0	4
19	Artificial Intelligence and Expert System	3	1	0	4
18	Advanced Control Systems	3	1	0	4

1. Special Topics in Electrical Engineering I

Details syllabus and reference will be given in class at the beginning of semester

2. Special Topics in Electrical Engineering II

Details syllabus and reference will be given in class at the beginning of semester

3. Analysis and Control of Electrical Machines

Introduction to generalized theory: elementary energy converter of Gibbs and Adkins, transformer with movable secondary, transformer voltage and speed voltage, transformation from 3-phase to 2- phase, stationery axes to rotating axes, transformed impedance matrix, generalized torque equation. Derivation of DC machine from generalized machine, performance evaluation of DC machine and speed control. Three phase induction motor: transformation methods (stationary, rotor and synchronous frames) and corresponding equivalent circuits. Vector control and direct torque control. Three Phase synchronous motor: representation, Park transformation and control. Permanent magnet synchronous motors- machine model (d-q) and control methods, Switched reluctance motor drive and various power circuit configurations and control.

Text Books:

1. P.C. Krause, *Analysis of Electric Machinery*, McGraw Hill, New York, 1987.
2. R.Krishnan, *Electric Motor Drives – Modeling, Analysis and Control*, Prentice-Hall of India Pvt Ltd., New Delhi,2003.

Reference Books:

1. C.V. Jones, *The Unified Theory of Electrical Machines*, Butterworth, London, 1967.
2. P.Vas, *Vector Control of A.C. Machines*, Clarendon Press, Oxford 1990.

4. Power Plant Engineering

The introduction of the various sources of the energy, principal types of the power plants and combustion of fuels, the various cycles used in power plants, viz., Rankine cycle, regenerative cycle, binary vapour cycle, otto cycle, diesel cycle, duel combustion cycle, gas turbine cycles. Description of different aspects of steam power plant, layout of a modern steam power plant, fuel handling, combustion equipment for steam boilers, ash handling, dust collection, chimney draught, boiler accessories, steam nozzles, steam turbines, cooling towers, cooling ponds etc. IC engines used in such a plant and essential components of diesel power plants, combustion phenomenon in IC engines, its related topics, layout of a diesel engine power plants, general aspects of gas turbine used in such a plant along with the description of gas power cycle used in such turbines, operation of gas turbines, gas turbines power plants layout. Elements of hydro-electric power plant, hydro-electric turbines, plant, layout, hydro-electric plant controls, hydrology. General aspects of nuclear engineering, nuclear power systems, nuclear reactors and their description, nuclear energy, advantages of combined operation of plants, load division between power stations, hydro-electric plant in combination with steam or nuclear power plants, co-ordination of hydro-electric and gas turbine stations, co-ordination of different types of power plants.

Text Books:

1. M.M.El-Wakil , *Powerplant Technology* , McGraw Hill
2. Arora & Domkundwar , *A Course in Power Plant Engineering* , Dhanpat Rai

Reference Books

1. B.G.A. Skrotzki &W.A.Vopat, *Power Station Engineering & Economy* , Tata McGraw Hill
2. M.V.Deshpande, *Elements of Electrical Power Station Design*, Wheeler

5. Advanced Power systems

Load frequency control: multi area load frequency control problem and concept of tie line control, speed governing system, AVR, AGC, economic operation of power system, introduction- incremental fuel rate curves, incremental fuel cost curve, constraints in economic operation of power system, cost function control for economic operation of a two area power system. Voltage control: methods of voltage control, tap changing transformer, HVDC operation and control: CIA, CC and CEA control. Determination of stable operating point. Introduction to FACTS – brief description of various FACTS devices and their principle of operation, role of FACTS in active and reactive power control. Harmonics in Power Systems – different sources of harmonics, effects of harmonics on power system performance and power quality. Introduction to SCADA and security monitoring.

Text Books:

1. A. J. Wood and B.F. Wollenberg, *Power Generation, Operation and Control*, 2nd edition, John Wiley.
2. K.R.Padiyar , *HVDC Power Transmission Systems – Technology & System Interaction*, Willey Eastern

Reference Books

1. E.W.Kimbark, *Direct Current Transmission*, Vol 1,Wiley Interscience
2. N.G.Hingorani & L.Guygyi, *Understanding Facts*, IEEE Press

6. Process Control & Automation

Concept of processes and units: process statics, mass and enthalpy balance. Modelling of process dynamics, Process control terminology, Modelling of chemical processes. Single loop control of standard first order process plants. Controller implementation: Electronic, Analog, Digital, Pneumatic, **Hydraulic** controllers. P, P-I, P-D, P-I-D control, Controller tuning, Ziegler-Nichlol's method. Simulation of process control systems. Boiler drum level control. Discrete controllers: Selection of sampling intervals, stability analysis, **controller design via frequency response analysis, pulse testing technique**. Cascade control, Feed-forward control, Ratio control, Multi-loop control, Interaction and decoupling non-linear effects in plants and controllers. Concepts of Modulating and Sequential control, Structure of Modulating control loops. Self-tuning and Multifunction controllers. Control valves, **Servo valves**. Process Actuators: Electrical, Pneumatic, Hydraulic, valve positioners, **P-I and I-P converters**. **Programmable Logic Controllers (PLC), Supervisory Control and Data Acquisition (SCADA)**, **Distributed control system: Architecture and loop elements, interfacing units, operating stations.**

Text Book:

1. D. Patranabis, Principles of process control, Tata McGraw Hill.
2. **D.R. Coughanowr and L.B. Koppel, "Process Systems Analysis and Control", Mc-Graw Hill.**
3. Surekha Bhanot, Process Control - Principles And Applications, Oxford University Press.
4. **D.E. Seborg, T.F. Edgar and D.A. Mellichamp, Process dynamics and control, Wiley.**
5. George Stephanopoulos, Chemical process control: an introduction to theory and practice, Prentice-Hall.

Reference Book:

1. William L Luyben and Michael L. Luyben, Essential of Process Control, McGraw Hill.
2. P.Harriot, Process Control, McGraw Hill, New York.
3. B.G.Liptak, Instrumentation Engineers Handbook, CRC Press.
4. Mukhopadhay, Sen & Deb, "Industrial Instrumentation, Control and Automation", Jaico Publishing.
5. S.K. Singh, Process Control: Concepts, Dynamics and Applications, PHI Learning.
6. Douglas M Considine, Process instruments and controls handbook, McGraw-Hill.

7. Opto-electronics Instrumentation

Introduction to electromagnetic field theory: Ray and wave optics, Reflection and transmission coefficients, Zero reflection condition. Modulators-Intensity, Polarization: Types of polarization, Polarization crystals. Birefringence, Isotropic and anisotropic media, Direct and indirect bandgap semiconductors. Phase, Read out schemes for modulation-polarimeter, Interferometer: Febry-perot interferometer, Finesses, Transportation media. Wave plates: Half wave plate, quarter wave plate, higher order wave plate. Optical fiber as a cylindrical wave guide, waveguide equations, Boundary conditions for cylindrical waveguide, Waveguide theory-slab waveguide, scalar wave equation. Opto-electronic devices: Sources-LED, Broadband calibration sources, Detectors-Photodiodes, PIN photodiodes, Photomultiplier tube, APD, Laser, Classifications of laser with its useful applications, Three level and Four level lasers, Laser diode, Optical fibre Characteristics:

absorption and dispersion, Cylindrical waveguide, PANDA fiber, Fibre optic polarizer, attenuator, copler and polarization splitter, Gaussian beam, Bessel beam, Brewster angle, GRIN lens, Fiber Bragg grating, Long fiber Bragg grating, Bragg reflection, Dispersion, Types of dispersion. Distributed fiber optic sensors: OTDR and OFDR principles in temperature measurement, Stress, strain and temperature measurement using fiber optic sensors, Microbend sensor, Fiber optic gyroscope : Principle and applications, Bicolour thermometry. Fiber optic gyro holographic measurement and its biomedical applications, Optoelectronic integrated circuit and integrated optics sensor, Optoelectronics sensors and system: sensor as a modulator, bulk modulator, fibre optic modulator. Sensing principles: electro-optic and magneto-optic (polarimetric and interferometric), magneto-striction based sensors.

Text Book:

1. G. P. Agrawal, *Fiber-Optic Communication System*, 3rd Edition, Wiley Student Edition
2. Amnon Yariv, PochiYeh , *Photonics: optical electronics in modern communications*, 6th edition, Oxford University Press.

Reference Book:

1. C. K. Sarkar, *Opto Electronics And Fibre Optics Communication*, New Age International (P) Ltd
2. Clifford R. Pollock, *Fundamentals of optoelectronics*, Irwin

8. High Voltage Engineering

Breakdown phenomenon: breakdown in gases - mechanism of breakdown in gases, Townsend's ionization coefficients, Paschen's Law, time lags for breakdown, streamer breakdown theory. Breakdown in liquids - suspended solid particle mechanism, cavitation and bubble mechanism, stressed oil volume mechanism, etc. Breakdown in solids - intrinsic breakdown, electromechanical breakdown, breakdown of solid dielectrics in practice, chemical and electrochemical deterioration and breakdown, breakdown due to treeing and tracking, breakdown due to internal discharges.

Basic idea about protection against overvoltage - lightning arresters, surge absorbers, ground wire, grounding practices etc. BIL, SIL of the equipments, v-t curve, concepts of insulation coordination.

Generation of high ac & dc voltage: high ac voltage generation – testing transformer and its cascaded connections. Single phase resonant circuits. High dc voltage generation - single stage and multi stage voltage multiplier circuits.

Impulse voltage and current generation: introduction to impulse current and voltage, impulse generator circuits, analysis of circuit "a" and "b".

Measurement of high voltage and current : electrostatic voltmeter, Chubb and Fortescue method of measuring peak value of a.c., sphere gap method, rod gap method of measuring high voltage, impulse voltage measurement using potential dividers, impulse voltage and current measurement using CRO.

High voltage testing: Testing of overhead line insulators, bushing, power transformer, circuit breakers, Testing of transformer oil, loss in dielectric, measurement of resistivity, dielectric constant and loss factor.

Text Books:

1. C. L. Wadhwa, *High Voltage Engineering*.
2. M.S Naidu & V Kamaraju , *High Voltage Engineering.*

Reference Books :

1. E. Kuffel and WS Zaengl, *High Voltage Engineering*-Fundamentals, Pergamon Press.
2. Alston , *High Voltage Technology* , Oxford University Press.

9. Electrical Machine Design

Designing an electrical machine – a paradigm shift from studying an electrical machine; converting & expressing electrical quantities and equations involving length, breadth, cross-section, etc, specifications for commencing a design; the three major sub-areas: electromagnetic, thermal & mechanical; use of empirical formulas, use of assumed constants, lack of clear mathematical relations make designing a repetitive task; no optimum but optimal design; use of computers. Transformer: initial values to be assumed, core design, window dimension design, yoke design, overall dimension design, LV winding design, HV winding design, checking the design output with specification: calculation of resistance, reactance, losses, efficiency, regulation, no load current, designing cooling system. Rotating machine: general concepts and constraints in design of rotating machines; output equation in terms of main dimensions, specific magnetic & electric loadings and speed; factors affecting the size of machines; choices of both specific loadings; separation of D & L for different types of machines. Output equation of induction motor – choice of average air gap flux density – choice of ampere conductor per metre - main dimensions –stator winding design – stator slots design – stator teeth & core - rules

for selecting rotor slots of squirrel cage machines – design of rotor bars & slots – design of end rings – design of wound rotor –– magnetic leakage calculations – leakage reactance of poly phase machines- magnetizing current - short circuit current – circle diagram - operating characteristics.

Text Books:

1. M G Say, *Performance and Design of ac machines*, CPS Publishers
2. S. K. Sen, *Principles of Electrical Machine Design with Computer Programmes*, Oxford and IBH Publishing Co. Pvt Ltd.

Reference Books:

1. R.K. Agarwal, *Principles of Electrical Machine Design*, S.K.Kataria & Sons
2. A.K. Sawhney, *A Course in Electrical Machine Design*, 6th edition, Dhanpat Rai and Sons

10. Advanced Power Electronics

Analysis of ac to dc, dc to ac, dc to dc converters; applications of state space averaging techniques, small signal modelling, control issues. Switched mode rectifier- operation of single/ three phase bilateral bridges in rectifier mode. Design of high frequency transformers and inductors. Introduction to resonant converters, Classification of resonant converters, Basic resonant circuit concepts, Load resonant converter, Resonant switch converter. Zero voltage switching, zero current switching, clamped voltage topologies.

Text Book:

1. Robert W. Ericson, *Fundamentals of Power Electronics*, Chapman & Hall
2. Ned Mohan, Undeland and Robbin, *Power Electronics: converters, Application and design*, John Wiley and sons.
3. L. Umanand, *Power Electronics: essentials and application*, Wiley

Reference Book:

1. Bose, Bimal K, *Power Electronics and AC Drives*, Prentice-Hall India

11. Optical Engineering and Laser Instrumentation

Optical fields and waves-their interaction with bulk and structured matter: Engineering principles for optical materials, components and systems. Laser and their related technologies, Principle and devices on electro-optic effect: **Phase and amplitude modulation**, acousto-optic: **A.O. diffraction, modulators, deflectors** and magneto-optic effect, Guided wave optics and harmonic generation, Methods of Q switching and mode locking, Ultrashort pulse generation, Laser based methods and systems for measurement and sensing, interferometry, holography, speckle, fibre and Fourier optics.

Text Book:

1. AmnonYariv, PochiYeh, *Optical waves in crystals: propagation and control of laser radiation*, Wiley.
2. OrazioSvelto , *Principles of Laser* ,Springer.

Reference Books

P Das , *Laser And Optical Engineering*, Springer

1. G. P. Agrawal , *Nonlinear Fiber Optics* , Academic Press.

12. Renewable Energy Technology

Energy resources, reserve and availability of Oil, gas and coal in global and national context. Environmental constraints of traditional non-renewable sources. Renewable Energy: need for accelerated growth, Technologies for electricity generation: Solar energy: solar fundamentals, solar energy resources, solar PV system: components, types, design, and applications; Thermo solar systems. Wind energy system: wind energy conversion and devices, power from the wind, wind energy and environment. Hydro electric system: classifications, concepts, benefits of hydel power generation. Tidal energy system: free-flow and dam-type, evaluation of tidal energy. Biomass energy generation; Geothermal power plants. Energy storage and Energy management.

Text Book:

1. B.H. Khan, *Non-Conventional Energy Resources*, McGraw Hill.
2. J. Andrews, N. Jelley , *Energy Science Principles, Technologies and Impact*, Oxford University Press.

Reference Books:

1. D.S. Chauhan, S.K.Srivastava , *Non Conventional Energy Resources*, New Age Int.(P) Ltd.
2. P. Gevorkian , *Sustainable Energy Systems Engineering* , McGraw Hill.

13. Solar Photovoltaic Systems

Solar cells, solar PV modules, PV module output as function of temperature and solar radiation, solar geometry, availability of solar radiation at a given location, solar PV systems and components, solar PV water pumping system, introduction to power electronic devices, off-grid and grid-connected PV systems, charge controller, DC-DC converter, DC-AC inverter, maximum power point tracking, energy storage options for solar PV systems, design of off-grid PV systems, design of grid-connected PV systems, hybrid PV Systems, life cycle cost analysis.

Text Book:

1. R.A. Messenger, J. Venture , *Photovoltaic Systems Engineering*, CRC Press.
2. R. Foster, M. Ghassemi, A. Cota, *Solar Energy* , CRC Press.

Reference Book:

1. S.P. Sukhatme , *Solar Energy* , Tata McGraw Hill.
2. C.S. Solanki , *Solar Photovoltaics*, Printace Hall of India.

14. Network Synthesis

Positive real function –synthesis of 2 port, R-L-C networks, cascading and interconnection, bisection theorem, synthesis of R-L and R-C filters-Butterworth, Chebyschev, Bessel type frequency transformations. Active networks and synthesis techniques. Synthesis of R-L-C, low pass, high pass, band pass and band reject filters. Biquad and simulation of physical systems and active networks.

Text Book:

1. Kuo, Franklin F, *Network Analysis and Synthesis*, John Wiley and sons, Singapore, 1966.
2. D Roy Chaudhury, *Network Analysis and Systems*, New Age International, New Delhi, 1996.
3. Rolf Schaumann, Mac E Van Valkenburg, *Design of Analog Filters*, Oxford University Press, 2001.

Reference Book:

1. M.E. Van Valkenburg, *An Introduction to Modern Network Synthesis* ,Wiley. Eastern Ltd..
2. Harry Y. F. Lam , *Analog and digital filter design and realization*, Prentice Hall

15. Embedded Systems

Introduction to Embedded Systems; Embedded Systems Hardware: Processors - Digital Signal Processors, Microcontrollers, Special Purpose Processors, I/O devices, interfacing and control - Analog I/O, Digital I/O, Bus I/O, Serial and Network I/O, Memory, Power and Display Devices - Reconfigurable and Custom Logic Devices, System Hardware Design Case Study; Embedded Systems Software : Introduction to Operating Systems, Real Time Operating Systems, Device Drivers; Embedded Systems Application Design and Programming Environments : System Specification and Modelling, Programming, Simulation and Verification, Performance Analysis and Optimisation; Selected Application Case Studies from areas such as : Instrumentation and Signal Processing Systems, Control and Actuation Systems, Power Electronic Drive Systems etc; Embedded Systems Testing.

Text/ Reference Books:

1. Santanu Chattopadhyay, "Embedded System Design", PHI Learning Pvt. Ltd.
2. Andrew N. Sloss, Dominic Symes, Chris Wright. "ARM System Developers Guide: Designing and Optimizing System Software", Elsevier
3. Richard Barnett, Larry O'Cull, Sarah Cox, "Embedded C Programming and the Microchip PIC", Delmar Cengage Learning.
4. P Lapsley, DSP Processor Fundamentals -Architecture and Features, Chand Publications
5. Hamid.A.Toliyat and Steven G.Campbell, "DSP Based Electro Mechanical Motion Control", CRC Press New York, 2004
6. Wayne Wolf," FPGA based system design ", Prentice hall, 2004.
7. Real-time Systems - Jane Liu, PH 2000.

16. Pulse Width Modulation Technique

Purpose of Pulse Width Modulation, Low switching frequency Pulse width modulation, Selective harmonic elimination, offline optimized pulse width modulation. Sine-triangle pulse width modulation, Harmonic injection pulse width modulation, Bus clamping pulse width modulation. Space Vector based PWM: Concept of space vector, Conventional space vector PWM, Space vector based bus clamping PWM, Space vector based

advanced bus clamping PWM. Harmonic analysis of PWM technique, Analysis of RMS line current ripple. Analysis of DC link current and DC capacitor current in a VSI. Evaluation of conduction loss and switching loss in three phase inverter, Design of PWM for reduced switching loss in three phase inverter. Effect of dead time on inverter output voltage for continuous PWM scheme and bus-clamping PWM scheme. Over-modulation in sine-triangle PWM inverter and in space vector modulated inverter. PWM for three level neutral point clamped inverter

Text/ Reference Books:

1. D. Grahame Holmes, Thomas A. Lipo, "Pulse width modulation of Power Converter: Principles and Practice", John Wiley & Sons.
2. Bin Wu, "High Power Converters and AC Drives", John Wiley & Sons Publication.

17. Power System Protection

Basic concepts of power system protection, overview of over current, distance, directional, differential protection. Protection of generators, transformers, bus bars and transmission lines. Distance protection. Computer relaying. Induction motor protection, Digital relays, Microprocessor based relay. Protection of distribution DG, special protection scheme. Phasor estimation, wide area protection.

18. Smart Grid Fundamentals with Renewable Integration

The Smart Grid: Introduction, Why implement the Smart Grid now, Ageing assets and lack of circuit capacity, Thermal constraints, Operational constraints, Security of supply, National initiatives, What is the Smart Grid?, Early Smart Grid initiatives, Active distribution networks, Virtual power plant, Other initiatives and demonstrations, Overview of the technologies required for the Smart Grid.

Introduction to Smart Grid Applications: Introduction, Voltage and Var Control and Optimization, Devices for Voltage and Var Control, Voltage Drop and Energy Loss in Distribution System, Load Response to Voltage Variations, Benefits Potential of Voltage and Var Control Approaches, Communication Requirements, Inclusion of New Controllable Resources, Interaction with Applications, Fault Detection, Isolation and Restoration (FDIR), Drivers and Benefits of FDIR, Field- Based FDIR Schemes, Control Centre Based FDIR Schemes, Reliability: Present and Future, Demand Response (DR), Types of DR Programs, Communication requirement, Statistical Reliability of Demand Response.

Smart Grid Monitoring and Control: Distributed Energy resources (DERs), Operation and Control, Communication Requirements, Sustainable Power Grid, Wide- Area Monitoring, Control and Protection (WAMCP), Structure of WAMCP system, Overview of WAMCP Application, Stabilizing and Emergency Control Actions, Implementation Aspects of WAMCP Systems.

Smart Grid Communications And Measurement Technology: Communication and Measurement, Monitoring, PMU, Smart Meters, and Measurements Technologies, Phasor Measurement Units (PMU), Smart Meters, Smart Appliances, Advanced Metering Infrastructure (AMI), GIS and Google Mapping Tools, Multiagent Systems (MAS) Technology, Multiagent Systems for Smart Grid Implementation, Multiagent Specifications, Multiagent Technique, Microgrid and Smart Grid Comparison

Performance Analysis Tools For Smart Grid Design: Introduction to Load Flow Studies, Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods, Load Flow State of the Art: Classical, Extended Formulations, and Algorithms, Congestion Management Effect, Load Flow for Smart Grid Design, Contingencies and Their Classification, Contingency Studies for the Smart Grid.

Stability Analysis Tools For Smart Grid: Introduction to Stability, Strengths and Weaknesses of Existing Voltage Stability Analysis Tools, Voltage Stability Assessment, Voltage Stability Assessment Techniques, Voltage Stability Indexing, Analysis Techniques for Steady-State Voltage Stability Studies, Application and Implementation Plan of Voltage Stability, Optimizing Stability Constraint through Preventive Control of Voltage Stability, Angle Stability Assessment, State Estimation.

Computational Tools For Smart Grid Design: Introduction to Computational Tools, Decision Support Tools (DS), Optimization Techniques, Classical Optimization Method, Heuristic Optimization, Evolutionary Computational Techniques, Adaptive Dynamic Programming Techniques, Pareto Methods, Hybridizing Optimization Techniques and Applications to the Smart Grid, Computational Challenges

Renewable Energy and Storage: Renewable Energy Resources, Sustainable Energy Options for the Smart Grid, Solar Energy , Solar Power Technology, Modeling PV Systems, Wind Turbine Systems, Biomass-Bio energy, Small and Micro Hydropower , Fuel Cell, Geothermal Heat Pumps, Penetration and Variability Issues Associated with Sustainable, Energy Technology, Demand Response Issues, Electric Vehicles and Plug-in

Hybrids, HEV Technology, Impact of PHEV on the Grid, Environmental Implications, Climate Change, Implications of Climate Change, Storage Technologies.

Reference Books:

1) *Smart Grid: Fundamental of Design and Analysis By James Momoh- Wiley Publication*
2) *Smart Grid Technology and Application By Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins- Wiley Publications*

19. Artificial Intelligence and Expert System

Expert Systems (ES): Major Characteristics of expert systems, techniques, rule-based expert systems, knowledge acquisition, applications.
Fuzzy Logic (FL): Fuzzy set theory, fuzzy inference, fuzzy logic expert system, fuzzy control.
Neural Networks (NS): Artificial neurons and neural networks, Learning process: error-correction learning, Hebbian learning, Boltzmann learning, Competitive learning, Supervised/ unsupervised learning, Perception and multilayer perception, Self-organising Kohonen networks, Hopfield neural networks, practical implementation and applications.
Genetic Algorithms (GA): adaptation and evolution, a simple genetic algorithm, genetic algorithms in optimization, genetic algorithms in controls.

Text/ Reference Books:

1. Michael Negnevitsky, "Artificial Intelligence: A guide to Intelligent Systems", Oxford University Press.
2. M. Gopal, "Digital Control and State Variable Methods, Conventional and Neuro-Fuzzy Control System", Oxford University Press.
3. Staurt Russel and Peter Norvig, "Artificial Intelligence- A modern approach", PHI.
4. Patrick Henry Winston, "Artificial Intelligence", 3rd Ed., Addition Wesley.
5. S. Haykin, "Neural Networks: A comprehensive Foundation", Pearson.

20. Advanced Control Systems

Introductory matrix algebra and linear vector space. State space representation of systems, Linearization, Solution of state equations, Evaluation of state transition matrix(STM).Simulation of state equation using MATLAB ,SIMULINK program, Similarity transformation and invariance of system properties due to similarity transformations, Minimal realization of SISO,SIMO, MISO transfer function .Discretization of a continuous time state space model. Convert state space model to transfer function model using Fadeeva algorithm .Fundamental theorem of feedback control, Controllability and Controllable canonical form .Pole assignment by state feedback using Ackermann's formula, controllable canonical form and numerically stable method based on controllable Hessenberg form. Eigen structure assignment problem. Linear Quadratic Regulator (LOR) problem and solution of algebraic Rieeati equation using eigen value and eigenvector methods, iterative method, and numerically stable algorithm .Controller design using output feedback. Observability and observable canonical forms. Design of full order observer using Ackermann's formula, observable canonical form, observable Hessenberg canonical form and Bass Gura algorithm, Duality. Observer based controller design. Reduced order observer design. Internal stability of a system. Stability in the sense of Lyapunov, asymptotic stability of linear time invariant continuous and discrete time systems. Solution of Lyapunov type equation Model decomposition and Decoupling by state feedback. Disturbance rejection, sensitivity and complementary sensitivity functions, internal model control (IMC).
Text/Reference Books:-

1. Norman N. Nise, "Control Systems Engineering" ,10th Edition wiley & son
2. B .C Kuo, "Automatic Control Systems", 4th Edn., Prentice Hall of India.
3. W . A Wolowich, "Automatic control systems, basic analysis and design".
4. K . Ogata, "Modern Control Engineering" ,5th Edition., Prentice Hall.