

## First Year 1st Semester

### **PE/Chem/T/111**      **CHEMICAL SCIENCE**

Electronic structure of atoms - Chemical bonding and molecular structure organic molecules. The gaseous, solid and liquid states. Chemical thermodynamics. Equilibrium - phase and chemical equilibrium. Acids, bases and salts. Electrochemistry. Kinematics and mechanism of reactions. Carbon compounds- reaction and synthesis. Chemistry of representative elements - water chemistry. Chemistry of semiconductor materials. Chemistry of radioactive materials - nuclear chemistry.

### **PE/Math/T/112**      **MATHEMATICS-IQ**

Differential Calculus: Successive differentiation, Rolle's theorem (statement only), Mean value Theorem, Taylors Theorem, Maclaurin's series, Maxima and minima, Indeterminate forms, Functions of two or more variables, Partial derivatives.

Integral Calculus: Properties of definite integrals, Fundamental theorem of integral calculus, Improper integrals, Beta and Gamma functions, Multiple integrals, definition and properties, Application Arc length and areas of plane curves. Volumes and surface areas of solids of revolution.

Vector Algebra: Vectors, Position vectors, Addition of two vectors, Multiplication of a vector by a scalar, Scalar and Vector products of two vectors Applications.

### **PE/Math/T/113**      **MATHEMATICS-IIQ**

Complex numbers: De'Moivre's Theorem, Exponential values of sines and cosines, Elementary knowledge of hyperbolic functions.

Determinants and Matrices: Definition and properties, Product of two determinants, Cramer's rule. Addition and Multiplication of matrices. Adjoint and inverse of a matrix. Solution of a system of linear equations by matrix method.

Sequence & Infinite series: Convergence and divergence, Comparison test, D' Alembert's ratio test and Cauchy's root test.

Fourier Series: Solution of one dimensional wave and diffusion equations and two dimensional Laplace equations.

### **PE/T/114**      **ENGINEERING MECHANICS-I**

Basic Units and dimensions, Introduction to vector algebra, vector calculus, and directed quantities, Free body diagram, Equilibrium equations, friction forces and application of friction forces, Collar, screw and belt friction, Properties of surfaces, Principle of virtual work, Distributed force and center of gravity. Kinematics of rectilinear motion.

### **PE/T/115**      **ENGINEERING DRAWING-I**

Introduction to Drawing instruments & aids. Types of lines. Engineering lettering.

Geometric drawing & curves. Scales & dimensioning, I.S. Conventions. Orthographic projections, Isometric drawing & Sectional views.

### **Ph/T/1A      PHYSICS-IA**

1. Use of vectors in particle mechanics, Unit vectors in spherical and cylindrical polar coordinates, Conservative vector fields and their potential functions - gravitational and electrostatic examples, Gradient of a scalar field, Equipotentials, States of equilibrium, Work and Energy, Conservation of energy, Motion in a central field and conservation of angular momentum.
2. Angular momentum of a system of particles, Torque, Moment of inertia, Parallel and Perpendicular axes theorem, Calculation of moment of inertia for (i) thin rod, (ii) disc, (iii) cylinder and (iv) sphere. Rotational dynamics of rigid body (simple cases).
3. Motion of fluids, Bernoulli's equation and its applications, motion of viscous fluids - Poiseuille's equation.
4. Simple harmonic motion, Composition of simple harmonic motion, Forced vibration and resonance, Wave equation in one dimension and travelling wave solution, Standing waves, Wave velocity and group velocity.
5. Assumption for the kinetic theory of gases, Expression for pressure, Significance of temperature, Deduction of gas laws, Qualitative idea of (i) Maxwell's velocity distribution. (ii) degrees of freedom and equipartition of energy, Specific heat of gases at constant volume and constant pressure.
6. Equation of state of a gas, Andrew's experiment, Qualitative discussion on van der Waal's equation of state, Critical constants, Law of corresponding states.
7. Macroscopic and microscopic description, Thermal equilibrium, Zeroth law of thermodynamics, Concept of international practical temperature scale, Heat and Work, First law of thermodynamics and some applications, Reversible and irreversible processes, Carnot cycle, Second law of thermodynamics, Concept of entropy, Thermodynamic relations.

### **Ph/S/1      PHYSICS LABORATORY-I**

(Selected Experiments from the following)

1. Determination of Galvanometer resistance by half - deflection method.
2. Determination of Galvanometer resistance by Thomson's method.
3. To find high resistance by Galvanometer deflection method.
4. To measure mechanical equivalent of heat, J by electrical method (Joule's) using copper calorimeter (radiation correction to be done).
5. To compare to low resistance by drop of potential method.
6. To determine resistance per unit length of wire by using Carey Foster bridge.
7. To estimate strength of a current by using copper voltmeter.
8. a) To compare the EMF's of two cells by using a potentiometer  
b) To measure current by using a potentiometer
9. To measure the horizontal components of earth's magnetic field intensity using deflection and vibrating magnetometers.

10. Determination of coefficient of linear expansion by optical lever method.
11. Determination thermal conductivity of metal by Searle's method.
12. To determine coefficient of viscosity by Capillary flow method.
13. Determination of Young's modulus by Flexure method.
14. To draw mutual and anode characteristics of triode and hence to find  $R_p$ ,  $\mu$ , and  $g_m$
15. To draw the transistor characteristics (NPN/PNP) in the given configuration and hence to find  $h_i$ ,  $h_f$
16. Determination of refractive index of the material of the glass prism by prism spectrometer (for at least two  $\lambda$ 's)
17. Study of collisions in one dimension using a linear air track
18. Use of an air track for obtaining potential energy curves for magnetic interactions.
19. Study of oscillations under potential wells of various shapes using an air track.
20. Experiments on diffraction in single slit, double slit and plane grating using He-Ne laser
  - a) To find the wavelength of a monochromatic light by single slit.
  - b) To find slit separation of a double slit.
  - c) To find number of rulings per cm of a plane grating
21. To find the wavelength of a monochromatic light by Newton rings.
22. Fabry-Perot interferometry: To find out separation of wavelength of sodium D1 & D2 lines.

**PE/Chem/S/112                      CHEMISTRY LABORATORY**

To supplement the theoretical course on "Chemical Science".

**PE/S/113                      ENGINEERING DRAWING-I**

Introduction to Drawing instruments & aids. Types of lines. Engineering lettering. Geometric drawing & curves. Scales & dimensioning, I.S. Conventions. Orthographic projections, Isometric drawing & Sectional views.

**PE/S/114                      WORKSHOP PRACTICE-I (Fitting & Carpentry)**

Fitting: Introduction to Fitter's tools, gauge & instruments. Different types of fitting work involving various fitting operations such as sawing, marking, chipping, filing, drilling, tapping etc. Carpentry: Types of wood & identification of wood for engineering purpose. Introduction to Carpenter's tools. Use of wood-working machines. Different types of joint-making, simple pattern-making.

**First Year 2nd Semester**

**Hum/T/B                      HUMANITIES-B**

English - 2 Pds/week - 50 Marks  
Sociology - 2 Pds/week - 50 Marks

## HUMANITIES

1. Basic writing skills
2. Report, Covering Letter & Curriculum-Vitae writing
3. Reading and Comprehension
4. Selected Short Stories

Text Book: ENGLISH FOR ALL

## SOCIOLOGY

1. Sociology: Nature and scope of Sociology - Sociology and other Social Sciences - Sociological Perspectives and explanation of Social issues
2. Society and Technology: Impact of Technology on the Society - A case study
3. Social Stratification: Systems of Social Stratification - determinants of Social Stratification - Functionalist, Conflict and Elitist perspectives on Social Stratification
4. Work: Meaning and experience of work: Postindustrial society- Post-Fordism and the Flexible Firm
5. Development - Conceptions of and approaches to development - The Roles of State and the Market in the Development
6. Globalization: The concept of globalization - globalization and the nation state - Development and globalization in post colonial times.
7. Industrial Policy and Technological change in India - The nature and Role of the State in India
8. Technology Transfer: The Concept and Types of Technology Transfer-Dynamics of Technology Transfer
9. Technology Assessment: The Concept - Steps involved in Technology Assessment
10. Environment: Sociological Perspectives on Environment - Environmental Tradition and values in ancient India
11. The Development of Management: Scientific Management - Organic Organization - Net Work organization - Post modern Organization - Debureaucratization - Transformation of Management
12. Technological Problems and the Modern Society: Selected Case Studies - Electric Power Crisis, Industrial and/or Environmental Disaster, or Nuclear Accident.

## **PE/Math/T/122      MATHEMATICS-IIIQ**

Ordinary Differential equations: Linear differential equations of 1st order, second order and higher order linear differential equations. Series solution of Bessel and Legendre Equations. Recurrence relations. Orthogonal property of Legendre polynomial. Geometry of Three Dimensions: Cartesian coordinates in three dimension. Direction cosines. Equations of planes and straight lines. Shortest distance between two skew lines. Standard equations of sphere, cylinders and cones. Applications of Calculus: Tangent, normal and asymptotes.

## **PE/T/123      ENGINEERING MECHANICS-II**

Curvilinear motion, projectile, relative motion, Newton's laws of motions, inertia force, central force motion, momentum and impulse, work, power & energy, impact, undamped free vibration of spring-mass system with single degree of freedom.

## **PE/CSE/T/124      NUMERICAL METHODS & COMPUTER PROGRAMMING**

Part A (Numerical Methods) : Iterative methods, Method of false position, Solution of non-linear equations by Newton-Raphson method, Finding roots of algebraic equations, Solution of simultaneous algebraic equations - Gaussian elimination, Gauss-Siedel method, Matrix inversion.

Interpolation - Newton's forward and backward difference formulae, Lagrange's method for unequal intervals. Least square methods of curve-fitting -trend line, Numerical differentiation and integration. Solution of ordinary differential equations - Picard's method of successive approximation, Euler's method, modified Euler's method, Runge-Kutta method - 2nd & 4th order.

Part-B (Computer Programming): Computer organization and working with special interest in Personal Computer. The structure and nature of algorithms. FORTRAN programming, problems of engineering interest, C programming with special emphasis on the use of data structures.

## **PE/T/125      ENGINEERING DRAWING-II**

Advanced problems on projection drawing, sectional views & auxiliary views, screw threaded forms, bolts and nuts, studs & their uses, keys splines, etc. riveted and welded joints, pulleys, rigid coupling & joints for rods, pipes, etc. various types of lines & their projections, concepts of true length, intersection & development of common surfaces.

## **PE/T/126      PHYSICS- IIA**

1. Electric potential and intensity, Flux of electric field, Gauss's law and its application to problems with spherical and cylindrical symmetry, Capacitance- parallel plate and spherical condensers, Energy of a capacitor, Energy density of an electric field, Potential and field due to a dipole, Dielectric polarisation, Electric displacement vector, dielectric susceptibility.

2. Biot-Savart law and Ampere's law in magnetostatics, Calculation of magnetic field in simple situations like (i) straight wire (ii) circular wire (at a point on the symmetry axis) and (iii) Solenoid.

3. Time-varying fields, Faraday's law of electromagnetic induction, Self and mutual inductance, Resonance and oscillation in electrical circuits.

4. Nature of light waves, Interference of light waves, Young's experiment, Spatial and temporal coherence, Fresnel bi-prism, Interference in thin film, Newton's rings, Measurement of film thickness and wavelength, Diffraction of light waves, Huygen's construction, Fresnel and Fraunhofer diffraction, Fraunhofer diffraction due to single slit and plane diffraction grating, Approximate rectilinear propagation of light, Zone

plate, Polarisation of light waves, Polarisation by reflection, Brewster's law, Double refraction- ordinary extraordinary rays, Polaroid, Optical activity.

5. Energy levels of the hydrogen atom and the Bohr atom model, X-ray spectra, X-ray diffraction, Bragg's law, Compton effect. De-Broglie waves, Particle diffraction, Uncertainty principle and its application.

### **Ph/S/2      PHYSICS LABORATORY-II**

(Selected Experiments from the following)

1. Determination of Galvanometer resistance by half - deflection method.
2. Determination of Galvanometer resistance by Thomson's method.
3. To find high resistance by Galvanometer deflection method.
4. To measure mechanical equivalent of heat, J by electrical method (Joule's) using copper calorimeter (radiation correction to be done).
5. To compare to low resistance by drop of potential method.
6. To determine resistance per unit length of wire by using Carey Foster bridge.
7. To estimate strength of a current by using copper voltmeter.
8. a) To compare the EMF's of two cells by using a potentiometer  
b) To measure current by using a potentiometer
9. To measure the horizontal components of earth's magnetic field intensity using deflection and vibrating magnetometers.
10. Determination of coefficient of linear expansion by optical lever method.
11. Determination thermal conductivity of metal by Searle's method.
12. To determine coefficient of viscosity by Capillary flow method.
13. Determination of Young's modulus by Flexure method.
14. To draw mutual and anode characteristics of triode and hence to find  $R_p$ ,  $\mu$ , and  $g_m$
15. To draw the transistor characteristics (NPN/PNP) in the given configuration and hence to find  $h_i$ ,  $h_f$
16. Determination of refractive index of the material of the glass prism by prism spectrometer (for at least two  $\lambda$ 's)
17. Study of collisions in one dimension using a linear air track
18. Use of an air track for obtaining potential energy curves for magnetic interactions.
19. Study of oscillations under potential wells of various shapes using an air track.
20. Experiments on diffraction in single slit, double slit and plane grating using He- Ne laser  
a) To find the wavelength of a monochromatic light by single slit.  
b) To find slit separation of a double slit.  
c) To find number of rulings per cm of a plane grating
21. To find the wavelength of a monochromatic light by Newton rings.
22. Fabry-Perot interferometry: To find out separation of wavelength of sodium D1 & D2 lines.

### **PE/S/122      PC LABORATORY- I**

Familiarization with personal computer and its peripherals like mouse etc. Practices on operating systems: DOS, UNIX etc., Practices on WINDOWS familiarization with Email

Internet etc., Writing and editing programs of engineering importance in FORTRAN and C.

### **PE/S/123      ENGINEERING DRAWING-II**

Advanced problems on projection drawing, sectional views & auxiliary views, screw threaded forms, bolts and nuts, studs & their uses, keys splines, etc. riveted and welded joints, pulleys, rigid coupling & joints for rods, pipes, etc. various types of lines & their projections, concepts of true length, intersection & development of common surfaces. Introduction to AUTO-CAD and its use in engineering drawing.

### **PE/S/124      WORKSHOP PRACTICE-II**

Introduction to different welding techniques and related shop works, e.g. gas welding, arc welding, TIG welding, MIG welding, Brazing etc.  
Complicated fitting works.

## **Second Year 1st Semester**

### **PE/T/211      ENGINEERING THERMODYNAMICS-I**

Concept of Thermodynamic system, surrounding, state, property, process and cycle. Path function and point function. Zeroth law of thermodynamics, quasistatic process, heat and work; first law of thermodynamics for closed and open systems, perfect gas laws, Vapour formation at const. Pressure, properties of vapour, vapour charts analysis of different non-flow processes with perfect gases & vapours, Limitations of the 1st law - perpetual motion machine of the first kind, power producing devices, power absorbing devices, PMM II, 2nd law of thermodynamics, corollaries of the 2nd law, Clausius inequality, entropy and disorder, Reversibility and Irreversibility, Thermodynamic property relations, Maxwell Relations, Clausius Clapeyron Equation, Joule Thomson Coefficient etc.  
Compression of air and gas, reciprocating compressor, volumetric efficiency, free air delivered, compression and compressor efficiency. Multistaging of reciprocating compressor.

### **PE/T/212      PRINCIPLE OF ELECTRICAL ENGINEERING**

Units and dimensions of electrical and magnetic quantities, conversion between various system of units, analysis of DC electric circuits, Kirchoff's laws, fundamental relations of electrostatic field - Coulomb's law, Gauss's law, electric flux, flux density and field density and field intensity, line charge, potential function, stored energy in electric field - capacitance calculation for simple geometries, elctro-magnetism, Ampere's law, magnetic flux, flux density and field intensity, magnetic force, Faraday's law, inductance calculation for simple geometries.  
AC fundamentals - sinusoidal waves and their phasor representation, concept of impedance and admittance, analysis of R-L-C series and parallel circuits - resonance.

Concept of polyphase circuits - relation between 3-phase voltage, current and power in different passive circuits, analysis of balanced 3-phase circuits, single line diagram, relation between voltage, current and power unbalanced 3-phase circuits.

### **PE/T/213      FLUID MECHANICS**

Properties of fluid, classification of fluid, Ideal fluid, Newtonian and Non-Newtonian fluid, Inviscid fluid, Newton's law of viscosity. Fluid statics, Fluid pressure and its variation within fluid at rest. Measurement of fluid pressure (manometers, micro-manometers etc.). Fluid Kinematics, rate of flow, average velocity, steady and unsteady flow, stream line, stream tube, path line, one & 3 dimensional continuity equation of motion, integration of the equation of motion, Bernoulli's equation, total head, application of Bernoulli's equation, dynamic pressure, conservation of linear momentum and its application; study of viscous flow, laminar and turbulent flow through circular and noncircular conduits, Darcy-Weisbach eqn., pipeline problems including frictional losses. Flow in open channel, Chezy's equation; Compressible fluid velocity of sound, Mach Number, Compressible factor, Stagnation enthalpy temperature, pressure and density.

### **PE/T/214      STRENGTH OF MATERIALS**

Concept of stress, strain, stress-strain diagrams, tension, compression and shear, statically indeterminate problems, thermal stresses, thin-walled pressure vessels, torsion in circular shafts, spring, shear force and bending moment diagram, shear and bending stresses in beams, General case of stress; Mohr's circle, Buckling of columns, strain energy in tension, compression, bending and torsion, Castiglione's theorem, Thick cylinder.

### **PE/T/215      CIRCUIT THEORY**

Elementary electrical network - basic definition -formulation of network equations, basic network theorems, maximum power transfer, Thevenin's -Norton's, reciprocity, superposition and Tellegen's theorem, elementary network topology - graph of networks, concepts of tieset, cutset and incidence matrix, loop and node variable analysis, formulation of equilibrium equation on the loop and node basis, source transformation, two-port networks, y-parameters and z-parameters and their equivalent circuits, h-parameters and ABCD parameters, cascade and parallel connection of 2-port networks, relationship between 2-port parameters, frequency response of networks, Bode plot, Fourier and Laplace transforms application for transient analysis, the time series representation of signals, time domain analysis of transient using the initial and final value theorem superposition theorem.

### **PE/IEE/T/216      ELECTRONICS**

Semiconductor Devices: Intrinsic/Extrinsic semiconductors, Drift/Diffusion currents, pn junction diode - characteristics, diode equation, forward bias, reverse bias. Diode circuits - DC analysis. Graphical, piecewise linear model, AC analysis - small-signal equivalent circuit. Rectifiers - Half wave, full wave, bridge rectifiers - filters, ripple voltage. Zener

diode - zener mechanism, characteristics, zener as voltage regulator - line regulation, load regulation.

Transistor: BJT -structures, current flow mechanism, basic transistor equation, npn and pnp transistors, forward active mode current-voltage characteristics - modes of operation (CE, CB, CC) - DC analysis of Transistors circuits ( CE circuit ), load line. Transistor biasing, stability of Q-point, Two power supply biasing, current mirror biasing for integrated circuits.

Small signal (voltage / current amplifier): AC analysis of transformer circuits - small signal hybrid p model, h-parameter model of BJT; AC load line, classification of amplifiers; CE amplifier circuit (with emitter resistor, with emitter resistor-bypass capacitor; Emitter follower amplifier. Multistage amplifier - cascade amplifier.

FET - structure, JFET, MOSFET, biasing techniques, common source amplifier. Source follower amplifier. Frequency response.

Large signal amplifiers. - Power amplifiers.: Class A, Class B, Class AB - load RC-coupled, transformer coupled - calculation of supply power, load power, efficiency.

Operational amplifiers: Ideal parameters, input-output characteristics, input stage differential amplifier; Inverting, non-inverting amplifiers. Applications - voltage followers, current-to-voltage and voltage-to-current converters, summing amplifiers, difference amplifier, Instrumentation amplifier., integrator / differentiator.

Feed back in amplifiers: Advantages / disadvantages of negative feedback, feed back topologies ( series-shunt-voltage amplifier, shunt-series-current amplifier, series-series-transconductance amplifier, shunt-shunt transresistance amplifier) using op-amplifier configurations.

Digital circuits: Number systems, binary, octal, hexadecimal system, binary - decimal, decimal - binary conversions. BCD code. Logic gates: AND, OR, NAND, NOR. Boolean theorems, DeMorgan's theorem, universal gates. Sum of products form. Algebraic simplification. Designing combinational logic circuits., Flip-flops - RS , D, JK.

Multivibrators - Bistable, Monostable, Astable. IC 555 used as astable multivibrator.

Counters and registers - basic design and operation using integrated circuits. Adder and subtractor.

### **PE/S/211          PEM LABORATORY-I (Applied Mechanics)**

Experiments on mechanics and strength of materials, momentum of inertia of flywheel, tension, torsion, bending tests, Hardness and impact test, Static and dynamic balancing test, governing apparatus, natural frequency of vibration of a beam, critical speed of a rotor.

### **PE/S/212          PEE LABORATORY-I (Basic Electrical Engineering)**

- 1) Verification of Thevenin's and Superposition theorem.
- 2) Verification of Norton's and Maximum power transfer theorem
- 3) R-L-C series and parallel circuits and resonance effects.
- 4) Studies on balanced 3-phase circuits
- 5) Studies on unbalanced 3-phase circuits- Phase sequence meters.
- 6) Characteristics of fluorescence lamps- measurements of power and power factors.

- 7) Measurements of armature and field resistance of D.C. machines
- 8) Magnetic circuit principles.
- 9) Calibration of ammeters and voltmeters
- 10) Study of half wave and full wave rectifiers.

**PE/IEE/S/213                      ELECTRONICS LABORATORY**

1. Familiarization with Electronic Components like R, L, C and active devices.
2. Familiarization with Electronic Workshop Tools and their use. Soldering Practice.
3. Study of the Characteristic of PN-Junction Diode, Clipper, Clamper, Rectifier circuits and Zener regulators.
4. Characteristics of BJT (CE mode).
5. Study of a CE Amplifier.
6. Studies on the applications of operation amplifier - voltage follower, summer, integrator, differentiator, astable multivibrator.
7. Timer-555 : Monostable and astable multivibrator using 555.

**PE/S/214                      WORKSHOP PRACTICE-III (Machining)**

Introduction to machining operations and machines, Shop work involving various operations with lathe, e.g. turning, facing, drilling, boring, thread cutting, taper turning etc. Shaping, Milling, Grinding. Introduction to advanced machining processes.

**Second Year 2nd Semester**

**PE/T/221                      ENGINEERING THERMODYNAMICS-II**

Energy or availability analysis of processes & cycles, 2nd law efficiency.  
 Vapour cycles - Performance parameters of cycles, Heat rate, Work ratio, Carnot vapour cycle, Rankine cycle, Reheat cycle, Ideal & Actual regenerative cycles, optimum degree of regeneration, Supercritical pressure cycle; Binary vapour cycle; Combined cycles.  
 Air standard cycles, Otto cycle, Diesel cycle, Dual combustion cycle, Brayton cycle.  
 Reversed Carnot cycle, Bell Coleman cycle, Vapour compression and absorption refrigeration cycle.  
 Mixture of gases, Psychrometry.

**PE/T/222                      HEAT TRANSFER**

Basic concepts of Heat Transfer, General heat conduction equation, Steady state one-dimensional conduction, Conduction through plane walls, cylinder, sphere and composite walls, Concept of film coefficients and thermal resistance, Network problems, Critical thickness of insulation, Extended surfaces, 2-D conduction, Transient conduction in 1-D.  
 Convection: Thermal boundary layer equation and its integral solution, Heat transfer in fully developed flows through pipes, Heat transfer over flat plates. Relation between fluid friction and heat transfer, forced convection correlation, Free convection, laminar free convection on vertical flat plates, empirical correlation. Boiling and condensation heat

transfer. Heat exchangers: LMTD and NTU methods of computation of heat transfer in heat exchangers.

Radiation: Basic laws e.g. Planck's law, Stefan-Boltzmann law etc., intensity of radiation, view factor, radiation exchange between surfaces and enclosures, luminous and non-luminous radiation, Application of heat transfer in power plants, Mixed mode of heat transfer, Heat transfer over rows of tube etc.

### **PE/T/223      ELECTRICAL MACHINES-I**

Transformers - 1-ph Transformers, Construction and Types, Types of Cooling, Principle of Operation, e.m.f. Equations, Phasor diagrams, Equivalent Circuits, P.U. system, Open circuit and Short circuit tests, Voltage regulation, Losses, Efficiency, All-day efficiency, Auto Transformers, Parallel Operation of 1-ph Transformers.

DC Machines - Construction, Principle of Operation, Methods of excitation and classifications, Torque, e.m.f. and speed equations, Armature reaction, Commutation, Interpoles, Back e.m.f. in DC machines, Motor Starter, Speed Control, Torque speed characteristics, Losses, Efficiency, Testing, Swinburn Test, Hopkinson Test.

Poly-phase Induction Motors -, Construction, Principles of working, Slip, Equivalent circuit, Performance equations, No load and blocked tests, determination of equivalent circuit parameters, Torque speed characteristics, Circle diagram, Speed control, Starting methods, applications.

1-ph Induction Motors - Construction, Principle of operation, Starting and classification, Revolving field theory, Equivalent circuit, determination of equivalent circuit parameters, Applications.

### **PE/T/224      MATERIALS AND PROCESSES**

Structure and properties of materials, defects in materials and plastic deformation, stress-strain curves and theories and failure, phase transformations and phase diagrams, Iron-carbon system, Heat treatment of steel, Electronic materials.

Casting: Pattern, different types of casting and cast products, gating system and riser design. Welding: Different types of arc welding, gas welding, Metal forming: Hot and cold working, forging, rolling, extrusion, drawing and press working. Machinery: Introduction to turning, milling, drilling, boring, shaping, tool geometry and tool angles, tool life and cutting force calculations, Introduction to some non-conventional machinery processes and their applications.

### **PE/T/225      THEORY OF MACHINES AND MACHINE DESIGN**

Planar mechanisms, four bar linkage, quick-return mechanism, velocity and acceleration analysis, kinematics of gears and gear trains, vibrations, balancing of rotating and reciprocating masses, gyroscopic motion, fly wheels, cam and cam follower design, inertia force analysis of reciprocating systems, design for variable and dynamic load,

design of shaft, screws; bolted, riveted and welded joints, pulley, clutch and brake design, spur gear design, design of bearings.

### **PE/IEE/T/226          POWER ELECTRONICS**

Power Semiconductor Devices: Power diodes: characteristics, types, series /parallel connected diodes.

Power Transistors: BJT, MOSFET; characteristics & Base / Gate Drives, series Parallel operation, di/dt, dv/dt limitation.

Thyristors: Types, characteristics, Two- transistor model turn - on, turn- off, di/dt, dv/dt protection series / parallel operation. Triggering circuit. Triac, Diac.

Diode rectifiers: (uncontrolled rectifiers): Single-phase, 3-phase bridge rectifiers, analysis & performance evaluation.

SCR rectifiers: (controlled rectifiers): single-phase, 3-phase half wave, full wave bridge circuits, Dual converters - analysis & performance evaluation. Freewheeling diodes, inductive load & transformer ratings. Power factor improvement.

DC line commutation: series & parallel capacitors, impulse commutation.

AC voltage controllers: Principles (on-off, phase control), single-phase, 3-phase controllers, operation & analysis.

Cycloconverters: single-phase, 3-phase, Blocked group operation, circulating current mode - operation & analysis.

DC choppers: step down, step up operation classification, switching mode

Regulators, transistor chopper circuits - operation & analysis.

Inverters: single phase, 3 phase - operation, performance parameters, voltage

Control of single phase, 3 phase inverters, forced commutated inverters, current source inverters, - (PWM - inverters); Resonant pulse inverter.

Applications: DC drives, variable voltage-variable frequency AC drives.

### **PE/S/221          PEM LABORATORY-II (Fluid Mechanics)**

Fluid mechanics: Study of different methods for measurement of pressure, velocity and discharge including calibration of selected measuring instruments; study of flow visualization technique, Study of characteristics of laminar & turbulent flow; Verification of Stroke law; Determination of losses through pipes and fittings, Venturimeter, Orificemeter, submerged axy. symmetry jet.

### **PE/S/222          PEE LABORATORY-II (Electrical Machine Lab. I)**

- 1) Studies of Electrical Machines,
- 2) Saturation characteristics of a D.C. machine.
- 3) External characteristics of a D.C. machine (Shunt and Compound)
- 4) Study of a D.C. Motor starter and speed control
- 5) Parallel operation of D.C. Generators and load sharing.
- 6) Coil connection and polarity test of a single phase transformer
- 7) Parallel operation of two single phase transformer
- 8) Open circuit and short circuit test of a transformer

9) Three phase transformer connection - Star, Delta and Zigzag- Effect of unbalanced load.

**PE/IEE/S/223          DIGITAL CIRCUITS LABORATORY**

1. Study of basic Logic gates.
2. Study of a 2-to-4 line decoder.
3. Realization of a 2:1 digital multiplexer
4. Study of different Flip Flops.
5. Study of a 4-bit binary up-counter.
6. Study of a 4-bit ring-counter.
7. Realization of a 1-digit decimal counter.

**PE/S/224          PC LABORATORY-II**

Review of C programming, C++ concepts of object oriented programming, class, objects, etc., C++ builder, programming with matlab and simulink, working with linux, share programming, introduction to assemblers.

**Third Year 1st Semester**

**PE/T/311          COMBUSTION AND POLLUTION**

Combustion Stoichiometry, Thermochemistry, Adiabatic Flame temp. , Chemical Equilibrium, Fundamentals of Mass Transfer and chemical kinetics, Coupling of chemical and Thermal Analysis for reacting systems.

Types of fuel, Properties and uses of different fuels.

Flames, Premixed and Non-premixed flames, Laminar and turbulent flames, Flame Quenching, Flammability, Flame Stability, Ignition, Explosion limits, Physical description of Jet flames.

Liquid fuel combustion, Droplet evaporation and burning, Spray formation, Fuel injectors.

Solid fuel combustion, Coal devolatilization & combustion.

Pollutant Emission, effects of pollutants, Quantification of emission, Formation of pollutants, emission from premixed and non-premixed combustion, Pollution control measures, green house gases and global warming.

Emissions from Power Plants and Automobiles.

**PE/T/312          I.C. ENGINE & GAS TURBINE**

Working principles of I.C. Engines, classification, two stroke & four stroke engines, different parts of I.C. engine their function, cycle analysis, air standard cycle, fuel air cycle, actual cycle Carburetion in S.I. Engine, Fuel injection in S.I. Engines.

Ignition systems in S.I. Engine, battery ignition, Magneto ignition and electronic ignition systems

Fuel injection in C.I. Engines.

Combustion in S.I. and C.I. Engines, Detonation and knock.  
Performance and testing of I.C. Engines  
Supercharging, turbo charging & Scavenging in I.C. Engines  
Lubrication and Cooling system in I.C. Engines.  
Gas turbine classification, and Analysis of open and closed, Regeneration, Intercooling, reheating, Plant accessories and auxiliaries.

### **PE/T/313      FLUID MACHINERY**

Impact of jet Euler's head equation, Positive displacement fluid machines, reciprocating pumps; constructional features, types and performance characteristics, centrifugal pump, fan, compressor: construction feature and types, multistaging performance characteristics, system curves, priming, cavitation, etc. Axial flow pump, fan and compressor: constructional features, types and performance, sp. speed, NPSH, Unit quantities,  
Hydro turbine: classification, Pelton wheel, Francis and Kaplan turbine, Deriaz and bulb turbine, Design, constructional features and performance of each type, cavitation and surging in hydroturbine, loss, efficiency. Fluid coupling, torque converter - elementary description and performance.

### **PE/T/314      ELECTRICAL MEASUREMENT AND INSTRUMENTATION**

Classification of electrical measuring instruments, General features of indicating instruments- controlling, damping and balancing of moving systems; Static and dynamic characteristics. Construction and principle of moving coil, moving iron, rectifier, electrostatic and induction type instruments for measuring voltage, current, power, energy, frequency and power factor. Extension of instrument range, shunt multiplier, C.T. and P.T. galvanometers- D' Arsonval, ballistic and vibration type. Measurement of low, medium and high resistances: measurement of inductance and capacitance by A.C. bridges: Potentiometers (A.C. and D.C.). Magnetic measurements, CRO, VTVM and digital instruments. Instruments for measuring pressure, temperature, flow, vibration, strain and pH values, etc.

### **PE/T/315      ELECTRICAL MACHINES - II**

Transformers - 3-ph Transformers, Construction, Connection and phasor groups, Harmonics and suppression of harmonics, Parameter estimation, Voltage regulation, Open delta and Scott connection, 3-ph and multiphase conversions, Testing of transformers, Parallel operation of 3-ph Transformers.

Synchronous Machines - Construction, Principle of working, Excitation, Phasor diagrams, Synchronous reactance, Voltage Regulation, determination of regulation by different methods, Two reaction theory, Phasor diagram of salient Pole Machines, Power angle characteristics, Transient Analysis, Sudden Short Circuit, Loading & Load rejection, Parameter Estimation, Transient reactances, Synchronizing, Synchronizing power and torque, Parallel Operation, V-curves, Starting of Synchronous Motors,

Hunting, Damper winding, Applications.

### **PE/T/316 INTRODUCTION TO AUTOMATIC CONTROL**

Introduction to feed back control - concept of a system, excitation and response of a system. Block diagram and signal flow graph, transfer functions, continuous and discrete data system. Time domain analysis of 1st and 2nd order systems. Proportional integral and derivative control, error constants. Stability analysis: frequency domain techniques - Bode plot, Routh and Nyquist criterion, gain phase plot, stability margin. Root locus techniques - lag, lead and lag-lead compensation, introduction to state variable analysis. Control system components - sensor of positions, speed, flow, etc. Actuators - hydraulic and servo motors, stepper motor.

### **PE/S/311 PEE LABORATORY-III (Electrical Measurements)**

- 1) Calibration of energy meters.
- 2) Kelvin's double bridge for measurement of low resistance.
- 3) Measurement of resistance, inductance and capacitance by LCRQ bridge.
- 4) Measurement of voltage and resistance by D.C. potentiometer.
- 5) Measurement of medium resistance by Wheatstone bridge.
- 6) Three voltmeter and three ammeter method of measuring single phase power.
- 7) Analysis of wave-forms by CRO.

### **PE/S/312 PEM LABORATORY-III (Steam & Combustion Lab)**

- 1) Determination of dryness fraction of steam by various methods,
- 2) study of steam properties.
- 3) Determination of maximum rate of discharge and critical pressure ratio of a nozzle.
- 4) Determination of nozzle efficiency.
- 5) Proximate and ultimate analysis of coal,
- 6) Determination of hardgrove index,
- 7) Determination of calorific value of fuel,
- 8) Determination of flash point of liquid fuel,
- 9) Studies of pre-mixed and non-premixed flames,
- 10) Measurement of burning velocity in pre-mixed flame,
- 11) Determination of burner stability curve,
- 12) Measurement of flame temperature, etc.

### **PE/S/313 MICROPROCESSOR LABORATORY**

Study of 8085

Study of 8086.

Assembly Language Programming using SDK-86/85 Trainers

Introduction to Assembler

Study of Microprocessor Interfaces

## **PE/S/314**      **PEM LABORATORY-IV (Heat Transfer Lab)**

- 1) Study of heat transfer in a lagged pipe and determination of thermal conductivity.
- 2) Study of conductivity of solid and liquid
- 3) Determination of emissivity of a plate
- 4) Study of heat transfer from a pin fin and determination of fin effectiveness and efficiency.
- 5) Determination of forced convection heat transfer coefficient in a pipe
- 6) Study of heat transfer in a counterflow and parallel flow heat exchanger and determination of heat exchanger effectiveness.
- 7) Study of heat transfer in a cooling tower
- 8) Study of boiling heat transfer

### **Third Year 2nd Semester**

#### **PE/T/321**      **STEAM GENERATOR**

Classification and application of boilers, fire and water tube boiler, Utility steam generator fundamentals; types of coal firing- stoker, PF, cyclone and fluidized bed firing; Boiler furnace, furnace design, types and arrangement of coal and oil burners, flame scanners and ignitors; Boiler draft and air flow control.

Boiling heat transfer, nucleate and film boiling, DNB; Circulation principles, Features of forced circulation and critical pressure boilers, once through and super-critical pressure boilers, Boiler mountings and accessories, Steam drum & drum internals, Steam water separation; Waterwall, superheater, reheater, economizer, heat transfer and fluid flow through different elements, disposition and calculations of heating surfaces, air preheaters, boiler casing and insulations, Superheater steam temperature adjustment and control, Boiler losses, Performance and heat balance.

Fluidized Bed Boilers: Types, merits and demerits.

#### **PE/T/322**      **STEAM TURBINE AND CONDENSER**

Principle of action of steam turbine; clarification, relative advantages of steam turbine as prime mover, different components of steam turbine & their functions,

Ideal and Actual flow of compressible fluid through nozzle, nozzle shape, critical pressure ratio, maximum rate of discharge, under expansion and over expansion in nozzle. Nozzle efficiency & velocity coefficient of nozzles. Supersaturated flow through nozzle,

Flow of steam through simple impulse turbine blading, velocity diagram, blade efficiency, Gross stage efficiency, net stage efficiency, optimum velocity ratio. Degree of admission.

Multistaging or Compounding of impulse turbine, velocity compounding, pressure compounding, velocity and pressure compounding, reheat factor, Internal efficiency, state point locus etc.

Flow of steam through Reaction turbine, velocity diagram, Degree of reaction, blade height, stage efficiency, optimum velocity ratio, axial thrust in reaction turbine.

Comparisons of impulse & reaction turbine, Losses in turbines, Partial admission loss, gland leakage loss, Erosion of turbine blade, Principle of turbine governing; Industrial turbine,

Condensers, classifications, elements of condensing plant, cooling water circulation systems, sources of air leakage in condenser its effects Air leakage tests, cooling water leakage tests, condenser performance, vacuum efficiency, condenser efficiency etc.

### **PE/T/323            NON CONVENTIONAL POWER GENERATION-I**

Difference between conventional and non-conventional Power Generation. Need for non-conventional Power Generation. Solar Power Generation - Solar Energy, Extraterrestrial and Terrestrial Solar Radiation, Solar-Thermal conversion, collectors, Heliostat, Heat transport system. Solar ponds, Hybrid plants.

Direct Energy Conversion system - M.H.D, Fuel cells, photovoltaic cells, Solar cells etc.

### **PE/T/324            HYDEL POWER GENERATION**

Introduction Potential of hydro-power in India- its development and future prospect. General hydrology- hydrological cycle, precipitation, run-off and its measurement, hydrography, unit hydrograph, flow duration and mass curve. Site investigations. Classification of hydroelectric power plants. Pondage and storage. Operating principles of different types of hydel plants like run-off-the-river type. Storage reservoir plant-pumped storage plant. Design, construction and operation of different components: Dams, spillways, Canals, penstocks, surge tanks, draft tubes etc.; Power-house structure. Selection of prime mover, speed and pressure regulation, methods of governing, starting and stopping of water turbines, operation of hydroturbines. Machine loading and frequency control, Maintenance of hydropower plants.

### **PE/T/325            POWER TRANSFER SYSTEMS**

Electrical power transfer, its necessity and superiority. Basic network structure for electrical power transfer, Overhead lines, Underground cables- Mechanical and Electrical aspects, selection of economic voltage, suitable conductors and insulators, high voltage transmission, HVDC vs. HVAC systems, Superconductor transmission, Transmission line parameters, skin and proximity effects, bundle conductors, transposition, P.U. system, Representation of short, medium and long lines for performance analysis, Power transfer equations, regulation and efficiency, line voltage regulators, reactive power compensation, Interconnected power systems, Power system control and stabilization, Voltage transience and line surges, Stability considerations, Equal area criteria, primary and secondary distribution systems, feeders and distributors, Radial and mesh systems, loading and its effect on voltage profile, Tariff systems, Power factor improvement and its importance, distribution, automation.

### **PE/T/326            ELECTRICAL MACHINE AND POWER CONTROL**

Concept of Electrical Drives -4-quadrant operation, Braking Schemes for Dc Motors

speed control - 1-ph Converter Drives, Semi-converter drives, 3-phase Converter Drives, Chopper-fed Drives. DC closed loop control.

Schemes for Induction Motors speed control - Rotor resistance control, Chopper controlled wound rotor Induction Motors, Slip power recovery Scheme, Variable frequency control, Control of Induction Motors by PWM Inverter, Constant v/f operation, Control of Induction Motors by Cycloconverter. AC closed loop control.

Excitation Control of Synchronous M/Cs, Load Frequency Control, Control of Voltage and Reactive Power, Stability analysis of Power Systems, Load Flow Studies, Economic Load dispatch - Unit Commitment, Load Scheduling.

### **PE/S/321      PEE LABORATORY-IV (Electrical Machines II)**

- 1) Starting of Synchronous motors and determination of V-curves
- 2) Parameter estimation of a 3 phase alternators
- 3) High Voltage test of transformers and Electrical Machines
- 4) Study of Micro-processor based Excitation Control
- 5) Back to back test of single phase transformer
- 6) Parameter estimation of three winding transformer
- 7) Open circuit and blocked rotor test of single phase and three phase induction motor.
- 8) Voltage regulations of a three winding transformer
- 9) Circle diagram of an induction motor.
- 10) Starting and loading of three phase induction motor
- 11) Three phase to two phase (Scott) and V connection of transformer.

### **PE/S/322      PEM LABORATORY-V (Fluid Machines Lab)**

Study and performance test of Centrifugal Pump, Blower, Jet Pump etc. Study of cavitation, Study of oil-hydraulic system including the characteristics of fluid power components such as pressure control valve, flow control valve etc. Study of characteristics of fluid control circuit using pneumatic servo-system etc. Performance test of Pelton turbine, Francis turbine, Gear pump, pumps in services & parallel.

### **PE/S/323      CAD LABORATORY**

Introduction to CAD softwares like PS CAD, FLUENT and CFDRC, Design/analysis of problems on the following

- a) load flow analysis and ELD
- b) Study of flow and heat transfer in various geometries
- c) Application of CFD.

### **PE/S/324      PEM LABORATORY-VI (Heat Power)**

Study of IC engines, Performance test on CI engines, performance test on SI engine, performance test on refrigeration unit, performance test on air compressor, study of boiler, performance test on boilers and turbines.

## **Fourth Year 1st Semester**

### **PE/T/411 POWER PLANT SYSTEMS AND MATERIAL HANDLING**

Familiarization with different systems of thermal power plant, fuel and flue gas systems, FD, ID and PA systems, Pulverizers and their types; Boiler Feed Pump, Construction and functioning of deaerator and closed feed water heaters, HP - LP By-pass systems, Turbine gland steam system, Lub. Oil and seal oil systems, Generator Stator water cooling and hydrogen cooling systems, ash disposal system, collection and removal of flyash, ESP, condensate cleaning system, circulating water system, Cooling Tower. Overview, Various types of material handling equipment Hoists, Conveyors, surface and overhead equipment, Belt Conveyers Application, various types, flow characteristics, belt conveyor components, calculations. Coal Handling System in Power Plants, Pneumatic System Overview, various types, conveying characteristics, various components. Hydraulic Transport 2 Phase flow and various flow regime, jet pump, centrifugal slurry pumps. Canes & Hoists Types, Terminologies, classification, operation drives, speed, brake. Ash Handling System in Power Plants.

### **PE/T/412 POWER SYSTEM PROTECTION**

Cause of over voltage and over current power system, arc phenomena in circuit breakers, power system transients, restriking and recovering voltages, technology of small capacity and inductive current interruptions, circuit breakers, material for contacts and medium, different types of circuit breakers, plane break and control break, oil, air vacuum and sulphur hexafluoride circuit breakers, protective relays, basic philosophy, principle of over current, earth fault, directional and differential relaying, desirable quality of relaying and annunciation schemes, protection schemes of generators, transformers, transmission line, bus bars and motors, fault current calculation and selection of CB ratings, lightning arresters, surge absorbers and suppressors, automatic devices for protections, automatic reclosure devices, automatic connections of backup power, automatic frequency load shedding, earthing schemes and earthing codes.

### **PE/T/413 INDUSTRIAL ADMINISTRATION AND MANAGEMENT SCIENCE**

Production management., project management - cpm, pert, application of network strategies, scheduling & line balancing investment & cost benefit analysis, present worth & breakeven analysis  
inventory & material control management - m. r. p, linear & dynamic programming, transportation problems., assignment problems., sequencing, introduction to queuing theory., theory of games, forecasting., correlation & regression., replacement, reliability & maintenance strategies, statistical quality control, work study & work management, total quality management, management information system.  
Behavioral science concepts & objectives of management, managerial control system, organization - authority & responsibility. managerial leadership, communication, delegation, decision making, motivation, transactional analysis, time management.

## **PE/T/414          NON CONVENTIONAL POWER GENERATION-II**

Wind Power Generation, its history, Principles of wind power, Maximum & Actual Power, Wind Turbine operation Small and Large Wind Turbines, recent developments. Ocean Thermal Power Generation.  
Wave Thermal Power Generation.  
Geothermal Power Generation.  
Variability in non-conventional power generation level, Integration and Grid inter connection.  
Energy Storage systems.

## **PE/T/415          TRANSDUCERS AND SENSORS**

Transducer and Sensors- basic principles and requirements.Measurement of Pressure, Flow, Temperature, Level, Conductivity, PH, linear and rotational displacement, strain. Thermocouples, RTDs. Primary flow measuring elements used in power plants. Pressure Transmitters. Drum level measurement using density correction. Valve position sensing. Limit switches.Sensing current, voltage, frequency and magnetic flux density. Hall effect devices. Optical temperature measurements- principles only.Signal conditioning requirements and signal transmission- the 4-20 mA loop. Telemetry.

## **PE/T/416          ELECTIVE-I**

**1. FLUIDIZED BED BOILER**

**2. HIGH PRESSURE UTILITY BOILER**

**3. AUTOMOBILE ENGINEERING**

**4. REFRIGERATION & AIR CONDITIONING**

**5. FLUID POWER AND CONTROL**

**6. FLUID FLOW AND GAS DYNAMICS**

**7. EXPERIMENTAL TECHNIQUES & MEASUREMENTS**

**8. FINITE ELEMENT METHODS**

**9. SYSTEM DESIGN AND OPTIMIZATION IN THERMAL ENGINEERING**

**10. HEAT EXCHANGERS**

**11. ADVANCED TOPICS IN FLUID MECHANICS**

## **PE/T/416A          FLUIDIZED BED BOILER**

Definition of particle diameter, sphericity, etc, powder classification, pressure drop through fixed and fluidized beds, minimum fluidization velocity, elutriation and transport disengagement height, two phase theory of fluidization, bubble diameter, bubble rise velocity, etc, Bubbling fluidized boiler, merits over conventional types, features of fluidized boiler, basic design consideration, start up and operation of fluidized boilers, combustion and heat transfer in fluidized boilers, regimes of fluidization from bubbling to pneumatic transport, basic thermodynamics of circulating fluidized beds, features of circulating fluidized boilers, design aspects start up, operation, etc. merits of CFB over bubbling beds, national Na international status of fluidized boilers, pressurized fluidized

boilers and using in combined cycle plants.

### **PE/T/416B HIGH PRESSURE UTILITY BOILER**

Types and features of High Pressure Boiler. Specification of a Power Station Boiler. Sub and Supercritical Pressure Large Boiler features, Comparison, Advantages and Disadvantages. Heat Loss and Efficiency calculation. Economizer, Superheater, Reheater Heat Transfer, Pressure Drop calculation. Boiler performance and problems of part load operation. Circulation, Natural, Forced, Assisted. Furnace Design, Heat Input. Materials of Boiler Tubes, Drum, Header. Thickness calculation of Superheater, Drum, Headers. Water Chemistry of High Pressure Boiler. Effect of Coal & Ash Quality on Boiler design and performance. Internal and External deposits of Boiler. ID, FD, PA Fan specification & selection. Boiler Mountings. Boiler Insulation. Thermal expansion of Boiler. Boiler structure & supports.

### **PE/T/416C AUTOMOBILE ENGINEERING**

History, Automobile Assemblies, Principle of operation, Engine parts-their functions, classification of Automobiles Production of Automobile in India. Fuel systems in Automobiles, Fuel feed, intake and exhaust systems. Engine cooling systems. Battery, starting and generating system, Lighting and electrical equipment, Ignition circuits, Bearing and Lubrication. Clutch, Power Transmission, its purpose & types, Gearboxes, Propeller shafts, differential, Axles. Brakes, Wheels and Tyres. Engine Tune-up, Tune up instruments, Engine Performance tests. Trouble shooting causes and Remedies.

### **PE/T/416D REFRIGERATION & AIR CONDITIONING**

Basic refrigeration cycles and methods, air cycle refrigeration and COP, vapour compressor refrigeration, thermodynamic analysis and cycle construction on TS, pv and ph planes, physical, chemical and thermodynamic properties of principal refrigerants, absorption system of refrigeration, refrigeration equipment, types of compressor, condensers and evaporators, surface requirements for evaporators and compressors, refrigeration piping and material and moisture removal, refrigeration control, liquid refrigerants control, automatic and thermostatic valves, float valves, suction line control, application of refrigeration in ice making, food preservation, house hold refrigerators. Atmospheric air, humidity terms and calculations, psychrometric chart, air humidity processes, humidification and de-humidification, by-pass factor, comfort air-conditioning, effective temperature, comfort chart, ventilation requirements, air-distribution systems, basic theory, air duct losses, design of air duct system, air delivery and distribution, air conditioning systems, unit conditioners, central air conditioning, control of air conditioning apparatus, space cooling load calculations, heat transmission through barriers, solar radiation, infiltration, occupants, electric light and appliances,

product load, outside air and ventilation, SHR, ADP, refrigeration load.

### **PE/T/416E FLUID POWER AND CONTROL**

Properties of industrial fluids, fluid reservoir for liquids and gases, fluid power units - pumps, compressors & blowers, accumulators & intensifiers, valves - one, two & three way valves, pressure control, flow control & sequence valves, master control valves, flexible piping & fittings, seals & packing, filtration of liquids, moisture control of gases, industrial hydraulic & pneumatic circuits - pressure regulating circuits, counterbalance circuits, sequence operation circuits, speed control circuits, meter-in-meter-out circuits, billed off functions, regenerative circuits, circuits using accumulators & intensifiers, fluid logic & control system - principles of fluid logic & application, open loop & closed loop system, block diagram, root locus method, steady state error & stability, system performance, optimization & reliability, feedback control system, analogue technique - application to hydraulic & pneumatic system.

### **PE/T/416F FLUID FLOW AND GAS DYNAMICS**

Introduction and definitions, equations of motion for 3-D flow, Navier-stokes equations, circulation and vorticity, potential flow, flow around bodies (cylinders and aerofoil), transformation of circle into aerofoil.

Introduction to compressible flow, velocity of sound and mach no. isentropic flow, flow with friction and heat transfer, Raulie line and Fanno line, analysis of flows with normal and oblique shock waves, supersonic flows, unsteady flows.

### **PE/T/416G EXPERIMENTAL TECHNIQUES & MEASUREMENTS**

Basic principles of experimental analysis, strain gauges and strain gauge circuits, Rosettes, photo elasticity, brittle coating methods, Moire fringe methods, holograph, etc. Flow visualization techniques, measurement of pressure, velocity, discharge, temperature in fluid flow, hot-wire anemometry, hot-film anemometry, LDA, PIV, solid transformation.

### **PE/T/416H FINITE ELEMENT METHODS**

Methods of weighted residuals and variational approach for solving differential equations, Galerkin and Rayleigh-Ritz methods, finite element methods and implementation, convergence criterion, finite element formulation for linear elastic continuum and extended Laplace equation including inertia and dissipative terms, subtracting, co-elements including isoparametric elements, plate bending and C elements, non-conforming elements and patch test, dynamic and non-linear problems.

### **PE/T/416I SYSTEM DESIGN AND OPTIMIZATION IN THERMAL ENGINEERING**

Introduction to thermal design, Regression Analysis and Equation Fitting, Basics of Fluid

flow and heat transfer required for design of thermal systems, Modeling of thermal equipment, e.g. Heat Exchangers, evaporators, Condensers, turbo-machines, etc. System simulation (Successive substitution, Newton Raphson method)- examples. Optimization, search methods, linear programming, dynamic programming, geometric programming, Lagrangian multipliers, examples applied to thermal systems such as power plants. Basics of second law analysis in heat and fluid flow, applications in thermal designs.

### **PE/T/416J            HEAT EXCHANGERS**

Review of Heat transfer: conduction, Convection and Radiation. Classification of heat exchangers, Tubular heat exchangers, Parallel flow, Counter flow and cross flow arrangements, Design and analysis of heat exchangers, LMTD and NTU methods and their applications, Shell and Tube heat exchangers, Flow arrangements for increased heat recovery, Application of extended surfaces. Heat exchanger with two phase mixtures, Condensers, evaporators - their design and analysis. Direct contact type heat exchangers - Cooling Towers.

### **PE/T/416K            ADVANCED TOPICS IN FLUID MECHANICS**

Reviews of basic laws of fluid flow in integral and differential form, Kinematics, ideal fluid flow, Newtonian fluid flow and applications, creeping flow, transition and turbulence, modeling and dimensional analysis, Boundary layer concept and its formulation in different situations, Blasius solution and similar solutions, thermal boundary layer.

### **PE/S/411            SEMINAR**

Each student has to deliver two seminars on topics related to power engineering and also has to submit reports on the seminar topics.

### **PE/S/412            POLLUTION MEASUREMENT & CONTROL LABORATORY**

Study of Stack Emission  
Study of IC Engine Exhaust Emission  
Study of Air Quality  
Study and Analysis on Noise Pollution  
Analysis of air Quality, Analysis of DM Water

### **PE/S/413            PPE FAMILIARIZATION CAMP**

Each student will have to undergo this sessional course in one or more power plants and load despatch centers for a total period of at least three weeks. The students will have to bear expenses for their board and lodging. Assessment will be made on the basis of Viva-voce and report submitted by each student by the training department of the concerned Power Plants / Load Despatch Centers.

### **PE/S/414      TRANSDUCER LABORATORY**

Measurement of Steam Pressure  
Measurement of Temperature  
Measurement & Control of Drum Level  
PH Measurement of Water  
Measurement of Electrical Conductivity of Water  
Measurement of Flow rate  
Study of various Transducers and their signal conditioning

### **PE/S/415      PROJECT-I**

Any topic related to power engineering (mechanical) - 2 semesters

### **PE/S/416      PROJECT-II**

Any topic related to power engineering (electrical) -- 2 semesters

## **Fourth Year 2nd Semester**

### **PE/T/421      POWER PLANT OPERATION AND MAINTENANCE**

Operation of feed pumps, condensate pumps and feed water heaters, Operation of FD, ID and PA fans, Operation of coal, oil and gas burners, Bringing a boiler on load, Run-up and Shutdown of turbogenerators, normal and emergency operation of power plants. Automatic voltage and frequency control, VAR-compensation during peak and off-peak hours and the voltage profile, Grid system of operation, Relay setting operation, Setting of under-voltage and under-frequency relays, Voltage collapse due to cascaded trippings and emergency measures, Automatic load-shedding, Resynchronization and Self-synchronization, Load scheduling and load despatch. Maintenance organization, routine and emergency maintenance of boilers, turbines and auxiliaries, like pumps, heat exchangers, mechanical shaft seals, ejectors etc. Economic operation of a plant, Optimization procedure for boiler and turbine operation, Maintenance records. Operation and maintenance of captive power plants, Maintenance of generators, transformers, Main and Transfer buses, Relay and circuit breakers and the drives, charging and discharging of storage cells and their maintenance.

### **PE/T/422      ENGINEERING ECONOMICS & COSTING**

Basics of demand and supply - elasticity of demand - concept and measurement.  
Theory of costs - short run and long run cost curves.  
Industrial development in India - trends - problems prospects - economic reforms and Indian industry - foreign direct investment and foreign collaboration in Indian industry.  
International environment - an overview of international trading environment - trends in World Trade and the problems of developing countries - International Economic

Institutions - GATT, WTO, World Bank, IMF.

Industrial Record Keeping - Double entry - concepts and conventions - Journal, Ledger, Trial Balance, Cash Book, Final Accounts.

Nature, Scope, Objectives and Functions of cost accounting and management accounting - costs and its classifications - preparation of cost sheet - accounting for material - pricing of material issues - ABC analysis - Just-in-time - concepts of overheads - allocation and apportionment of overhead - absorption of overheads - marginal costing.

Capital budgeting - methods of appraisal - average rate of return - pay back period - discounted cash flow (net present value, internal rate of return).

Management - definition - functions - organization - definition and principles - other functions of management.

### **PE/T/423      POWER PLANT INSTRUMENTATION AND CONTROL**

Instrumentation- General concepts and objectives, instrumentation of complex systems, different types of power plants and role of instrumentation in controlling and monitoring the power production, optimization and adaptation, Thermal power plant instrumentation, controlling and monitoring of boilers, turbines and generators, Transformers, condensers and power plant auxiliaries. Furnace draft and temperature control, combustion control, drum and feedwater level control, emergencies and actions, alarm and annunciation, safety, interlock and supervisory schemes, salient features of instrumentation of hydro-electric, nuclear and non-conventional power plants, Monitoring generation and load flow, plant efficiency, Excitation control and temperature profile.

### **PE/T/424      NUCLEAR POWER GENERATION**

Introduction to nuclear physics, Nuclear power generation in general, Reactor fuel system, Fuel cycle, Production of reactor fuels, Fuel enrichment, Properties of fuel materials, Fuel management, Reprocessing of spent fuels etc. Non-fuel reactor materials, different materials used as moderator, Material for fuel cladding, etc. Reactor types, different power reactor systems, PWR, BWR, PHWR, Fast breeder reactors, gas cooled reactors, etc. Core vessel and coolant system of different reactors, description of reactor in India. Reactor safety, general principles of safety, Safety features, Reactor safety analysis, Design basis, Accidents, Loss of Coolant Accident etc., Reactor control, general control features, control devices, control rods and their driving mechanisms, control in reactor operation, radiation protection, radiation hazards, different units of radiation, protection standards, biological effects, radioactive, Biological effects, radioactive waste treatment systems etc.

### **PE/T/425      ELECTIVE-II**

#### **1. MICROCOMPUTERS AND DIGITAL SYSTEMS**

#### **2. ADVANCED TOPICS IN ELECTRICAL MACHINES**

#### **3. POWER PLANT SIMULATION AND MODELING**

#### **4. COMPUTER AIDED POWER SYSTEM ANALYSIS & OPERATION**

#### **5. CONTROL AND REGULATION OF POWER PLANTS**

## **PE/T/425A            MICROCOMPUTERS AND DIGITAL SYSTEMS**

Introduction to 8086 based systems- organization and architecture. Memory and I/O. Micro-computer interfaces- Interrupts and IRQ. Interfacing serial ports- UARTS, RS 232 and RS 485 . Parallel Port and USB interfaces.  
Micro-computer based instrumentation systems for power plants- Data Acquisition Systems, SCADA, GPIB. Concepts of Field-Bus

## **PE/T/425B            ADVANCED TOPICS IN ELECTRICAL MACHINES**

Generalized theory of electrical machines, linear transformations - matrix model of dc, inductive & synchronous machines - motional impedance matrix, effects of saturation, harmonics & solid iron rotor/pole shoe on the performance of synchronous machines, stability assessment in terms of generalized machine model, Asynchronous operation of synchronous machines - resynchronisation - self synchronisation, heating & cooling of large power transformers & turbine-generators, effects of surge voltage on electrical machines, industrial testing of electrical machines - types tests & routine tests - IS specifications.

## **PE/T/425C            POWER PLANT SIMULATION AND MODELING**

Concept of a model- their classifications - concept of similarity and simulation - physical vs mathematical simulation - analog, digital and hybrid simulation, stochastic models - sampling techniques - data storage & data handling, identification & estimation of system parameters - on-line & off-line techniques, model validation - accuracy of simulation verses cost, modeling of power network & load, mathematical models of one-machine, two-machines & multi-machines problems, liberalization of models under small perturbation, reduced order models , time domain vs frequency domain analysis, computer methods of system analysis - stability assessment, simulation experiments - micro-machine model of power system.

## **PE/T/425D            COMPUTER AIDED POWER SYSTEM ANALYSIS & OPERATION**

Introduction, operational problems of electrical power system, load-fore-casting, unit-commitment, load scheduling, network modeling & load flow studies - functions of load-dispatch centers, concept of optimal load flow, load-frequency control - one area & two area systems, short-circuit, asynchronous operation & stability analysis using computer programmes, transient & dynamic overvoltage, reliability of system & generation planning.

## **PE/T/425E            CONTROL AND REGULATION OF POWER PLANTS**

Introduction, discrete data system and Z-plane analysis, state space analysis, observability and controllability, performance specification and compensation, analysis of non-linear systems, face plane, and D-partition methods, concept of adaptive control, power plant

system and sub-systems and their mathematical models, identification of control objectives, coordination of different control units, application of solid state devices, excitation control, microprocessor and PLC control of excitation and drives, digital and hybrid control scheme.

Power system stabilizers, automatic control of frequency, voltage generation and load flow, automatic recloser, automatic load shedding on loss of generation, optimality concept, dynamic optimization of multivariable system.

#### **PE/T/426            GENERAL VIVA-VOCE**

This viva-voce shall be conducted by a panel of internal and external subject experts.

#### **PE/S/421            PROJECT-I**

This will be a continuation of the Project I undertaken in Final Year first semester.

#### **PE/S/422            PROJECT-II**

This will be a continuation of the Project I undertaken in Final Year first semester.

#### **PE/S/423            PEE LABORATORY-V (Electrical Machine and Power System)**

- 1) Study of Active and Reactive Power Transfer.
- 2) Measurement of ABCD parameters of a transmission line.
- 3) Power frequency test with porcelain insulator.
- 4) Impulse withstand and power-frequency tests of pin insulators.
- 5) Di-electric test of transformer oil and insulating material.
- 6) Synchronization and Parallel operation of alternators.
- 7) Studies of SOLAR cells.
- 8) Performance study of induction type relay.
- 9) Performance study of attraction type relay.

#### **PE/S/424            INSTRUMENTATION AND CONTROL LABORATORY**

- 1) Study of synchro
- 2) Study of Stepper Motor
- 3) Study of an AC position control system
- 4) Study of a DC position control system
- 5) Study of waveforms using a signal generator and a CRO
- 6) Study of a PID controller module
- 7) Study of a Compensation Design module
- 8) Micro-processor based servo motor speed control
- 9) Micro-processor based voltage control using a SCR