SYLLABI

CHE210 INTRODUCTION TO CHEMICAL ENGINEERING 3 1 0 4

Unit 1

Compositions of mixtures and solutions: methods of expressing compositions of mixture and solutions, wet and dry basis concept; Gas calculations: ideal and real gas laws – gas constant – normal molal volume, calculations of pressure, volume and temperature using ideal gas law; Gas mixtures - use of partial pressure and pure component volume in gas calculations; Dissociating gases – applications of real gas relationship in gas calculation.

Unit 2

Material balance: Concept of material balance – degree of freedom and closure of a problem – material balance without chemical reaction – tie and inert material – recycling and bypass operation application of material balance to unit operations like distillation, evaporation, crystallization, drying, etc. – phase rule – material balance involving key components, material balance with chemical reaction – limiting and excess reactants – degree of completion – application of material balance to various types of chemical reactions – recycle and bypassing operations – concept of purge; Humidity and saturation: Calculation of absolute humidity, molal humidity, relative humidity, and percentage humidity – dew point – use of humidity in condensation and drying – wet and dry bulb temperatures – humidity chart – solving problems using humidity chart; Fuels and combustion: Calculation of Orsat analysis of products of combustion of solid liquid and gas fuels – calculation of hydrogen to carbon ratio and percentage excess air from glue gas analysis, calculations of sulfur and sulfur compounds burning operations.

Unit 3

Thermophysics: Heat capacity of solids, liquids, and gases – mean heat capacity – calculation of sensible heat using heat capacity, Kopp's rule, various types of latent heats – use of latent heats in heat calculations; Thermochemistry: Standard heat of reaction, standard heat of formation and combustion. Hess law, calculations of standard heat of reaction. Heat of reaction at other temperatures – effect of pressure and temperature on heat of reaction - heats of solution and mixing – adiabatic reaction temperature; Unsteady state material and energy balances: Concept of unsteady state material and energy balances, problems on unsteady state material and energy balances.

TEXTBOOKS:

1. *B.L. Bhatt and S.M. Vora, "Stoichiometry", 3rd Edition, Tata McGraw-Hill, 1996.*
2. *D.M. Himmelblau, "Basic Principles and Calculations in Chemical Engineering", EEE 6th Edition, Prentice Hall Inc., 2003.*

3. *R.M. Felder and R.R. Rousseau, "Elementary Principles of Chemical Processes", 3rd Edition, John Wiley & Sons, New York 2000.*

REFERENCES:

1. *O.A. Hougen, K.M. Watson and R.A. Ragatz, "Chemical Process Principles", Part I, CBS Publishers, 1973.*
2. *W.K. Lewis, A.H. Radasch & H.C. Lewis, "Industrial Stoichiometry", McGraw Hill, New York, 1995.*

CHE211 FLUID MECHANICS 3 1 0 4

Unit 1

Elementary concepts – density, specific weight, specific gravity, viscosity – dynamic and kinematic viscosity – surface tension, capillarity, vapour pressure, compressibility; Concept of gauge and absolute pressure, measurement of pressure using manometers of different types; Hydrostatic force on plane and curved surfaces – center of pressure – buoyancy and stability of submerged and floating bodies – metacentric height – period of oscillation; Types of flow, definitions and explanations of unsteady, steady, non-uniform, laminar and turbulent flows. Ideal flow – rotational and irrotational, stream function, potential function; Path line, streak line and stream line – continuity equation – derivation of three dimensional equation, application of one dimensional steady flow – circulation and vorticity.

Unit 2

Derivation of Bernoulli's energy equation and Euler's equation, examples illustrating the use of energy equation; Flow meters – venturimeter; Orifice meter, nozzle, derivation of equations of discharge, pitot tubes – applications to flow measurement; Boundary layer theory, boundary layer equation – Blasius solution, drag on flat plate, boundary layer separation and its control; Laminar flow through circular pipe – shear stress, pressure gradient, velocity profile, Hagen–Poiseulle equation, power calculations, laminar flow between parallel plates – Coutte flow and Poiseulle flow; Flow in closed conduits – friction loss and flow calculations, turbulent flow, Reynolds number, Darcy-Weisbach equation, use of Moody diagram, minor losses – pipe networks; Dimensional analysis and modal testing - Reynolds and Froude numbers and their use in model testing.

Unit 3

Friction factor for flow through different cross sections and different flow types, friction-factor charts, friction from changes in velocity or cross section (contraction, expansion, fittings); Flow past immersed bodies – drag, drag coefficient, flow though beds of solids, one dimensional motion of particle through fluid, terminal velocity, hindered settling, fluidization – minimum fluidization velocity, types of fluidization, applications; Transportation of fluids – pipes, fittings, valves. Pumps - head, power requirement, suction lift, cavitation. Positive displacement pumps –

reciprocating pump. Rotary pumps – centrifugal pumps – theory – pump characteristics.

TEXTBOOKS:

1. N. de Nevers, "Fluid Mechanics for Chemical Engineers", 3rd Edition, McGraw-Hill, 2004.
2. J.R. Welty, "Fundamentals of Momentum, Heat, and Mass Transfer", 4th Edition, John Wiley, 2001.
3. J.F. Douglas, J.M. Gasiorek, J.A. Swaffield., "Fluid Mechanics", 4th Edition, Pearson Education, 2000.

REFERENCES:

1. W.L. McCabe, J.C. Smith and P. Harriot, "Unit Operations in Chemical Engineering", 6th Edition, McGraw-Hill, 2001.
2. C.P. Kothandaraman and R. Rudramoorthy, "Basic Fluid Mechanics", New Age International Publishers, 1999.
3. V.L. Streeter and E. B. Wylie, "Fluid mechanics", 9th Edition, McGraw Hill Book Co., 1998.

CHE212 CHEMICAL ENGINEERING THERMODYNAMICS 3 1 0 4

Unit 1

Introduction: system, properties and processes, phase rule; First law: closed and open systems, enthalpy; Second law: statements, entropy, available energy and free energies: Thermodynamic formulations and Maxwell relations; Pure substances: P-V-T behaviour, ideal and real gases; Thermodynamic analysis of flow processes and refrigeration cycles; Mixtures: partial molar properties, standard states.

Unit 2

Excess properties of mixtures: T & P dependence, Gibbs-Duhem equations: composition dependence, ideal & non-ideal solutions, fugacities and activity coefficients; Criteria of equilibrium in multicomponent non-reacting systems, vapor-liquid equilibrium: completely miscible liquids – equation of state approach and excess free energy models, bubble and dew point calculations, thermodynamic consistency.

Unit 3

Equilibrium constant, homogeneous gas phase reactions, variations of yield with pressure, temperature and composition, simultaneous reactions.

TEXTBOOKS:

1. J.M. Smith and H.C. Van Ness, "Introduction to Chemical Engineering Thermodynamics", 6th Edition, McGraw Hill, 2003.
2. K.V. Narayanan, "A Textbook of Chemical Engineering Thermodynamics", Prentice Hall India, 2009.
3. Y.V.C. Rao, "Chemical Engineering Thermodynamics", Universities Press, 1997.

CHE213 HEAT TRANSFER IN CHEMICAL ENGINEERING 3 1 0 4

Unit 1

Modes of heat transfer – Fourier's law of heat conduction and applications; Thermal conductivity measurement; Heat transfer in extended surfaces; Heat transfer to fluids without phase change: concepts of heat transfer by convection – natural and forced convection, analogies between transfer of momentum and heat – Reynold's analogy; Prandtl and Colburn analogies.

Unit 2

Dimensional analysis in heat transfer, correlations for the calculation of heat transfer coefficients; Heat transfer to fluids with phase change – heat transfer from condensing vapors, drop wise film wise condensation, condensation of superheated vapors; Heat transfer to boiling liquids – mechanism of boiling, nucleate boiling and film boiling; Theory of evaporation; evaporator types; single effect and multiple effect evaporation; evaporator design considerations.

Unit 3

Radiation heat transfer – emissive power, black body radiation, emissivity, Stefan–Boltzman law, Planck's law, radiation between surfaces; Parallel and counter flow heat exchangers – log mean temperature difference – single pass and multipass heat exchangers; Heat exchangers – types & effectiveness; number of transfer units – chart for different configurations; Design of various types of heat exchangers (including furnaces, condensers, & evaporators.

TEXTBOOKS:

1. W.L. McCabe, J.C. Smith and P. Harriot, "Unit Operations in Chemical Engineering", 6th Edition, McGraw-Hill, 2001.
2. M.N. Ozisik, "Heat Transfer – A Basic Approach", McGraw-Hill Companies, 1984.
3. J.P. Holman, "Heat Transfer", 8th Edition, McGraw-Hill, 1997.

REFERENCES:

1. F.P. Incropera, "Fundamentals of Heat and Mass Transfer", 6th Edition, Wiley, 2006.
2. J.M. Coulson, and J.F. Richardson, "Chemical Engineering Vol. 1", 4th Edition, Asian Books Private Limited, India, 1998.

CHE220 INORGANIC CHEMICAL TECHNOLOGY 3 0 0 3

Unit 1

Chemical processing, the role of a chemical engineers in process industries, importance of block diagrams and flow charts, unit operations, unit processes, process utilities and economics, industrial safety and pollution, outline of plant and equipment design, process control and instrumentation;

Chlor-Alkali Industry: definition of electrochemistry, manufacture of soda ash by solvay process, manufacture of chlorine & caustic soda by diaphragm cell, advantages & disadvantages of diaphragm & comparison with mercury cell.
Cement: definition of cement & portland cement, process description, raw material, flow sheet & major engineering problems associated with the dry processes for manufacturing of portland cement;
Glass & ceramics Industries: definition and general composition of glass, raw material, methods of manufacture, special glasses - fused silica and high silica glass; Ceramics – properties, classification, manufacturing process; Types of refractories and manufacturing processes; kilns.

Unit 2
Inorganic acids & allied industry: flow sheet, raw materials, industrial applications, and engineering problems for sulfuric acid (includes production of sulfur) and hydrochloric acid.
Fuel gases: manufacture of producer gas, water gas by continuous process, coke oven gas, natural gas & LPG;
Paints & varnishes: brief description of requirements for surface coatings, simple flow sheet of paint coatings, simple flow sheets of paint manufacturing process, varnishes & their applications;
Soap & detergent industry: continuous hydrolysis & saponification process, flow sheet for continuous process, for fatty acids, soap & glycerine; types of surface active agents, different constituents of detergent, manufacturing process of detergent (sulfonation and sulfation and compounding of detergent).

Unit 3
Vegetable oils: extraction methods, hydrogenation of vegetable oils, general methods of production;
Pulp & Paper Industry: kraft process for pulp manufacture, Fourdrinier and cylinder machine processes for paper manufacture, and paper finishing;
Fertilizer industry: mixed and direct-application fertilizers, NPK value, granulation, Haber process for ammonia synthesis;
Food industry: types of processing (refining & milling, canning, concentration, freezing, drying, pasteurization);
Sugar: manufacture and refining of cane sugar, decolorization, bagasse, beet sugar.

TEXTBOOKS:

1. *C.E. Dryden, "Outlines of Chemicals Technology", 2nd Edition, Edited and Revised by M. Gopala Rao and M. Sitting, Affiliated East–West Press, 1993.*
2. *G.I. Austin, "Shreve's Chemical Process Industries", 5th Edition, Tata McGraw Hill, Singapore, 1990.*

REFERENCE:

M. Bickford, "Kirk-Othmer - Concise Encyclopaedia of Chemical Technology", (2-volume set), 4th Edition, Wiley-Interscience, 1999.

CHE221 MECHANICAL OPERATIONS 3 0 0 3

Unit 1
Properties and handling of particulate solids - characteristics of solid particles, standard screen series, mixed particle size and screen analysis, properties of particulate masses; Storage and conveying of solids - bins, hoppers and silos, flow out of bins; conveyor selection, different types of conveyers and their performance characteristics; Screening: theory of screening, effectiveness and capacity of screens, screening equipment: gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier.

Unit 2
Centrifugal separation - continuous centrifuges, bowl classifier, super centrifuges, design of basket centrifuges; Industrial dust removing equipment - cyclones and hydro cyclones, with special reference to electrostatic and magnetic separators; Heavy media separations, floatation; Filtration – theory, filtration considerations, batch and continuous filtration equipments (pressure and vacuum) – selection, operation and design of filters and optimum cycle of operation.

Unit 3
Principle of cake filtration, pressure drop through filter media, compressible and incompressible filter cakes, constant pressure and rate filtration, continuous filtration, washing of filter cakes; Centrifuges, membrane and ultrafiltration; Mixing and agitation: mixing of liquids (with or without solids), mixing of liquids (with solids), mixing of liquids (with solids), mixing of powders, selection of suitable mixers, power requirement for mixing.

TEXTBOOKS:

1. *W.L. McCabe, J.C. Smith, and P. Harriot, "Unit Operations in Chemical Engineering, 6th Edition, McGraw-Hill, 2001.*
2. *W.L. Badger and J.T. Banchero, "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.*
3. *A.S. Foust, L.A. Wenzel, C.W. Clump, L. Naus, and L.B. Anderson, "Principles of Unit Operations", 2nd Edition, John Wiley & Sons, 1994.*

REFERENCE:

J.M. Coulson and J.F. Richardson, "Chemical Engineering Vol. I", 4th Edition, Asian Books Pvt Ltd., India, 1998.

CHE240 INORGANIC AND PHYSICAL CHEMISTRY 3 1 0 4

(Pre-requisite: CHY100)

Unit 1
Types of bonding: ionic bond, covalent bond, coordinate bond. Intermolecular forces

– van der Waals, dipole, hydrogen bonding - principles of Valence Bond Theory (VBT) and Molecular Orbital Theory (MOT) - energy level diagrams for homogeneous and heterogeneous molecules; Transition metals and coordination chemistry: d-block and f-block elements – characteristics – coordination compounds – terminology – nomenclature – isomerism – metal ions in biological systems - crystal field theory, crystal field effects in linear(ML2), tetrahedral, square planar (ML4) and octahedral geometry (ML6), pairing energies, weak field and strong field case, crystal field stabilization energy, factors affecting magnitude of 10Dq, high and low spin complexes, evidences for crystal field stabilization, tetragonal distortions from octahedral geometry, electronic spectra and magnetism.

Unit 2

Organometallics: EAN rule, 18 electron rule, metal carbonyls - synthesis, bonding and structure - Ziegler Natta catalysts, metallocenes - synthesis and properties - homogeneous and heterogeneous catalysis – vaska complex - applications;
Inorganic polymers: phosphorous, silicone.
Bioinorganic chemistry: metalloporphyrins, metalloproteins, hemoglobin and myoglobin - structure and function;
Photochemistry: laws of photochemistry, quantum efficiency, photochemical reactions, actinometry, kinetics and mechanism of hydrogen – bromine reaction, hydrogen – chlorine reaction, photosensitization, chemiluminescence, flash photolysis

Unit 3

Colloids and surface chemistry: adsorption – Langmuir isotherms - layer characterization techniques – introduction – properties of colloids – origin of charge and determination of size of colloidal particles – emulsions – gels – applications of colloids – nanoparticles (Au, Ag, Pt) – preparation – characterization – applications in catalysis and drug delivery systems;
Electrochemistry: electrical conductance – variation with dilution – Kohlrausch's law – transport number – galvanic cells – EMF and its measurement – reference electrode – standard hydrogen electrode – Nernst equation - electrochemical series – applications of EMF measurements: fuel cells – Hydrogen-Oxygen fuel cell.

TEXTBOOKS:

1. *B.H. Puri, L.R. Sharma and M.S. Pathania, "Principles of Physical Chemistry", Vishal publishing Company, 2008.*
2. *J.D.Lee, "Concise Inorganic Chemistry", Wiley India Pvt. Ltd., 5th edition, 2008.*
3. *P.C. Jain and M. Jain, "Engineering Chemistry", Dhanpatrai Publishing Co. Ltd., New Delhi, 2005.*

REFERENCES:

1. *J.E. Huheey, E.A. Keiter and R.L. Keiter, "Inorganic Chemistry", 4th Edition, Addison-Wesley, New York, 2000.*
2. *S. Glasstone, "Textbook of Physical Chemistry", Macmillan India Press, Madras.*

CHE241 MATERIAL SCIENCE AND STRENGTH OF MATERIALS 4 0 0 4

Unit 1

Materials structure and mechanical behaviour of materials: crystal systems - space lattice - miller indices of atomic planes and directions - small problems in crystallography - crystal defects - point, line and surface defects - elastic deformation - characteristics of elastic deformation - atomic mechanism of elastic deformation - inelastic deformation - strain - time curves plastic deformation - mechanism of plastic deformation - slip and twinning - Strengthening mechanisms: Work hardening - grain boundary hardening, dispersion hardening.

Unit 2

Creep: primary, secondary and tertiary creep - fracture: ideal fracture stress - brittle fracture - Griffith's theory - cup and cone type fracture, Schmidt's law - critical resolved shear stress PHASE DIAGRAMS: solid solution - inter-metallic compound, cooling curves, non-equilibrium cooling - phase rule - equilibrium diagrams – isomorphous – eutectic - peritectic and eutectoid reactions with examples – iron - iron carbide diagram. Engineering materials: steels and cast irons - properties and applications - effect of alloying elements on steel.

Unit 3

Simple stresses and strains - stress-strain - Hooke's law - elastic limit - linear strain - lateral strain - modulus of elasticity - modulus of rigidity - bulk modulus – relationship between elastic modulli; Theory of simple bending – shear force and bending moment diagrams - different types of support conditions; Flexural formula - symmetrical sections – analysis of complex stresses - stresses on inclined planes - principal stresses and planes – torsion of circular sections - theories of failure - thin shells - thin cylindrical shells subjected to internal pressure.

TEXTBOOKS:

1. *W.D. Callister, "Materials Science and Engineering", 6th Edition, John Wiley & sons, 2003 .*
2. *A.S., "Introduction to Physical Metallurgy", 2nd Edition McGraw Hill, 1997.*
3. *F.D. Beer and E.R. Johnston, "Mechanics of Materials", 3rd Edition, McGraw Hill, 2001.*

REFERENCES:

1. *K.M. Gupta, "Materials Science and Engineering", Umesh Publications, 2001.*
2. *G.E. Dieter, "Mechanical Metallurgy", McGraw Hill ISE, 1988.*
3. *E.P. Popov, "Engineering Mechanics of solids", 2nd Edition, Pearson Education, 2003.*

CHE290 INORGANIC AND PHYSICAL CHEMISTRY LAB. 0 0 3 1

Melting point determination; Boiling point determination; Determination of Molecular weight by Rast's micro method; Transition temperature of salt hydrates –

determination of molecular weights from elevation in boiling point and depression in freezing point of solvent; Solubility of a solute in water - evaluation of the heat of solution; Mutual solubility curve of liquid – liquid systems – effect of impurity; Distribution coefficient of a solute between two solvents. Phase diagrams of binary eutectic systems; Determination of viscosity of liquids using Ostwald's viscometer and Redwood's viscometer; Determination of density and surface tension of pure liquids; Kinetics and order of reactions in solutions; Dielectric constant and dipole moments.

TEXTBOOKS:

1. *C.W. Garland, J.W. Nibler, and D.P. Shoemaker, "Experiments in Physical Chemistry", 7th Edition, McGraw Hill, 2002.*
2. *J.B. Yadav, "Advanced Practical Physical Chemistry", Goel Publishing House, Meerut.*

CHE291 FLUID MECHANICS LAB. 0 0 3 1

Calibration of constant and variable head meters, calibration of weirs and notches, determination of drag coefficient, flow through straight pipe, flow through annular pipe, pressure drop studies in packed column, minimum fluidization velocity in gas – solid and liquid – solid fluidization column, open drum orifice and draining time, flow through helical coil and spiral coil, characteristic curves of pumps, losses in pipe fittings and valves, viscosity measurement of Non Newtonian fluids; Reynold's experiment for laminar, transitional, & fully turbulent flows.

CHE292 STRENGTH OF MATERIALS LAB. 0 0 3 1

Tensile test on metals, compression test on wood, Rockwell Hardness test, Brinell Hardness test, spring test, torsion test, impact test – charpy, impact test – izod, fatigue test, deflection test on beams.

CHE293 MECHANICAL OPERATIONS LAB. 0 0 3 1

Mechanical operations experiments: size analysis, effectiveness of screen, jaw crushers, roll crusher, drop weight crusher, ball mill, sedimentation, sub sieving, cyclone separator, leaf filter, filter press.

CHE310 DIFFUSIONAL MASS TRANSFER OPERATIONS 3 1 0 4

(Pre-requisites: CHE210, CHE213)

Unit 1

Molecular diffusion in gases and liquids, steady state diffusion under stagnant and laminar flow conditions; diffusivity measurement and prediction; multi-component

diffusion; diffusion in solids and its applications; eddy diffusion; concept of mass transfer coefficients; theories of mass transfer, analogy equations; Interphase mass transfer, relationship between individual and overall mass transfer coefficients, steady state cocurrent and countercurrent mass transfer processes, stages, cascade and stage efficiencies, stage-wise and differential contactors, NTU AND NTP concepts.

Unit 2

Equipment for countercurrent and cocurrent mass transfer operations; Gas absorption – equilibrium solubility: Raoult's and Henry's laws; absorption factor; packed columns for absorption: rate-based design, HTU and NTU calculations; absorption with chemical reaction; Humidification operations: humidity chart; Lewis relation; enthalpy transfer – temperature profiles in humidifiers and dehumidifiers; theory and design of cooling towers and dehumidifiers.

Unit 3

Theory and mechanism of drying, drying curves, classification of dryers, design of batch and continuous dryers, theory of crystallization, classification of crystallizers, design of and continuous crystallizers.

TEXTBOOKS:

1. *R.E. Treybal, Mass Transfer Operations, 3rd Edition, McGraw-Hill, 1981.*
2. *J.R. Welty, C. E. Wicks, G. L. Rorrer and R. E. Wilson, Fundamentals of Momentum, Heat, and Mass Transfer, 4th Edition, Wiley, 2000.*

REFERENCES:

1. *J.M. Coulson, and J. F. Richardson, "Chemical Engineering Vol. II", 4th Edition, Asian Books Pvt. Ltd. India., 1998.*
2. *W.L. McCabe, J.C. Smith, and P. Harriot, "Unit Operations of Chemical Engineering", 6th Edition, McGraw-Hill, International Edition, 2001.*
3. *A.S. Foust, L.A. Wenzel, C.W. Clump, L. Naus, and L.B. Anderson, "Principles of Unit Operations", 2nd Edition, Wiley, 1980.*

CHE311 CHEMICAL REACTION ENGINEERING 3 1 0 4

(Pre-requisite: CHE210)

Unit 1

Chemical kinetics: rate equation, elementary, non-elementary reactions and their measurements, theories of reaction rate and temperature dependency, analysis of experimental reaction data, evaluation of rate equation; Homogeneous systems: design of homogeneous system, batch, stirred tank and tubular flow reactor, combination of reactor system, size of comparison of reactors.

Unit 2

Design of homogeneous reactors for single and multiple reactions, recycle; Heterogeneous reactors and solid catalysis – rate equations for heterogeneous reactions, nature of catalysis, adsorption isotherms, rates of adsorption and desorption, surface reaction analysis of rate equation and rate controlling steps, surface area and pore-volume distribution, catalyst preparation.

Unit 3

Gas–solid catalytic reactors – diffusion within catalyst particle, effective thermal conductivity, mass and heat transfer within catalyst pellets, effectiveness factor, Thiele Modulus, fixed bed reactors; Gas–solid non–catalytic reactors – models for explaining kinetics, volume and surface models, controlling resistances and rate controlling steps, time for complete conversion for single and mixed sizes, fluidized and static reactors.

TEXTBOOKS:

1. *O. Levenspiel, "Chemical Reaction Engineering", 3rd Edition, John Wiley, 1999.*
2. *H.S. Fogler, "Elements of Chemical Reaction Engineering", 4th Edition, Prentice Hall of India Ltd., 2000.*

REFERENCES:

3. *G.F. Froment and K.B. Bischoff, "Chemical Reactor Analysis and Design", 2nd Edition, John Wiley and Sons, 1990.*
4. *J.M. Smith, "Chemical Engineering Kinetics", 3rd Edition, McGraw-Hill, New York, 1981.*

CHE312 EQUILIBRIUM STAGED OPERATIONS 3 1 0 4

(Pre-requisites: CHE210, CHE212)

Unit 1

Design of mass transfer equipment based on the concept of equilibrium stage; **Distillation:** vapor-liquid equilibria, Raoult's law and deviations from ideality, methods of distillation; Equilibrium and operating line concepts; Design calculations by McCabe-Thiele and Ponchon-Savarit methods; Continuous-contact distillation (packed tower) design; Extractive and azeotropic distillation, low pressure distillation; Steam distillation; Tray tower equipment.

Unit 2

Absorption: design of tray-tower absorbers; Operating characteristics of stagewise and differential contactors; Design calculations for single-stage, multistage cocurrent and countercurrent absorbers;

Liquid-liquid extraction: equilibrium in ternary systems; Design calculations for batch and continuous extractors, equipment - spray, packed and mechanically agitated contactors; Pulsed extractors, centrifugal extractors.

Unit 3

Leaching: solid-liquid equilibria; Equipment – batch and continuous types; Calculation of number of stages;

Adsorption and ion exchange: theories of adsorption of gases and liquids; Principle of ion-exchange; Equipment for batch and continuous operation; Design calculations for adsorption and for ion-exchange resins;

Miscellaneous separation processes: introduction to membrane separation process; Solid and liquid membranes; Reverse osmosis; Electrodialysis.

TEXTBOOKS:

1. *R.E. Treybal, Mass Transfer Operations, 3rd Edition, McGraw-Hill Kogakusha, 1980.*
2. *J.D. Seader and E.J. Henley, Separation Process Principles, 2nd Edition, Wiley, 2005.*

REFERENCES:

1. *J.M. Coulson and J.F. Richardson, Chemical Engineering Volume II, 4th Edition, Asian Books Pvt. Ltd. India, 1988.*
2. *W.L. McCabe, J.C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 6th Edition, McGraw-Hill, International Edition, 2001.*

CHE313 COMPUTATIONAL METHODS IN CHEMICAL ENGINEERING 2 0 3 3

(Pre-requisites: MAT111, MAT212, CHE210)

Unit 1

Basics of numerical analysis: Error analysis, computations of errors of algorithms, stiffness of algorithms, Interpolation of functions (Lagrange approximation), polynomial approximation and curve fitting (Newton method), least squares method, numerical differentiation (forward, backward and central differences) and integration (Trapezoidal and Simpson's rules);

Solutions to linear algebraic equations Ax = b: Review of vector and matrix algebra, vector spaces, linear independence, basis of a space, Eigen values & Eigen vectors; Gauss-Jordan method, triangular factorization, iterative techniques; Applications to chemical engineering problems.

Unit 2

Solutions to nonlinear algebraic equations: Bisection method, Secant method and Newton-Raphson method for single variables, convergence criteria; Applications in thermodynamics; Introduction to multivariable Newton-Raphson method; Applications in thermodynamics, equilibrium-stage operations and reaction engineering;

Solutions to ordinary differential equations: Euler method, Taylor series method, Runge-Kutta method; Problems in reaction engineering, heat transfer, process control; Orthogonal collocation.

Unit 3

Solutions to partial differential equations: Finite difference methods for parabolic and elliptic PDEs, numerical solution of unsteady heat conduction & diffusion problems, reaction-diffusion problems and convective-diffusion problems, case studies.

TEXTBOOKS:

1. *M.K. Jain, S.R.K. Iyengar, and R. K. Jain, "Numerical Methods for Scientific and Engineering Computation", 5th Edition, New Age International, 2008.*
2. *S.K. Gupta, "Numerical Methods for Engineers", New Age International, 2003.*
3. *K.J. Beers, "Numerical Methods for Chemical Engineering: Applications in MATLAB", Cambridge University Press, 2007.*

REFERENCE:

C.F. Gerald and P.O. Wheatley, "Applied Numerical Methods", 7th Edition, Addison Wesley, 2003.

CHE320 ORGANIC CHEMICAL TECHNOLOGY 3 0 0 3

Unit 1

STRUCTURE REACTIVITY AND MECHANISM: (a) Classification of IUPAC nomenclature of organic compounds. (b) Bonding in organic molecules such as methane, ethylene and butadiene (c) Polarity of bonds (electron displacement effect), inductive effect, time variable effects (inductometric and electromeric effects), conjugative (mesomeric) and resonance effects. Hyper conjugation, steric effects, types of bondage breakage - homolysis and hetrolysis with examples (d) types of reagents - electrophiles and neucleophiles, (e) types of reactions- Addition [>C=C<, >C=O], substitution elimination and rearrangement reactions, general conditions and mechanism and each of the above, strengths of acids and bases (to be discussed based on the above concepts); Stereochemistry: General idea of optical and stereo isomerism, geometrical isomerism, Baeyers strain theory, Sasese and Mohrs theory, concept of conformation analysis with respect to ethane, ethylene, ethylene dichloride, cyclohexane and its simple derivatives. Introduction to molecular modelling.

Unit 2

Petroleum refining industry: Constituents of petroleum, products of refining, processing or refining;

Petrochemicals industry: Unit operations, chemical conversions, manufacture of petrochemicals, reactions producing petrochemicals;

Dyes and intermediates: Raw materials, important cyclic intermediates, chemical conversions, structure and classification of dyes.

Unit 3

Polymers & plastics industries: Definitions, types of polymers, classifications,

polymerization reactions, manufacture of formaldehyde, vinyl esters, and phthalic anhydride;

Rubber industries: Natural and synthetic rubber, rubber compounding, rubber fabrication, latex compounds, and rubber derivatives;

Pharmaceutical: Classification, alkylation, condensation and cycliztaion, dehydration, halogenations, oxidation, sulfonation, amination, biologicals.

TEXTBOOKS:

1. *R.T. Morrison and Robert N. Boyd, "Organic Chemistry", 6th edition, Prentice Hall of India Pvt. Ltd., New Delhi,1992.*
2. *C.E. Dryden, "Outlines of Chemicals Technology", 2nd Edition, Edited and Revised by M.G. Rao and M. Sitting, Affiliated East–West Press, 1993.*
3. *G.I. Austin, "Shreve's Chemical Process Industries", 5th Edition, Tata McGraw Hill, Singapore, 1990.*

REFERENCES:

1. *M. Bickford, "Kirk-Othmer - Concise Encyclopaedia of Chemical Technology", (2-volume set), 4th Edition, Wiley-Interscience, 1999.*
2. *I.L. Finar, "Organic Chemistry: - Vol-I: The Fundamental Principles", Longman Publishing Group, 1998.*

CHE330 ADVANCED TOPICS IN CHEMICAL ENGINEERING 0 0 3 1

Types of problems in chemical engineering, career opportunities, social problems with relevance to chemical engineering, major chemical industries – Worldwide and Indian scenarios; Past, current, and future trends; New paradigms in chemical engineering: Health, climate change & energy and product design; articles on "Perspectives in Chemical Engineering" from AIChE journal; Student is expected to review articles in leading chemical engineering journals for which a list will be provided by the instructor.

PRACTICAL:

Building detailed non-functional models of various chemical engineering operations such as heat exchangers, mechanical operations, packed bed columns, tray towers and reactors.

Developing experimental procedure, building functional experimental setup and measuring relevant chemical engineering data for simple experiments such as: fluidized bed, coolers/heaters, piping, flow/level/pressure/temperature measurement, evaporators, crystallizers and dryers

CHE331 PROCESS DYNAMICS AND CONTROL 3 1 0 4

(Pre-requisite: MAT211)

Unit 1

Laplace transformation, transform of standard functions, derivatives and integrals, inversion, theorems, application to solve ODEs. Open – loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics.

Unit 2

Closed loop control systems, development of block diagram for feedback control systems, servo and regulatory problems, transfer function for controllers and final control element, pneumatic and electronic controllers, transportation lag, transient response of closed – loop control systems and their stability.

Unit 3

Frequency response of closed – loop systems, control system design by frequency response techniques, bode diagram, stability criterion, tuning of controller settings. Introduction to advanced control systems - cascade control, feed-forward control; Control of chemical processes; Introduction to computer control of chemical processes; Principles of measurements; Measuring instruments for process control.

TEXTBOOKS:

1. *D. Coughanowr, "Process Systems Analysis and Control", 2nd Edition, McGraw Hill, 1991.*
2. *G. Stephanopoulos, "Chemical Process Control", 8th edition, Prentice Hall India. 2009.*
3. *T.G. Beckwith. R.D. Marangoni, and J.H. Lienhard V, "Mechanical Measurements", 6th Edition, Prentice Hall, 2006.*

REFERENCES:

1. *T.E. Marlin, "Process Control", 2nd Edition, McGraw Hill, 2000.*
2. *E.O. Doebelin, "Measurements Systems Application & Design", McGraw Hill, 1990.*
3. *C.A. Smith, and A.B. Corripio, "Principles and Practice of Automatic Process Control", 2nd Edition, John Wiley, 1997.*

CHE351 MODERN SEPARATION METHODS 3 0 0 3

(Pre-requisites: CHE310, CHE312)

Unit 1

Membrane separation processes: Classification of membrane process, nature of synthetic membranes, general membrane equation, cross-flow microfiltration, ultrafiltration, reverse osmosis, membrane modules and plant configuration, membrane fouling.

Unit 2

Electrodialysis, reverse osmosis water treatment plant, pervaporation, liquid membranes, gas separations - chromatographic separations: Elution chromatography, band broadening and separation efficiency, types of chromatography, large scale elution chromatography, selective adsorption of proteins, simulated countercurrent techniques.

Unit 3

Combined reaction and separation, comparison with other separation techniques - ionic separations: Ion exchange resins, resin capacity, equilibrium, exchange kinetics; Ion exchange equipments - other techniques: Supercritical fluid extraction, oil spill management; Industrial effluent treatment by modern techniques. Reactive extraction, reactive distillation.

TEXTBOOKS:

1. *J.D. Seader and E.J. Henley, "Separation Process Principles", 2nd Edition, Wiley, 2005.*
2. *R.W. Baker, "Membrane Technology and Applications", John Wiley & Sons Ltd, UK, 2004.*

REFERENCES:

1. *P.C. Wankat, "Separation Process Engineering", 2nd Edition, Prentice Hall, 2006.*
2. *R.W. Rousseau, "Handbook of Separation Process Technology", Wiley-Interscience, 1987.*
3. *J.M. Coulson and J.F. Richardson, "Chemical Engineering - Volume 2", 5th Edition, Butterworth-Heinemann, 2002.*
4. *Y. Osada and T. Nakagawa, "Membrane Science and Technology", Marcel Dekker, 1992.*

CHE352 PETROLEUM REFINING AND PETROCHEMICAL TECHNOLOGY 3 0 0 3

(Pre-requisites: CHE213, CHE311)

Unit 1

Petroleum refining: Crude oil distillation process - thermal conversion processes. Conventional thermal cracking – vis-breaking and design variables of vis-breaking - coking: Fluid coking, flexi coking, delayed coking and hardware considerations - catalytic conversion processes - fluid catalytic cracking with special reference to catalyst and reactor design configurations - hydro-treating, hydrodesulphurization and hydro-cracking - Reforming: process, catalyst, reactor design configuration – alkylation – isomerization - lube oil manufacturing process, solvent - de-asphalting, solvent de-waxing and hydro-finishing - production of Pet, waxes and bitumen.

Unit 2

Petrochemical technology: Petrochemical industry overview, primary raw materials for petrochemicals, first generation petrochemicals - hydrocarbon intermediates and their production, non-hydrocarbon intermediates, olefin production, processing of olefins, processing of olefins C_4 & C_5 Cut from steam cracking and fluid cracking.

Unit 3

Aromatics production, second generation petrochemicals from: methane and synthesis gas derivatives, ethylene and ethylene derivatives, propylene and propylene derivatives, C_4 and C_5 derivatives, aromatics – benzene, toluene and xylene derivatives - third generation petrochemicals - polymers, elastomers, polyurethanes and synthetic fiber.

TEXTBOOKS:

1. *Ram Prasad, “Petroleum Refining Technology”, Khanna Publishers, Delhi, 2000.*
2. *J.H. Gary, G.H. Handwerk, and M.J. Kaiser, “Petroleum Refining Technology and Economics”, 5th Edition, CRC Press, New York, 2007.*
3. *G.D. Hobson and W. Pohl, “Modern Petroleum Technology”, 6th Edition, Wiley, New York, 2000.*
4. *B.K. Bhaskara Rao, “A Text on Petrochemicals”, Khanna Publishers, New Delhi 2008.*

REFERENCES:

1. *R.A. Meyers, “Handbook of Petroleum Refining Processes”, 2nd Edition, McGraw Hill, New York, 1996.*
2. *J.A. Moulijin, M. Makkee, and A. van Diepen, “Chemical Process Technology”, Wiley, New York, 2001.*
3. *I.D. Mall, “Petrochemical Process Technology”, Macmillan India Ltd, New Delhi, 2007.*
4. *Sami Matar and Lewis.F. Hatch, “Chemistry of Petrochemical Processes”, Gulf Publishing Company, Houston, Texas, 2000.*

CHE353 BIOCHEMICAL ENGINEERING 3 0 0 3

(Pre-requisite: CHE311)

Unit 1

Enzymes and enzyme kinetics - enzymes fundamental concepts, classification of enzymes; industrial application of enzymes; industrially important enzymes; mechanism of enzymatic reactions; Michaelis-Menten and Briggs Haldane equation; Models for complex enzyme kinetics; enzymes inhibition; factors affecting the reaction rates; immobilization; enzyme reactors with typical examples.

Unit 2

Microbial kinetics: Typical growth characteristics of microbial cells, factors - affecting growth; Monod’s equation; Transport in microbial system: Newtonian and non-Newtonian behaviour of broths; agitation and mixing; power consumption; gas – liquid transport in cells; transfer resistances; mass transfer coefficients and their role in scale – up of equipments.

Unit 3

BIOREACTORS: batch and continuous types; immobilized whole cell and enzyme reactors; high performance bioreactors downstream processes and effluent treatment: Recovery and purification of products, different unit operations in down streaming with special reference to membrane separations; extractive fermentation; anaerobic treatment of effluents; typical industrial examples for downstream processing and effluent disposal.

TEXTBOOKS:

1. *M.L. Shuler and F. Kargi, “Bioprocess Engineering Basic concepts”, 2nd edition, Prentice Hall of India, 2002.*

2. *J.E. Bailey and D.F. Ollis, “Biochemical engineering Fundamentals”, McGraw Hill, , 2nd Edition, McGraw Hill, 1986.*

REFERENCES:

1. *J.M. Lee, “Biochemical Engineering”, Prentice Hall, 1992.*
2. H.W. Blanch and D.S. Clark, “Biochemical Engineering”, 2nd *Edition, CRC Press, 1997.*

CHE371 INTERFACIAL SCIENCE AND ENGINEERING 3 0 0 3

(Pre-requisite: CHY100)

Unit 1

Introduction to surfaces, interfaces, and colloids; Surface and Interface – molecular origin, the work of cohesion and adhesion, surfactants structure, types interaction forces and potential, chemical and physical interaction, classification of physical forces. Van der Waals force, interaction between surface and particles - electrostatic forces and electric double layer.

Unit 2

DLVO theory, Hamaker constant, Boltzmann distribution, Debye length, specific ion adsorption, ion adsorption, stern layer, electrostatic, steric and electrosteric stabilization, zeta potential, surface tension, wetting and spreading, Young’s equation, contact angle - solid surfaces - surface mobility, characteristics, formation.

Unit 3

Adsorption, energy consideration of physical adsorption vs chemisorptions, Gibbs surface excess, Gibbs adsorption equation, Langmuir isotherm, BET isotherm, adsorption at solid-liquid interfaces - stability of colloids – emulsions, formation and stability, HLB number, PIT (phase inversion temperature) foams, aerosols, microemulsions, vesicles, micelles and membranes - applications of various colloidal systems.

TEXTBOOKS:

1. *D. Myers, “Surfaces, Interfaces, and Colloids: Principles and Applications”, 2nd Edition, Wiley-VCH, 1999.*
2. *T. Cosgrove, “Colloid Science: Principles, Methods and Applications”, 2nd Edition, Wiley-Blackwell, 2010.*

REFERENCE:

P.C. Hiemenz and R. Rajagopalan (Editors), “Principles of Colloid and Surface Chemistry”, 3rd Edition, Academic Press, New York, 1997.

CHE372 POLYMER MATERIALS AND RHEOLOGY 3 0 0 3

Unit 1

POLYMER MATERIALS: History of polymers and current scenario of polymer industry

– condensation polymerisation – addition polymerisation – free radical and ionic mechanisms – polymerisation methods – bulk, solution, suspension and emulsion – structure of polymers – crystalline, amorphous, orientation – molecular weight distribution – structural relationship between rubber, plastic and fibre.

Unit 2

Manufacture, properties and applications of commodity plastics – polyethylene, polypropylene, polyvinyl chloride, styrenics – engineering plastics – polyamides, polyesters, thermosets – phenolics and epoxy resins – natural and synthetic rubbers. POLYMER RHEOLOGY: Basic concept of Rheology – Newtonian and Non-Newtonian fluids, time independent and time-dependent fluids – shear and extensional viscosities – dependence of viscosity on temperature, pressure, molecular weight, strain rate and time; Normal stress difference – Weissenberg effect; Melt flow analysis: Laminar flow through circular cross section, parallel plates; Flow analysis using rheological models.

Unit 3

Measurement of rheological properties - concentric cylinder viscometer, cone and plate rheometer, capillary rheometer – viscoelasticity – effect of rate of strain, temperature and time on mechanical behaviour of polymeric materials, creep, stress relaxation; Dynamic mechanical properties – Boltzman principle, time – temperature equivalence, WLF equation – extrudate swell – polymer processing – injection molding, extrusion, compression molding; Application of rheology in polymer processing.

TEXTBOOKS:

1. *J.A. Brydson, "Plastics Materials", 7th Edition, Butterworth–Heinemann, 1999.*
2. *M. Morton, "Rubber Technology", 3rd Edition, Springer, Netherlands, 2009.*
3. *R.J. Crawford, "Plastics Engineering", 3rd Edition, Butterworth-Heinemann, 1998.*
4. *B.R. Gupta, "Applied Rheology in Polymer Processing", Asian Books, New Delhi, 2005.*

REFERENCES:

1. *M. Chanda and S.K. Roy, "Plastics Technology Handbook", CRC Press, Atlanta, 2007.*
2. *H.F Mark (Editor), "Encyclopaedia of Polymer Science & Technology", Wiley, New York, 2004.*
3. *J.A. Brydson, "Flow Properties of Polymer Melts", 2nd Edition, George Godwin Ltd., 1981.*
4. *J.M. Dealy and K.F. Wissburn, "Melt Rheology and its Role in Plastics Processing: Theory and Applications", Springer, 1999*

CHE373 MATERIALS CHARACTERIZATION AND SPECTROSCOPIC METHODS 3 0 0 3

(Pre-requisite: CHY100)

Unit 1

Imaging microscopies and image analysis: Optical microscopy, scanning electron microscopy, HRTEM, scanning probe microscopy, atomic force microscopy;

Unit 2

X-ray and electron diffraction: Properties of X-rays, review of crystal systems and Miller indices, stereographic projections, the Reciprocal Lattice, diffraction methods, phase identification, small angle scattering;

Unit 3

Spectroscopic techniques: Energy dispersive X-ray spectroscopy, X-ray photoelectron spectroscopy; Thermal and thermomechanical techniques: Differential scanning calorimetry and differential thermal analysis, thermogravimetric analysis, dynamic mechanical analysis and thermomechanical analysis.

TEXTBOOKS:

1. *H.H. Willard, L.L. Merritt, Jr., J.A. Dean and F.A. Settle Jr., "Instrumental Methods of Analysis", 7th Edition, Wadworth Publishing Company, 1988.*
2. *B.D. Cullity and S.R. Stock, "Elements of X-ray Diffraction", 3rd Edition, Prentice Hall, 2001.*
3. *R.F. Egerton, "Physical principles of electron microscopy: an introduction to TEM, SEM, and AFM", Springer, 2005.*

REFERENCES:

1. *N.P. Cheremisinoff and P.P. Cheremisinoff (Editors), "Handbook of Advanced Materials Testing", Marcel Dekker, New York, 1997.*
2. *H. Czichos, T. Saito and L.M. Smith (Editors), "Handbook of Materials measurement Methods", Springer, 2006.*

CHE380 SOLAR ENERGY 3 0 0 3

Unit 1

Solar radiation, its measurements and analysis. Solar angles, day length, angle of incidence on tilted surface, sunpath diagrams, shadow determination. Extraterrestrial characteristics, effect of earth atmosphere, measurement and estimation on horizontal and tilted surfaces.

Solar thermal collectors, flat plate collectors, concentrating collectors. Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers; conversion of heat energy in to mechanical energy, solar thermal power generation systems.

Unit 2

p-n junction, homo and hetro-junctions, metal-semiconductor interface, dark and illumination characteristics, figure of merits of solar cell, efficiency limits, variation of efficiency with band-gap and temperature, efficiency measurements, high efficiency cells, Tandem structure.

Preparation of metallurgical, electronic and solar grade silicon, production of single crystal 'Si', Chocharlski (CZ) and Float Zone (FZ) method for preparation of silicon, procedure of masking, photolithography and etching, design of a complete silicon, GaAs, InP solar cell. High efficiency III-V, II-VI multijunction solar cell, a-Si-H based solar cells, Quantum well solar cell, Thermophotovoltaics. Nanosolar cells.

Unit 3

Solar cell arrays, system analysis and performance prediction, shadow analysis, reliability, solar cell array design concepts, PV system design, design process and optimization, detailed array design, storage autonomy, voltage regulation, maximum tracking, power electronic converters for interfacing with load and grid, use of computers in array design, quick sizing method, array protection and trouble shooting. Centralized and decentralized SPV systems, stand alone, hybrid and grid connected systems, system installation, operation and maintenances, case studies and field experience, PV market analysis and economics of SPV systems.

REFERENCES:

1. *John W. Twidell and A D Weir, "Renewable Energy Resources", ELBS.*
2. *H.P. Garg and J. Prakash, "Solar Energy: Fundamentals & Applications", Tata McGraw Hill, New Delhi, 1997.*
3. *S.P. Sukhatme, "Solar Energy", Tata McGraw Hill.*
4. *J.F. Kreider and Frank Kreith, "Solar Energy Handbook", McGraw Hill.*
5. *D.Y. Goswami, Frank Kreith, and J.F. Kreider, "Principles of Solar Engineering", Taylor & Francis.*
6. *T. Bhattacharya, "Terrestrial Solar Photovoltaic", Narosa Publishers Ltd., New Delhi.*
7. *Alan L. Fahrenbruch and Richard H Bube, "Fundamentals of Solar Cells: PV Solar Energy Conversion", Academic Press, New York , 1983.*
8. *Larry D Partain (ed.), "Solar Cells and their Applications", John Wiley and Sons, Inc, New York, 1995.*
9. *Richard H. Bube, "Photovoltaic Materials", Imperial College Press, 1998.*
10. *H S Rauschenbach, "Solar Cell Array Design Handbook", Van Nostrand Reinfold Company, New York, 1980.*
11. *Martin Green, "Solar Cells: Operating principles, Technology and Systems Applications", UNSW, Australia.*
12. *Roger Messenger and Jerry Vnetre, "Photovoltaic Systems Engineering", CRC Press.*
13. *"Stand Alone PV Systems: A Handbook of Recommended Design Practices", Report No. SAND 87-7023, Sandia National Lab. USA.*
14. *L.L. Kazmerski, "Photovoltaics: A Review of Cell and Module Technologies", Renewable and Sustainable Energy Reviews, 1(1/2), 71-170, 1997.*

CHE381 INTRODUCTORY MODERN BIOLOGY 3 0 0 3

Unit 1

Introduction and macromolecules: Introduction to biology; carbon chemistry; macromolecules; Carbohydrates: energy storage building blocks; Lipids: membranes,

energy storage; Proteins: structure, folding, catalysis; Nucleic acids: storage and transfer of genetic information.

Unit 2

Molecular genetics: Genes; basics of DNA replication, transcription, translation, genome organization; mutations; gene technology.

Cell biology and energetics: Cell structure; Membranes; Function of cell organelles; Cell cycle; Cell division: mitosis, meiosis, gamete formation; Energetics; ATP and glycolysis; Respiration.

Unit 3

Molecular biology techniques: Gel electrophoresis; Molecular scissors; Polymerase Chain Reaction (PCR); Ligation; Cloning; DNA-sequencing; Microarray.

TEXTBOOKS:

1. *W. K. Purves et al., « Life, The Science of Biology", 7th Edition, W. H. Freeman and Co., 2003. http://www.whfreeman.com/thelifewirebridge2/*
2. *Richard Durban and Sean R. Eddy, "Biological sequence analysis, Probabilistic Models of Proteins and Nucleic acids", Cambridge University Press, 1998.*

REFERENCES:

1. *Peter H. Raven et al., "Biology", 6th Edition, McGraw Hill, 2007. http://www.ravenbiology.com*
2. ***David L. Nelson et al., "Lehninger, Principles of Biochemistry", 5th Edition, W. H. Freeman, 2009.***

CHE382 FUNDAMENTALS OF ORGANIC ELECTRONICS 3 0 0 3

Unit 1

Materials and processing: Organic semiconductors - conjugated polymers, Petancene, Polythiophene, Indolo [3,2-b] carbazole, polyfluorenes, poly(*p*-phenylene vinylene), Alq3, Phthalocyanines - organic vapour phase deposition – thermal imaging and micro contact printing – digital lithography.

Unit 2

Device physics: Charge transport and injection in organic semiconductors – magnetic field effect in organic semiconducting materials and devices – interface in organic semiconductor devices: Dipoles, doping, band bending and growth and new insights to traditional concepts - electronic properties of interfaces between model organic semiconductors and metals.

Unit 3

Devices manufacturing: From transistor to large scale integrated circuits – displays, light emitting diodes – polymer FET devices – polymer solar cells – heterojunction solar cells – large area detectors and sensors.

TEXTBOOKS:

1. *Franky So, "Organic Electronics: Materials, Processing, Devices and Applications", CRC Press, Taylor and Francis Group, 2010.*
2. *Hagen Klauk, "Organic Electronics: Materials, Manufacturing and Applications", WILEY-VCH Verlag GmbH & Co.,2006.*
3. *Wolfgang Brütting, "Physics of Organic Semiconductors" WILEY-VCH Verlag GmbH & Co.,2005.*

REFERENCE:

G. Meller, T. Grasser, "Organic Electronics (Advances in Polymer Sciences)", Vol. 223, Springer Publications, 2009.

CHE383 FUNDAMENTALS OF PLASTIC PRODUCT AND MOULD DESIGN 3 0 0 3

Unit 1

Properties of plastics - mechanical/chemical/environmental/rheological properties - special properties - processing methods - mechanical behavior of plastics - short term testing - long term testing - design methods for plastics - pseudo elastic design method - thermal stresses and strains – time-temperature superposition - fracture behavior - creep behavior - impact behavior.

Unit 2

Design of injection molded parts - manufacturing considerations - mold filling considerations - Weld line - shrinkage and warpage - cooling and solidification - structural design considerations - structural members - design for stiffness - processing limitations in product design.

Mould and die design - concept and materials - compression and transfer mould design - basics of mould construction - mould design - positive moulds - positive moulds with lands – multi-cavity moulds with individual/common loading chamber - moulds with a slide core - split cavity moulds. Calculation of material requirement - heat losses and energy requirement.

Unit 3

Injection mould design - basics of mould construction - methodical mould design - design of feed system - ejection system - venting - cooling system - mould alignment concepts - demoulding techniques - examples on complete mould design for industrial components along with costing – defects in moulded products – isolation of cause – remedies.

Blow mould design - materials selection - mould cooling - clamping force – venting - pinch off. Head die design - Parison diameter calculation - wall thickness - vertical load strength - blow ratio - base pushup - neck and shoulder design - thread and beads - bottom design. Extrusion die design - die geometry - dies for extrusion products.

TEXTBOOKS:

1. *P.S. Cracknell and R.W. Dyson, "Handbook of Thermoplastics - Injection Mould Design", Chapman & Hall, 1993.*
2. *Laszlo Sors and Imre Balazs, "Design of Plastics Moulds and Dies", Elsevier, Amsterdam, 1989.*
3. *R.G.W. Pye , "Injection Mould Design", SPE Publication, 2000.*
4. *R J Crawford, "Plastics Engineering", Butterworth-Heinemann, Oxford, 1999*
5. *Edward Miller(Ed), "Plastics Product Design Handbook Part A – Materials and Components", Marcel Dekker, 1981.*

REFERENCES:

1. *R.A. Malloy, "Plastic Part Design for Injection Molding - An Introduction", Hanser, 1997.*
2. *A.N. Gent (Ed), "Engineering with Rubber, How to Design Rubber Components", Hanser, New York, 2001.*
3. *N. Rao and K. O'Brien, "Design Data for Plastics Engineers", Hanser, New York, 1998*

CHE384 PLASTICS: MATERIALS, PROCESSING AND PROPERTIES 3 0 0 3

Unit 1

Plastics materials – historical development – advantages over metals - special features of plastics and rubbers – molecular weight, glass transition, crystallinity – addition and condensation polymers - commodity plastics – polyethylene, polypropylene, polyvinyl chloride, styrenics - additives – fillers, process aids, stabilizers, curatives, etc.

Unit 2

Engineering plastics – polyamides – polyesters. Thermosets – phenolics and epoxy resins - natural and synthetic rubbers – properties – physical – mechanical – viscoelastic behavior – dynamic mechanical analysis, stress relaxation and creep – rheology – friction and wear – tribology – fracture behavior – moisture resistance - thermal behavior.

Unit 3

Processing techniques - injection moulding, extrusion, blow molding, compression molding, thermoforming, etc. – applications – automobiles, tyres, packaging, consumer goods, aerospace, structural engineering, etc.

TEXTBOOKS:

1. *J. A. Brydson, "Plastics Materials" Butterworth- Heinemann – Oxford, 7th Edition, London, 1999.*
2. *John S. Dick, "Rubber Technology", Hanser, Munich, 2001.*

REFERENCES:

1. *Manas Chanda and Salil K. Roy, "Plastics Technology Handbook", CRC Press, Atlanta, 2007.*
2. *Hermann F Mark [Ed], "Encyclopaedia of Polymer Science & Technology", Wiley, New York, 2004.*

CHE385 COMPOSITES FOR AEROSPACE APPLICATIONS 3 0 0 3

Unit 1

General introduction to composite materials: Concept and definition, classification of composites (CMC, MMC, PMC). Functional roles of reinforcement and matrix and importance of interface. Applications diversity of composites, including aerospace fields.

Polymer Matrix Composites (PMCs): Fiber-reinforced and particulate filled polymer composites. Reinforcements (glass, carbon/graphite, kevlar), matrices (thermoplastics and thermosets). Thermoset matrices of interest to aerospace components (polyesters, epoxides, phenolics, vinyl esters, polyimides, cyanate esters). Choice of reinforcements and matrices for different application needs. PMCs used in current aerospace applications with some examples *(All composite aircraft, Airframe structures, defense and aerospace components, civil aircraft parts, etc.)*

Unit 2

Fiber-Reinforced Polymer composites (FRPs): Basic rule of mixtures. Stress-strain relationships. Tailoring of structural properties through laminar - sequencing and choice of fiber fractions/fiber orientations, to meet design requirements. Effect of environmental conditions on properties.

Mechanical behavior of FRP composites: Fiber-controlled and matrix-dependent properties (tensile, compressive, shear). Experimental determination of composite properties by standard test methods. Composite constructions: Monolithic composite laminates: unidirectional & bidirectional, multi-axial, 3D, filament wound & braided types.

Unit 3

Composite precursors: SMCs, DMCs, BMCs and prepreg materials and their choice in specific applications.

Fabrication processes for FRP-composites: hand lay-up, spray-up, vacuum bag moulding, compression moulding, filament winding, braiding, pultrusion, RTM, RIM, RRIM, RFI, autoclave moulding, injection moulding, etc. Common manufacturing processes used in aerospace applications. Room temperature and hot curing of composites. Composite post-processing joining composite elements and repairs.

TEXTBOOKS:

1. *G. Lubin(Ed), "Handbook of Composites, Van-Nostrand Reinhold Pub.1982.*
2. *Comptec (IIT Madras), "Composite Technology notes", Vol I – VI, FRP Institute Chennai.*

REFERENCES:

1. *R.P. Weatherhead, "FRP Technology", Applied Science Pub.*
2. *J.H. Mohr et al, "SPI Handbook of Tech. & Engg of RP/Composites", Van-Nostrand Publications.*
3. *P.K. Mallick, "Fibre-Reiforced Composites-Materials", Manufacturing & Design, Marcel Dekker Publications.*

CHE390 CHEMICAL TECHNOLOGY LAB. 0 0 3 1

1. Identification and characterization of various functional groups by their characteristic reactions: reactions of aldehyde, ketone, carboxylic acid, amide, ester, primary, secondary and tertiary amines.
2. Analysis of an unknown organic salt – identification of functional groups in the given organic compound and preparation of suitable solid derivatives.
3. Introduction to organic synthetic procedures.
   Acetylation of aniline to acetanilide; Preparation of acetyl salicylic acid (from salicylic acid and acetic anhydride).
4. Determination of acid value for different oils (any two).
5. Determination of saponification value for different oils (any two).
6. Determination of Flash Point of given oil (any two).
7. Determination of Flash Point of given oil (any two).
8. Determination of viscosity by Redwood Viscometer.

CHE391 HEAT TRANSFER LAB. 0 0 3 1

Thermal conductivity of solid materials, transient heat conduction, electrical analogies, natural convection, forced convection, heat transfer in pool boiling, condensation heat transfer, steady and un-steady state heat transfer through submerged coils in agitated vessels. Radiation heat transfer, characteristics and efficiency of heat transfer equipments such as heat exchangers, jacketed pans and evaporators.

CHE392 MASS TRANSFER LAB. 0 0 3 1

Measurement of diffusion coefficient, concentration profile, Wetted wall column, Ternary liquid-liquid equilibrium, leaching, extraction in packed and plate columns, steam distillation, simple distillation, distillation in packed columns, adsorption isotherms and drying rate measurements, characteristics and efficiency of mass transfer equipments.

CHE393 CHEMICAL REACTION ENGINEERING LAB. 1 0 3 2

Lectures on RTD studies; Study of kinetic expressions for first and second-order reactions, Kinetic studies in batch reactor, CSTR, PFR, RTD Study in CSTR in series, RTD study in a PFR, RTD study in a packed bed.

CHE397 SEMINAR 0 0 3 1

CHE400 ENVIRONMENTAL ENGINEERING FOR PROCESS INDUSTRIES 3 1 0 4

(Pre-requisites: CHE210, CHE220, CHE320)

Unit 1

Introduction: Ecology and environment, overall picture of environmental pollution, environmental pollution from chemical process industries, standards and Acts-Indian, EPA& EURO.

Pollution prevention: Process modification, alternative raw material, recovery of by co-product, recycle and reuse of waste, energy recovery and waste utilization. Material and energy balance for pollution minimization; water usage minimization, housekeeping, and maintenance.

Air pollution control: Sources and effects of air pollutants on physical environment and living systems, methods of measuring and sampling of gaseous and particulate pollutants. Selection and design of particulate and gaseous pollution control equipments; mechanical separation, electrostatic precipitation, wet gas scrubbing, adsorption and adsorption.

Unit 2

Water pollution control: Waste water characteristics: physical, chemical and bacteriological, types of pollutants in waste water of chemical industries, methods of sampling, preservation of samples and analysis. Methods for the treatment of liquid wastes: Physical, chemical and biological methods, selection and design of equipments. Physical treatment: pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation. Chemical treatment: Anaerobic and aerobic treatment biochemical kinetics, trickling filter, activated sludge process, lagoons, aeration systems, fluidized bed bioreactors; Disinfection, Ion exchange, Electro-dialysis, Reverse osmosis; Sludge treatment and disposal.

Unit 3

Solid wastes management: Characterization of wastes - hazardous and non-hazardous wastes. Waste disposal and management laws and guidelines; Problems of collection and handling; various processing techniques used in solid waste management - treatment, disposal, utilization and management; value-extraction from the wastes;

Noise pollution: Effects and control methods.

Case studies: Pollution abatement in important chemical industries like fertilizer, petroleum refineries and electro-chemicals, pulp and paper, pharmaceuticals, tannery, sugar, distillery, food processing, cement and electroplating.

TEXTBOOKS/REFERENCES:

1. *C.S. Rao, "Environmental Pollution Control Engineering," 2nd Edition, New Age International Publishers, 2006.*
2. *G. Kiely, "Environmental Engineering", Special Indian Edition, Tata McGraw-Hill, 2009.*
3. *G. Tchobanoglous, F.L. Burton, and H.D. Stensel, "Wastewater Engineering: Treatment and Reuse", 4th Edition, McGraw Hill Science, 2002.*
4. *S.P. Mahajan, "Pollution Control in Process Industries", Tata McGraw Hill, 2001.*
5. *A.P. Sincero and G.A. Sincero, "Environmental Engineering: A Design Approach", Prentice Hall, 1995.*
6. *H.S. Peavy, D.R. Rowe, and G. Tchobanoglous, "Environmental Engineering", 7th Edition, McGraw Hill, 1987.*
7. *M.N. Rao and H.V.N. Rao, "Air Pollution", Tata McGraw Hill, 2001.*
8. *F. Kreith and G. Tchobanoglous, "Handbook of Solid Waste Management", 2nd Edition, Mc Graw Hill, 2002.*

CHE410 TRANSPORT PHENOMENA 3 1 0 4

(Pre-requisites: MAT111, MAT112, CHE211, CHE310)

Unit 1

Mathematical background: principles of mathematical modeling, vector analysis, tensor mathematics, Green's theorem; Momentum transport: Viscosity, mechanism of momentum transport, shell balance method, Newton's law, pressure and temperature effect on viscosity of gases and liquids, velocity distributions in falling film, circular tube, annulus, etc.

Unit 2

Equations of change and turbulent flow: Equation of continuity, motion, mechanical energy, use of equations of change to solve flow problems, dimensional analysis of equations of change, comparison of laminar and turbulent flows, time-smoothed equation of change, empirical expressions; Energy transport: Thermal conductivity, mechanism of energy transport, shell energy balance, Fourier's law, temperature and pressure effect on thermal conductivity of gases and liquids, temperature distribution in solids and laminar flow, heat conduction through composite walls, cylinders, spheres, fins, and slits; Equations of change for non-isothermal system and temperature distribution in turbulent flows: Energy equations, use of equations of change, dimensional analysis of equations of change, time-smoothed equations of change, empirical expressions, temperature distribution for turbulent flow in tubes, jets.

Unit 3

Mass transport: Diffusivity, mechanism of mass transport, concentration distribution in solids and in laminar flow, Fick's law, temperature and pressure effect, theory of diffusion in gases and liquids, mass and moles transport, shell mass balances, concentration distribution through stagnant gas, diffusion in heterogeneous and homogeneous chemical reaction, falling film, porous catalyst; Equations of change for multicomponent systems and concentration distribution in turbulent flows: The equation of continuity and use of equations of change.

TEXTBOOK:

R.B. Bird, W.E. Stewart and E.W. Lightfoot, "Transport Phenomena", 2nd edition, John Wiley, 2002.

REFERENCES:

1. *R.S. Brodkey and H. C. Hershey, "Transport Phenomena", McGraw Hill, 1988.*
2. *J.R. Welty, R.W. Wilson and C.W. Wicks, "Fundamentals of Momentum, Heat, and Mass Transfer", 3rd Edition, John Wiley, 1984.*
3. *J.S. Slattery, "Advanced Transport Phenomena", Cambridge University Press, 1992.*
4. *R. Aris, "Vectors, Tensors, and the Basic Equations of Fluid Mechanics", Dover Publications **Inc., 1990.***

CHE430 PROCESS EQUIPMENT DESIGN AND DRAWING 1 0 3 2

(Pre-requisites: CHE221, CHE241, CHE310, CHE311, CHE312)

Design and drawing of chemical engineering equipments – hydrodynamic design, process design, mechanical design and drawing (conventional and computer aided approach) of the following equipments but not limited to:

Unit 1

Heat exchangers, pumps, valves, dryers.

Unit 2

Cooling towers, crystallizers, absorption columns.

Unit 3

Distillation columns, extraction columns, reactors

TEXTBOOK:

M.V. Joshi and V.V. Mahajan, "Process Equipment Design", 3rd Edition, MacMillan India Ltd., 1996.

REFERENCES:

1. *R.H. Perry, D.W. Green and J.O. Maloney, "Perry's Chemical Engineers' Handbook", 7th Edition, 1997.*
2. *S.D. Dawande, "Process Design of Equipments", Central Techno Publications, Nagpur, 2000.*
3. *"Indian Standard Specifications", IS-803, 1962; IS-4072, 1967; IS-2825, 1969, Indian Standards Institution, New Delhi.*
4. *S. Tickoo, "AUTOCAD 2000", Galgotia Publications, New Delhi, 2001.*
5. *D. Kern, "Process Heat Transfer", McGraw-Hill, 1999.*

CHE440 BIOCHEMISTRY AND MOLECULAR BIOLOGY 3 0 0 3

(Pre-requisite: CHY100)

Unit 1

Chemistry of biomolecules – essentials of structure and classification of carbohydrates, lipids, amino acids and proteins and nucleic acids; Supramolecular

assemblages and arrangement of cell organelles; Biocatalysis: Enzymes – structural aspects, cofactors, activation, catalytic mechanism – specific examples; Enzyme kinetics – Michaelis-Menton equation, classes of inhibition; Allosteric enzymes, isoenzymes and multienzyme complexes;

Unit 2

Metabolism: overview, important pathways related functions and inter-relationships – glycolysis, citric acid cycle; hexose monophosphate shunt; mitochondrial electron transport chain; oxidative phosphorylation process; ATP synthase; oxidation of fats and amino acids; urea cycle;

Unit 3

Cellular process of genetic information: Assemblages of DNA and RNA, nature of genetic code, replication of DNA, transcriptional aspects and translation process; Regulation of gene expression.

TEXTBOOK:

D. Voet and J.G. Voet, "Fundamentals of Biochemistry", 3rd Edition, Wiley, 2005.

REFERENCE:

D.L. Nelson, A.L. Lehninger, and M.M. Cox, "Principles of Biochemistry", 4th Edition, W.H. Freeman, 2004.

CHE450 PAPER PULP AND FERTILIZER TECHNOLOGY 3 0 0 3

Unit 1

Pulp and paper technology: Structure and properties of pulp wood; Preparation of pulp wood; Manufacture of pulp - mechanical, Sulphite, Kraft and alkaline process pulps; Treatment of pulp; Bleaching of pulp; Testing of wood pulp; Preparation of stock for paper making - manufacturer of paper and boards; special papers; Auxiliary paper mill equipment; Recycling of waste and recovery of chemicals in the paper and pulp industry; Pollution control and effluent treatment in paper and pulp industries; Specification for paper and boards; Testing of paper and paper products; Future and scope of paper industry in India; Use of alternate raw materials.

Unit 2

Fertilizer technology: Types of fertilizers and their uses, production and consumption pattern, raw materials, mini and large plants their merits and demerits, symbiosis, different nitrogen fixation processes, nitrogen cycle in the nature, different nutrient of the soil and their removal, status of ammonia production, synthesis gas by reforming hydrocarbons from natural gas and naphtha; Production of urea - urea processes, manufacture of other nitrogenous fertilizers such as ammonium sulphate, calcium ammonium nitrate, ammonium chloride, etc.

Unit 3

Phosphoric fertilizers - single & triple super phosphate manufacture; Production of ammonium phosphates & nitro phosphates, manufacture of phosphoric acid; Potassium fertilizers, mixed & compound fertilizers, liquid fertilizers; Indian fertilizer industry - production economics and future plans; Fertilizer application techniques for different soils, controlled release fertilizers.

TEXTBOOKS:

1. *K.W. Britt (Editor), "Handbook of Pulp and Paper Technology", 2nd Edition, CBS Publishers, 1984.*
2. *M.G. Halpern, "Pulp Mill Processes", Noves Publications, 1981.*
3. *J.B. Calkin, "Modern Pulp and Paper Making", 3rd Edition, Reinhold Publishing Corporation, 1957.*

REFERENCES:

1. *A.M. Springer, "Industrial Environmental Control: Pulp and Paper Industry". 2nd Edition, Tappi Publishing, 1997.*
2. *F.T. Nielsson, "Manual of Fertilizer Processing", Marcel Dekker, 1987.*
3. *V. Sauchelli, "Chemistry and Technology of Fertilizers", Reinhold, 1960.*
4. *M. Bickford, "Kirk-Othmer - Concise Encyclopaedia of Chemical Technology", (2-volume set), 4th Edition, Wiley-Interscience, 1999.*

CHE451 SAFETY AND HAZARD MANAGEMENT IN CHEMICAL INDUSTRIES 3 0 0 3

Unit 1

Hazard identification: General hazards of plant operation toxic hazards, fire and explosions – hazards. Transport of chemicals with safety unforeseen deviations, emergency management, planning for safety, selecting a basics of safety - preventive and protective measures, safety based on emergency, relief systems, safety based on containment operational safety procedural instructions Sla-Routine checks, process and product changes, safety checks, checklist for safety, leaks and detection.

Unit 2

Hazards of plant operation: Toxic hazards, fire and explosion hazards, reaction hazards, literature calculations & explosions screening, normal reaction, gas evolution, characterizing runaways, control and mitigation of gas emanations, absorption with chemical reaction, health and environmental effects. Special problem of developing countries, safety gadgets, dispersions, degree of hazards, disposals, hierarchy of options, I.C.A. application, nil hazards & alternate methods, threshold limits, laws of safety, accident reporting.

Unit 3

Storage, central handling safety, unintentional spills, runoff emits, containment economics, waste disposal and environmental protection, incineration, alternatives.

Risk analysis, evaluation, mitigation, Hazop, Hazan, definition, probability, quantification-risk, engineering, clean technology, initiatives, standards, emergency handling, accident investigation, legislation, nil-risk quantification methods. Case histories of accidents, examples of hazards assessment, examples of use of Hazan, explosion hazards in batch units, technical process, documentation for hazardous chemicals, format and methods.

TEXTBOOKS:

1. *A.K. Rohatgi, "Safety handling of Hazardous Chemicals", J.K. Enterprises, Bombay, 1986.*
2. *S.K. Shukla, "Enviro Hazards and Techno Legal Aspects", Shashi Publications, Jaipur, 1993.*
3. *G.L. Wells and R.M.C. Seagrave, "Flow sheeting for safety", Institution of Chemical Engineering, London, 1977.*

REFERENCES:

1. *T. Kletz, "Learning from Accidents", 3rd Edition, Gulf Professional Publishing, London, 1988.*
2. *J. Barton and R. Rogers, "Chemical Reaction Hazards - A Guide to Safety", Institution of Chemical Engineering, Gulf Professional Publishing, London, 1997.*

CHE452 PHARMACEUTICAL TECHNOLOGY 3 0 0 3

(Pre-requisites: CHE320, CHY260)

Unit 1

PHARMACEUTICAL TECHNOLOGY: Introduction to drugs, drug dosage forms, and drug delivery systems: Introduction to drugs and pharmacy: New drug development and approval process, current good manufacturing practices and current good compounding practices, intellectual property considerations, dosage form design.

Unit 2

Pharmaceutical and formulation considerations & biopharmaceutical and pharmacokinetic considerations; Characteristics of biopharmaceutical drugs; Solid dosage forms and solid modified-release drug delivery systems: Powders and granules, capsules, tablets, solid oral modified-release dosage forms and drug delivery systems, semisolid dosage forms and transdermal systems: Ointments, creams, and gels, transdermal drug delivery systems.

Unit 3

Pharmaceutical inserts: Suppositories and inserts, liquid dosage forms: Solutions, disperse systems, sterile dosage forms and delivery systems: parenterals, biologics, special solutions and suspensions, novel and advanced dosage forms, delivery systems, and devices.

TEXTBOOKS:

1. *L.V. Allen, N.G. Popovich, and H.C. Ansel, "Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems", 9th Edition, Lippincott Williams and Wilkins, 2010.*

2. *K.E. Avis, L, Lachman, and H. Lieberman, "Pharmaceutical Dosage Forms: Parentral Medication"s, 2nd Edition, Informa Healthcare, 1993.*

REFERENCES:

1. *L. Lachman, "The Theory and Practice of Industrial Pharmacy", CBS Publishers & Distributors Pvt. Ltd., 2009.*
2. *S.K. Niazi, "Handbook of Preformulation: Chemical, Biological, and Botanical Drugs", Informa Healthcare, 2006.*

CHE453 FOOD AND BIOPROCESS ENGINEERING 3 0 0 3

(Pre-requisites: CHE213, CHE311)

Unit 1

Food-process engineering: an overview - general aspects of food industry; world food needs and Indian situation - food constituents, quality and derivative factors - constituents of food; quality and nutritive aspects; food additives; standards; deteriorative factors and their control - general engineering aspects and processing methods - preliminary processing methods; conversion and preservation operations - food preservation methods - preservation by heat and cold; dehydration; concentration; drying irradiation; microwave heating; sterilization and pasteurisation; fermentation and pickling; packing methods.

Unit 2

Production and utilisation of food products - cereal grains; pulses; vegetables; fruits; spices; fats and oils; bakery; confectionery and chocolate products; soft and alcoholic beverages; dairy products; meat; poultry and fish products.

Bio-process engineering: Introduction to bioprocesses - historical development of bioprocess technology, an overview of traditional and modern applications of biotechnological processes, role of bioprocess engineer in the biotechnology industry, outline of an integrated bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses, generalized process flow sheets - fermentation processes - general requirements of fermentation processes, basic design and construction of fermentor and ancillaries; Main parameters to be monitored and controlled in fermentation processes, an overview of aerobic and anaerobic fermentation processes and their application in the biotechnology industry, solid-substrate fermentation and its applications.

Unit 3

Enzymatic bioconversion processes - kinetics and thermodynamics of enzyme-catalyzed reactions, techniques of enzyme immobilization, basic design and configuration of immobilized enzyme reactors, applications of immobilized enzyme technology - media design and sterilization for fermentation processes - medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and

other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design and usage of various commercial media for industrial fermentations, thermal death kinetics of microorganisms, batch and continuous heat, sterilization of liquid media, filter sterilization of liquid media & air-kinetics of microbial growth - phases of cell growth in batch cultures, simple unstructured kinetic models for microbial growth, Monod model, growth of filamentous organisms.

TEXTBOOKS:

1. *J.E. Bailey and D.F. Ollis, "Biochemical engineering Fundamentals", McGraw Hill, 2nd Edition, McGraw Hill, 1986.*
2. *D.R. Heldman, "Food Process Engineering", AVI Publishing Co., Westport, 1975.*
3. *J.L. Heid and M.A. Joslyn, "Fundamentals of Food Processing Operations", AVI Publishing Company, Westport, 1967.*

REFERENCES:

1. *N.N. Potter, "Food Science", AVI Publishing Co., Westport, 1963.*
2. *S.E. Charm, "The Fundamentals of Food Engineering", AVI Publishing Co., Westport, 1963.*
3. *Shuler and Kargi, "Bioprocess Engineering", Prentice Hall, 1992.*

CHE454 CATALYSIS IN REFINING AND PETROCHEMICALS 3 0 0 3

(Pre-requisite: CHE311)

Unit 1

Catalysis in 21st century: Challenges for future and opportunities - role of catalysis in petroleum refining and petrochemical industry: an overview - designing specific catalysts for refining process applications - FCC, DCC catalysts for Olefins and LPG maximization.

Unit 2

Reforming catalyst - hydrocracking and hydrotreating catalysts - alkylations and isomerization catalysts - physio-chemical characterization of the catalysts: overview of various techniques.

Unit 3

New and emerging trends in catalysis & catalytic materials for refining and petrochemicals - analysis and design of heterogeneous catalytic reactors – fixed-bed reactor, fluidized-bed catalytic reactor, slurry reactor, trickle-bed and multiphase reactor.

TEXTBOOKS:

1. *J.J. Carberry, "Chemical and Catalytic Reaction Engineering", Dover Publications, 2001.*
2. *G.F. Fremont and K.B. Bischoff, "Chemical Reactor Analysis and Design", 2nd Edition, Wiley, 1990.*
3. *D.L. Trimm, "Design of Industrial Catalysts", Elsevier Scientific Publishing Company, 1980.*

REFERENCES:

1. *J.M. Coulson and J.F. Richardson, "Chemical Engineering - Volume 2", 5th Edition, Butterworth-Heinemann, 2002.*
2. *I. Muchlyonor, E. Dobkina, V. Deryozhkina, and V. Sorco, "Catalyst Technology", MIR Publication, Moscow 1982.*

CHE460 MOLECULAR MODELING AND COMPUTATIONAL CHEMISTRY 3 0 0 3

(Pre-requisites: PHY100, MAT111, MAT112)

Unit 1

Introduction - computational models - symmetry, stability, homogeneity and quantization. Elements of symmetry, point group, irreducible representation spectroscopic labelling; Quantum chemistry: Time-independent and time-dependent Schrodinger equation, solution to Schrodinger equation; Huckel's molecular orbital theory: Variational principle, method of finding the expectation energy, overlap, Coulomb and the Resonance integral - secular matrix, applications to find bond order, free valency index, delocalization energy and spectral characterization.

Unit 2

Hartree-Fock theory: Boson and Fermions, Slater determinant - formulation of Hartree and Hartree-Fock method - Roothan Hall equation - Koopman theorem; basis set: STO and GTO - minimal basis set - contracted and split basis set - basis set truncation error and basis set super imposition error; modifications to HF: computation of correlation energy - configurational interaction - many body perturbation theorem. Neglect of differential overlap - AM and PM method.

Unit 3

Molecular mechanics: Morse potential - harmonic oscillator - common force fields and force field formulation; molecular modelling: PES-transition state - single point energy calculation - population analysis - thermodynamic properties - input formats; simple computational experiments: single point energy - geometry optimization - vibrational analysis - population analysis – conformation - delocalization energy – spectra - basis set.

TEXTBOOKS:

1. *K.I. Ramachandran, G. Deepa, and P.K. Krishnan Namboori, "Computational Chemistry and Molecular Modeling: Principles and applications", Springer-Verlag, 2008.*
2. *D.W. Rogers, "Computational Chemistry using the PC", Wiley-Interscience, 2003.*

REFERENCE:

Tamar Schlick, "Molecular Modeling and Simulation: An Interdisciplinary Guide", Springer Verlag, 2002.

CHE461 CHEMICAL PROCESS MODELING AND SIMULATION 3 0 0 3

(Pre-requisites: MAT111, MAT112, CHE210)

Unit 1

Systematic approaches to problem solving: system definition, changes of variables, coordinate systems, lumped vs. distributed-parameter systems; lumped-parameter systems: mixing, evaporators, separation operations, isothermal and non-isothermal CSTR; simultaneous heat and mass transfer in a packed tower – separation operations, packed-bed reactors; distributed-parameter systems: settling tanks, heat exchangers, isothermal and non-isothermal PFR, catalytic reactors.

Unit 2

Responses of linear systems: linear ODEs with constant coefficients; responses of nonlinear systems: equilibrium-staged operations, diffusion equation: 1-D and 2-D; change of variables and similarity transforms.

Unit 3

Introduction to flowsheet simulation: flowsheeting on the computer, solving linear and Non-linear algebraic equations, property estimation in flowsheets, degree of freedom analysis of a flowsheet; tearing in a flowsheet, sequential modular approach and equation-oriented approach, linear and quasi-linear approaches.

TEXTBOOKS:

1. *W.L. Luyben, "Process Modeling, Simulation and Control for Chemical Engineers", 2nd Edition, McGraw Hill, 1996.*
2. *C.L. Smith, R.W. Pike and P.W. Murrill, "Formulation and Optimization of Mathematical Models", International Textbook Company, USA, 1970.*

REFERENCE:

L.T. Biegler, E.I. Grossman and A.W. Westerberg, "Systematic Methods of Chemical Process Design", Prentice Hall, 1997.

CHE462 COMPUTATIONAL METHODS IN FLUID DYNAMICS 3 0 0 3

(Pre-requisites: MAT111, MAT112, MAT212, CHE211)

Unit 1

Introduction to Computational Fluid Dynamics (CFD) - a research, modelling and design tool - historical perspective - experimental, analytical and computational approaches to the prediction of flow and heat transfer processes.

Unit 2

Commercial CFD packages - mathematical description of physical phenomena - governing differential equations of fluid flow and heat transfer – transport equations

– various discretization methods - finite difference, finite element, control volume methods.

Unit 3

Solving fluid dynamics problems with commercial software: introduction to numerical grid generation – structured and unstructured grid generation methods - automatic grid generation; conservation laws of fluid motion, boundary conditions, turbulence modelling, diffusion problems, convection – diffusion problems, pressure velocity coupling in steady flows, unsteady flows.

TEXTBOOKS:

1. *H.K. Versteeg, W. Malalasekera, "An Introduction to Computational Fluid dynamics (The Finite Volume Method) ", Longman Scientific and Technical, 1995.*
2. *J.D. Anderson, "Computational Fluid Dynamics", McGraw Hill, 1995.*

REFERENCES:

1. *A.W. Date, "Introduction to Computational Fluid Dynamics", Cambridge University Press, 2005.*
2. *S.V. Patankar, "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corp., 1980.*

CHE471 NANOSCIENCE AND NANOTECHNOLOGY 3 0 0 3

(Pre-requisite: CHY100)

Unit 1

NANOSCIENCE AND NANOTECHNOLOGY: Nanotechnology fundamentals - atomic structure, molecules and phase, top-down and bottom-up approach, optical, nano dots, nano manipulations.

Unit 2

Micro/Nano fabrication techniques: optical and electron beam lithography, molecular beam epitaxy, etching, vacuum processing, molecular self-assembly, polymerization, nanoparticle synthesis, sol-gel process, carbon nanotubes.

Unit 3

Characterization technique for nanostructures and nanomaterials: spectroscopy, electron microscopy, AFM and STM - nanotechnology applications: molecular switches (electron, pH and light stimuli), molecular computing, biotechnology (lipids, SAMs, biosensors, drug delivery and so forth), miniaturizing devices (transistors, chip interconnects, MEMS/NEMS).

TEXTBOOK:

M.A. Ratner and D. Ratner, "Nanotechnology: A Gentle Introduction to the Next Big Idea", Prentice Hall, 2002.

REFERENCES:

1. *M. Wilson, K. Kannangara, G. Smith, M. Simmons and B. Raguse, "Nanotechnology: Basic Science and Emerging Technologies", Chapman and Hall, 2002.*
2. *A. Nouailhat, "An Introduction to Nanosciences and Nanotechnology", Wiley-ISTE, 2008.*

CHE480 PROJECT ENGINEERING OF PROCESS PLANTS 3 0 0 3

(Pre-requisite: CHE430)

Unit 1

Scope of project engineering - the role of project engineer - R & D - TEFR - plant location and site selection - preliminary data for construction projects - process engineering – flow diagrams - plot plans - engineering design and drafting; planning and scheduling of projects - bar chart and network techniques.

Unit 2

Procurement operations - office procedures - contracts and contractors - project financing – statutory sanctions;

Details of engineering design and equipment selection I: design calculations excluded - vessels - heat exchangers - process pumps - compressors and vacuum pumps - motors and turbines - other process equipment.

Unit 3

Details of engineering design and equipment selection II: design calculations excluded - piping design - thermal insulation and buildings - safety in plant design - plant constructions, start up and commissioning.

TEXTBOOKS:

1. *H.F. Rase and M.H. Barrow, "Project Engineering of Process Plants", John Wiley and Sons Inc., 1957.*
2. *P. Watermeyer, "Handbook for Process Plant Project Engineers", Wiley, 2002.*

REFERENCES:

1. *M. Peters, K. Timmerhaus, and R. West, "Plant Design and Economics for Chemical Engineers", 5th Edition, McGraw-Hill, 2002.*
2. *L.S. Srinath, "Pert and Cpm: Principles and Applications", 3rd Edition, Affiliated East-West Press Pvt. Ltd., 1989.*
3. *R.H. Perry, D.W. Green and J.O. Maloney, "Perry's Chemical Engineers' Handbook", 7th Edition, 1997.*
4. *K.K. Humphreys, "Jellen's Cost and Optimization Engineering". 3rd Edition, McGraw Hill, 1991.*

CHE481 MANAGEMENT AND ECONOMICS OF CHEMICAL PROCESSES 3 0 0 3

(Pre-requisites: CHE211,CHE221,CHE310,CHE311,CHE312)

Unit 1

Process economics – economic feasibility of project using order of magnitude cost estimates. Plant and equipment cost estimation, product cost estimation; cash flows – time value of money, investment, costs, sales, profits, taxes, depreciation; break even analysis; profitability analysis – rate of return, payback period, discounted rate of return, net present worth, internal rate of return, comparing investment alternatives; conceptual process synthesis – systematic hierarchical synthesis of flow sheets, structural layers of a flow sheet; economic balances in operation.

Unit 2

Reactor network synthesis – reactor type and conditions for simple reaction systems, use of attainable regional diagrams for complex reaction systems; separation system synthesis – distillation column sequencing for ideal liquid mixtures, separation system structure for non-ideal mixtures using distillation / residue curves.

Unit 3

Heat exchanger network synthesis using Pinch Technology – targets for minimum utilities, area, total cost, maximum, energy recovery design, evolutionary synthesis for minimum number of exchanges design, super-targeting, heat and power integration, integration of heat exchanger network with distillation columns.

TEXTBOOK:

M.S. Peters and K.D. Timmerhaus, "Plant Design and Economics for Chemical Engineers", McGraw-Hill, 1980.

REFERENCES:

1. *W.D. Baasel, "Preliminary Chemical Engineering Plant Design", 2nd Edition, Van Nostrand Reinhold, 1990.*
2. *J.M. Douglas, "Conceptual Design of Chemical Processes", McGraw Hill, 1988.*
3. *R. Smith, "Chemical Process Design", McGraw Hill, 1995.*
4. *L.T. Biegler, E.I. Grossman and A.W. Westerberg, "Systematic Methods of Chemical Process Design", Prentice Hall, 1997.*
5. *W.D. Seider, J.D. Seader and D.R. Lewin, "Process Design Principles – Synthesis, Analysis and Evaluation", John Wiley, 1999.*

CHE490 COMPUTER-AIDED DESIGN LAB. 1 0 3 2

Unit 1

ASPEN PLUS and its applications: Model library of unit operations, placing units on flowsheets, data entry, specifying components, properties, input streams and

block parameters, running the problem and interpreting the results, checking results, preparing and saving reports;

Material and energy balance problems: Mass balance with and without reactions, energy balance with and without reactions, recycle, bypass and purge problems; mass and energy balance of process flowsheets.

Unit 2

Unit operation design: sedimentation, shell and tube heat exchangers, binary and multicomponent distillation, packed bed absorption, extraction;

Chemical reactor design: batch reactors, PFR, CSTR – isothermal and non-isothermal variants.

Unit 3

Process flowsheet simulation: Case studies of selected industrial processes.

REFERENCES:

1. *B.A. Finlayson, "Introduction to Chemical Engineering Computing", Wiley Interscience, 2006.*
2. *L.T. Biegler, E.I. Grossman and A.W. Westerberg, "Systematic Methods of Chemical Process Design", Prentice Hall, 1997.*

CHE491 CHEMICAL PROCESS CONTROL LAB. 0 0 3 1

Calibration of pressure, temperature and flow measuring instruments (indicating and recording) transient response of thermometers and thermocouples. control valve characteristics and study of control systems involving temperature, pressure, flow and level.

CHE499 PROJECT 10 cr

CHY100 CHEMISTRY 3 0 0 3

Unit 1

Water Technology: Hardness – units of hardness – alkalinity - dissolved oxygen. Boiler feed water – boiler compounds – boiler problems - internal conditioning - external conditioning – zeolite and ion exchange process. Municipal water treatment – desalination by RO and electro dialysis.

Phase rule: Phase rule – statement and explanation of terms–one component system – water-vapor-ice – thermal analysis – condensed phase rule - Two component system – Ag – Pb – simple Eutectic – compound formation - Cu – Au solid solution - Ellingham diagram and its application.

Unit 2

Spectroscopy: Significance of spectroscopy as analytical tool – Electromagnetic spectrum, intensities of spectral lines and the Beer-Lamberts law. Vibration of Diatomic molecules - Energy levels - Principles of selection rules - Introduction to IR spectrum – vibrational frequency – fundamental vibrations – IR instrumentation and its applications – Electronic spectra – types of electronic transition – chromophore concept – absorption and intensity shifts – conjugated dienes - solvent effects – UV Instrumentation and its applications. Principles of H-NMR – number of signals – chemical shift – splitting of the signals.

Chemistry of corrosion and its control: Chemical and electro chemical corrosion – Pilling Bed worth ratio – forms of corrosion.

Unit 3

Electrochemical series - galvanic series - corrosion potential – corrosion current – rate of corrosion – units of corrosion - rate determination – weight loss method. Corrosion control - cathodic and anodic protection.

Advanced Engineering Materials: Introduction to Nanoscience and Technology – significance of nano materials – methods of synthesis – Carbon Nanotubes - synthesis – properties and applications. Conducting polymers - mechanism of conduction - applications. Organic LEDs - their functioning - advantages and disadvantages over conventional LEDs - their commercial uses. Liquid crystals – positional and orientation order - classification of liquid crystals - requirement for substance to exhibit liquid crystalline state - chemical constitution - identification of liquid crystals - electro-optic effect in liquid crystals, application of liquid crystals.

TEXTBOOKS:

1. Gordon M Barrow, "Physical Chemistry", 5th edition, Tata McGraw-Hill, (2007).
2. Jain P C & Monika Jain, "Engineering Chemistry", Dhanpatrai Publishing Co Ltd, New Delhi, (2005).

REFERENCES:

1. Fontana and Mars G, "Corrosion Engineering", 3rd edition, McGraw hill, (1987).
2. Robert M Silverstein and Francis X Webster, "Spectrometric Identification of Organic Compounds", 6th edition, Wiley & Sons, (2006).
3. Charles P Poole, Jr Franck J Owens, "Introduction to Nanotechnology", Wiley Interscience, (2003).
4. Chandrasekhar A, "Liquid crystals", Cambridge University Press, Cambridge, UK, (1992).
5. CNR Rao, "UV & Visible Spectroscopy – Chemical Application", Butter Worths.
6. CNR Rao, "IR Spectroscopy – Chemical Application", Academic Press

CHY181 CHEMISTRY LAB. 0 0 3 1

1. Estimation of Hardness of sample water.
2. Estimation of alkalinity of sample water.
3. Estimation of Kinetics of Ion Exchange reactions.

4. Estimation of HCl and CH_3COOH by conductometric titration.
5. Estimation of Fe^{2+} by potentiometric titration.
6. Phase diagram of two component system.
7. Determination of Corrosion rate and Inhibitor efficiency by weight loss method.
8. One step preparation of simple organic/inorganic compound.
9. Determination of molecular weight of polymer by viscosity method.
10. Adsorption by Activated charcoal method.

(Any 9 experiments of the above list)

Experiment for Demonstration

11. Desalination by Reverse osmosis.
12. Estimation of Dissolved oxygen of sample water.
13. Spectrophotometric analysis of trace element (Fe) in water.

CHY250 CATALYTIC CHEMISTRY 3 0 0 3

Unit 1

Catalysis: Introduction, Industrial applications. Rates of reactions - equilibrium, energy of activation and the catalyst's role, Elementary reactions in catalytic transformations homogeneous and heterogeneous catalysis.

Catalysis in solutions: Acid-base catalysis - catalysis in the gas phase, catalysis in dilute aqueous solution, catalysis in concentrated strong acid solutions, catalysis by bases, catalysis by metal ions, catalysis by electron transfer, organometallic catalysis, catalysis in Ziegler Natta/Metallocene/Metathesis polymerization.

Unit 2

Catalysis by macromolecules, Phase transfer catalysis.

Catalysis by Enzymes: Introduction - kinetics of enzyme catalyzed reaction, catalysis through enzyme, organic catalysis, metalloenzyme catalysis, supported enzymes. Industrial applications of enzyme catalyst.

Catalysis by Polymers: Attachment of catalytic groups to polymer supports, Adsorption and the Kinetics of polymer-catalyzed reactions**.**

Unit 3

Catalysis in polymer gels, bifunctional and multifunctional catalysis, porous polymers, Applications of polymer catalysis.

Catalysis in Molecular scale cavities: Structures of crystalline solids, structure of Zeolites, catalysis by Zeolites, catalysis by Zeolites containing metal complexes and clusters. Catalysis on surfaces – surface catalysis, catalysis on metal surfaces**.**

TEXTBOOKS:

1. *Bruce C Gates, "Catalytic Chemistry", John Wiley & Sons, Inc. USA, (1992).*
2. *Viswanathan B, Sivasankar S, Ramaswamy A V, "Catalysis, Principles and Applications", CRC Press, (2006).*

REFERENCES:

1. *James E House, "Principles of Chemical Kinetics", Academic Press, (2007).*
2. *Kuriacose J C, "Catalysis", Macmillan India Limited, New Delhi, (1991).*

CHY251 CHEMISTRY OF ENGINEERING MATERIALS 3 0 0 3

Unit 1

Chemical materials in Electronics and Electrical Engineering: Structural correlation to behavior of conducting polymers, Semi-conducting polymers - properties of organic polymers containing metal groups such as poly ferrocene - optical fibers - definition, principle and structure - characteristics of optical fibre - photo resist optical fibre - advantages of optical fibre - liquid crystalline - peizo and pyroelectric polymers - magnetic materials, hard and soft magnets – sensors (voltametric).

Nanomaterials: Nanotubes and Nanowires, Carbon nanotubes, single walled and multiwalled, aligned carbon nanotubes, doping with boron – applications - Nanostructured polymers.

Unit 2

Chemical aspects in biotechnology - Enzymes and bio reactors - Biotechnological processes – Bio-sensors - glucose biosensors, bio-filters and bio-membranes – Bio-fertilizers, Bio-surfactants.

Chemistry of Engineering Plastics: Preparation, properties and applications of ABS, Polycarbonates, Epoxy resins - Polyamides - Nylon and Kevlar.

Photochemistry in Electronics: Photochemical reactions - laws of absorption (Grothers - Draper law - Stark - Einstein's law) - Quantum efficiency - photochemical decomposition of HI and HBr - and Quantum yield.

Unit 3

Florescence and Phosphorescence - chemiluminescence - photo sensitization.

Chemistry of Toxic Materials and Toxicology: Principles of Toxicology - Volatile poisons - Gases CO, hydrocyanic acid - H_2S - PH_3 - CO_2 - SO_x - NO_x - Heavy metals - lead, arsenic, mercury, antimony, barium, bismuth, selenium, zinc, thallium - Pesticides - Food poisoning - Drug poisoning - barbiturates - narcotics - ergot - LSD - alkaloids - Radioactive Toxicology - Radiation hazards.

TEXTBOOK:

Kuriacose J C, Rajaram, "Chemistry in Engineering and Technology, Systematic Organic and Inorganic Chemistry and Chemistry of Materials (Vol 1 & 2)", Tata McGraw-Hill Publishing Company Limited, 1999.

REFERENCE:

Van Vlack, Lawrence H, "Elements of Material Science and Engineering" (6th edition), New York Addison-Wesley, 1989.

CHY252 CHEMISTRY OF ADVANCED MATERIALS 3 0 0 3

Unit 1

Chemistry of Engineering Plastics: Preparation, properties and applications of ABS, polycarbonates, epoxy resins - polyamides - Nylon and Kevlar.

Chemistry of Carbon nanotubes: Introduction, carbon nanotubes - fabrication, structure, electrical properties - vibrational properties - mechanical properties - applications of carbon nanotubes.

Unit 2

Electron transfer studies in salt based conductors and magnets: Introduction - definitions and units - ferro magnets and ferrimagnets. One-dimensional conductors - quasi one and two-dimensional super conductor. Fullerides - paramagnetic conductors and superconductors. Electron transfer salt based ferro magnets: nitroxide, metallocene and ferric magnet-based ferro magnets - weak ferro magnets. Nanopore containment of magnetic particles - nanocarbon ferromagnets.

Unit 3

Functional electro active polymers: Conjugated polymers - synthesis, processing and doping of conjugated polymers: polyacetylene, polyaniline, polythiophene, poly (p-phenylenevinylene) - ionically conducting polymers - applications of conjugated polymers. Semi-conducting, poly ferrocene - photo resist optical fibers and sensors, photo chromic & thermo chromic materials.

Photochemistry in Electronics: Laws of absorption - quantum efficiency and quantum yield - florescence and phosphorescence – photosensitization.

High energy materials: Preparation, properties and application of ammonium nitrate (AN), NH_4NO_3, ammonium perchlorate (AP), NH_4ClO_4, ammonium dinitramide (AND), $NH_4N(NO_2)_2$, hydrazinium nitroformate (HNF), $N_2H_5C(NO_2)_3$ etc.

TEXTBOOKS:

1. *Van Vlack, Lawrence H, "Elements of Material Science and Engineering", 6th edition, New York Addison, Wesley, (1989).*
2. *Chawla S, "A Textbook of Engineering Chemistry", Dhanpatrai & Co, Delhi, (2001).*

REFERENCES:

1. *Mark Ratner and Daniel Ratner, 'Nano technology - A gently introduction to the next big idea', Pearson Education, (2003).*
2. *Interrante L. V. and Hampden Smith M.J, 'Chemistry of Advanced Materials', Wiley-VCH, (1988).*

CHY253 ADVANCED POLYMER CHEMISTRY 3 0 0 3

Unit 1

Newer Polymers and Polymerizations: Polymeric Liquid Crystals - Inorganic and Organometallic polymers - Synthesis and reactions of Phosphorus - Nitrogen polymers - Boron - Silicone polymers. Cyclisation versus Linear Polymerization - Molecular weight control in linear polymerization - Molecular weight distribution in linear polymerization - Molecular weight distributions in nonlinear polymerization - Multichain Polymerization - Metallocene Polymerization.

Unit 2

Solid-state irradiation polymerization - Atom transfer radical polymerization - Plasma Polymerization - Zwitterionic Polymerization - Isomerization polymerization - Polymer supported solid phase reactions - Merrifield method.

Polymer degradation and stabilization: Mechanism of different types of degradation - Commonly used antidegradants and the mechanism of their stabilization**.**

Unit 3

Polymer solutions: Criteria for solubility - Heat of Dissolution and Solubility parameters - Conformation of polymer chains in solutions - Nature of polymer molecules in solution - Size and shape of macromolecules in solution - Thermodynamics of polymer solutions - Phase equilibria - Entropy and heats of mixing of polymer solutions - Effect of molecular weight on solubility - Solubility of crystalline and amorphous polymers - Flory Huggins theory of polymer solution, Equation of state theory, Flory Krigbaum theory and cluster type theory - Viscosity of dilute polymer solutions.

TEXTBOOKS:

1. *George Odian, "Principles of Polymerization", John Wiley & Sons Inc., New York, (1991).*
2. *Malcolm P.Stevens, "Polymer Chemistry", Oxford University Press, New York, (1999).*

REFERENCES:

1. *Harry R Allcock and Frederick W Lampe, "Contemporary Polymer Chemistry", 2nd edition, Prentice Hall, Inc., New Jersey, (1990).*
2. *Charles E Carraher, Jr., "Polymer Chemistry", 5th edition, Marcel Dekker Inc., New York, (2000).*
3. *Jayadev Sreedhar and Govariker, "Polymer Chemistry".*

CHY254 POLYMERS FOR ELECTRONICS 3 0 0 3

Unit 1

Conducting polymers: Conducting mechanisms - Electron transport and bipolar polymers - electrodepositable resists, resins. Applications - Organic light emitting

diodes, Sensors, EMI shielding, printed Circuit Boards, Artificial nerves, Rechargeable Batteries, Electromechanical Actuators and switches.

Unit 2

Photoconductive polymers: Charge carriers, charge injectors, charge transport, charge trapping. Polymers for optical data storage - principles of optical storage, polymers in recording layer.

Nonlinear optics: NLO properties and NLO effects, wave guide devices, polymer optical fibers - through plane modulators.

Unit 3

Thermosensitive polymers: Applications - Mechanical actuators and switches - Tissue culture, Drug delivery, Photo resists - Types - Chemically amplified photoresists - Applications. Magnetic polymers - structure and Applications.

Liquid crystalline polymers: Fundamentals and process, liquid crystalline displays - Applications.

TEXTBOOK:

Kiichi Takemoto, Raphael M. Ottenbrite, Mikiharu Kamachi, "Functional Monomers and Polymers", CRC Press, (1997).

REFERENCE:

1. *A B Kaiser, "Electronic properties of conjugated polymers - basics, models and applications", Springer Verlag, (1987).*
2. *J. A. Chilton and M T Goosy, "Special polymers for electronics and optoelectronics", Kluwer Academic Publishers, (1995).*

CHY255 CHEMISTRY OF TOXICOLOGY 3 0 0 3

Unit 1

Introduction to Toxicology: Definition - scope - history - relationship to other sciences - dose-response relationship - sources of toxic compounds - Classes of Toxicants - broad overview of toxicant classes such as metals, agricultural chemicals, food additives - contaminants, toxins, solvents, drugs, and cosmetics - history, exposure route, and toxicity of the non-essential metals - cadmium, lead, and mercury - medical treatment of metal poisoning - classes of agricultural chemicals - Toxins - source, including microbial, fungal, algal, plant and animal - examples - Brief discussions - food additives and contaminants – solvents - therapeutic drugs - drugs of abuse - combustion products - cosmetics.

Unit 2

Exposure Classes, Toxicants in Air, Water, Soil, Domestic and Settings: Occupational Air, water and soil as primary media for human exposure to various classes of chemical toxicants in environmental, domestic, and occupational settings - historic and present status of air pollution and air quality - introduction to the major classes of soil and water pollutants - sources, exposure routes and potential adverse health effects - Classes of occupational toxicants - route of exposure and permissible levels - specific examples of concern.

Unit 3

Toxicant Analysis and Quality Assurance Principles: Introduction to procedures, principles and operation of analytical laboratories in toxicology. Summary of the general policies - analytical laboratory operation, analytical measurement systems, quality assurance (QA) - quality control (QC) procedures.
Environmental Risk Assessment: Environmental risk assessment procedures - particular environmental risk problem - appropriate endpoints - development of conceptual models, analyzing exposure – effects, information - characterizing exposure - ecological effects - management of risks.
Future Considerations for Environmental and Human Health: Changes in toxicology - evaluation of future risk assessment - more fundamental aspects of toxicology - in vivo and in vitro toxicity - biochemical toxicology - molecular toxicology - development of selective toxicants.

TEXTBOOK:

Ernest Hodgson, "Modern Toxicology", John Wiley & Sons, Inc., (2004).

REFERENCES:

1. *John Wright, "Environmental Chemistry", Routledge, (2003).*
2. *A K DE, "Environmental Chemistry", New Age International, (2003).*
3. *Fritz Helmet, "Environmental Chemistry", Sarup and sons (Delhi), (2003).*

CHY256 CHEMISTRY OF NANOMATERIALS 3 0 0 3

Unit 1

Introduction: Introduction to Nanomaterials: Size dependence of properties - Surface to volume ratio and Quantum confinement. Microscopic techniques to study nano structures - SEM, AFM - TEM and STM - Raman spectroscopy.
Synthesis of Nanomaterials: Synthetic approaches: Colloidal Self-Assembly (Self-assembled monolayers - SAMs) and electrostatic self-assembly, electrochemical methods, sol-gel deposition

Unit 2

Langmuir-Blodgett (LB) technique, chemical vapour deposition, plasma arcing and ball milling.
Carbon nanostructures: Carbon Clusters: Fullerenes, structure, synthesis, alkali doped C_{60} - superconductivity in $C_{60,}$ applications of fullerenes. Carbon nanotubes:

Classification, properties, synthesis, characterization, and potential applications, growth mechanism of carbon nanotubes.
Other Nanostructures: Quantum Dots: Preparation, properties and applications of Au, CdS and CdSe quantum dots,

Unit 3

Fabrication and applications of conducting polymer nanotubes, TiO_2 and metallic nanotubes.
Molecular Electronics and Machines: Molecular electronics: Working of Molecular and supramolecular switches, transistors and wires. Molecular machines: Working of Molecular motors, rotors, cars, elevators and valves.

TEXTBOOKS:

1. *Charles P Poole Jr, Frank J Ovens, "Introduction to Nanotechnology", Wiley Interscience, (2003).*
2. *Alexei Nabok, "Organic and Inorganic Nanostructure", Artech House, Inc. (2005).*
3. *Peter J F Harris, "Carbon Nanotube Science: Synthesis, Properties and Applications", Cambridge University Press, (2009).*
4. *Balzani V, Credi A, Venturi M, "Molecular devices and machines - A journey in to the Nanoworld", Wiley VCH, (2003).*

REFERENCES:

1. *Rao C N R, Muller A, Cheetham A K (Eds.), "The Chemistry of Nanomaterials: Synthesis, Properties and Applications", WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, (2004).*
2. *Zhong Lin Wang, "Characterization of nanophase materials", Wiley VCH, (2000).*
3. *Massimiliano Di Ventra, Stephane Evoy, James R Heflin, "Introduction to nanoscale science and technology", Kluwer Academic Publishers, (2004).*
4. *William A Goddard, III, Donald W Brenner, Sergey Edward Lyshevski and Gerald J. Iafrate, "Handbook of Nanoscience, Engineering, and Technology", CRC Press, (2003).*
5. *Balzani V, Credi A, Venturi M, "Molecular devices and machines- A journey in to the Nanoworld" Wiley VCH (2003).*
6. *Bharat Bhushan, "Hand book of Nanotechnology", Springer, (2004).*

CHY257 BIOMATERIALS SCIENCE 3 0 0 3

Unit 1

Introduction: Bulk properties, Surface properties and characterization - polymers, silicone biomaterials, medical fibres and biotextiles - Smart polymers - bioresorbable and bioerodible materials - natural materials, metals and ceramics - physicochemical surface modification.
Biocompatibility concepts : Introduction to biocompatibility - cell material interaction – types of materials - toxic, inert, bioactive - long term effects of materials within the body - cell response.

Unit 2

Chemical and biochemical degradation of polymers - degradation of metals and ceramics - calcification of biomaterials.

Host reactions and their evaluation: Inflammation and foreign body response - adaptive immunity - systemic toxicity and hypersensitivity - blood coagulation and blood materials interactions - device related infections.

Unit 3

Biological testing of biomaterials: Invitro and invivo assessment of tissue compatibility - evaluation of blood materials interaction - microscopy in biomaterials. **Practical aspects of biomaterials:** Bioelectrodes, biomedical sensors and biosensors - sterilization of implants - implant failure - implant retrieval and evaluation - legal aspects, ethical issues and regulation aspects.

TEXTBOOK:

Buddy D Ratner, Allan S Hoffman, "Biomaterials Science - An introduction to materials in Medicine", Elsevier academic press, (2004).

REFERENCES:

1. *Jonathan Black, "Biological Performance of Materials: Fundamentals of Biocompatibility", 4th edition, CRC Press, (2006).*
2. *John D. Enderle, Susan M. Blanchard, Joseph D. Bronzino, "Introduction to Biomedical Engineering", 2nd edition, Elsevier Academic Press, 2005.*

CHY258 ENVIRONMENTAL CHEMISTRY 3 0 0 3

Unit 1

Air and air pollution (earth's atmosphere): Regions - ozone - CFC and other chemicals - catalytic decomposition of ozone - 'ozone hole' formation - Air pollution due to gas emission from industries - Atmospheric aerosols – dust, combustion products, aerosol concentration and lifetimes - Automobile exhausts, smog and effects - Acid rain - chemistry of acid rain, roll of meteorology, greenhouse gases and global warming - air pollution due to jet engines.

Water and water pollution (hydrosphere): Physical and chemical properties of water- microbiological processes - carbon, nitrogen cycles - Water pollution - polluting agents - indices of pollution, heavy metal pollution and toxicity - BOD and COD determination - suspended solids - determination of other ions by photometric methods - Chemistry of anaerobic process, use of Effective Microorganisms.

Unit 2

Aerobic processes - wastewater treatment systems (brief description only) - anaerobic and aerobic - sewage treatment, primary, secondary and tertiary processes - water reuse and recycle. Eutrophication of lakes, nitrogen and

phosphorus in effluents - Drinking water standards - sources - fluoride and arsenic in water, purification, sterilization - chemistry of chlorination - water purification for domestic use - reverse osmosis -nano filters and membranes.

Industrial Pollution and its control: Industrial pollution and waste waters from various types of industries - environmental pollution due to paper mills, textile mills etc., and its control. Solid waste disposal - methods - solid waste from mining and metal production and its disposal - Electrochemical treatment of pollution control, electro-coagulation and flocculation - Green chemical processes and green solvents-reaction conditions to control industrial pollution.

Unit 3

Other types of pollution: Soil pollution - agricultural pollution - use of chemical fertilizers - Organic chemicals and environment, dioxins and furans - chemistry of some of the pesticides, insecticides and herbicides, ill effects due to uncontrolled use - Bulk storage of hazardous chemicals and disasters, Radioactive pollution, radiation units, sources - exposure and damage - safety standards - radioactive wastes and their disposal - Toxicological substances, testing of toxic substance, enzyme inhibition and biochemical effects of toxic chemicals on humans.

Sampling and Measurements of Pollutants: Sampling and analysis techniques of air pollutants (brief outline only) - analysis of particulate matter and lead - Sampling and measurements of water pollutants - organic loadings, phosphates and nitrogen compounds - monitoring of water quality - water test kits, various analytical methods (brief outline only).

TEXTBOOKS:

1. *Gary W.VanLoon and Stephen J.Duffy, "Environmental Chemistry", Oxford University Press, (2000).*
2. *Ajay Kumar Bhagi and G.R.Chatwal, "Environmental Chemistry", Himalaya Publishing House, (2003).*

REFERENCES:

1. *John Wright, "Environmental Chemistry", Routledge, (2003).*
2. *A K De, "Environmental Chemistry", New Age International, (2003).*
3. *Fritz Helmet, "Environmental Chemistry", Sarup and sons (Delhi), (2003).*
4. *Clair N Sawyer, Perry L McCarty and Gene F Parkin, "Chemistry for Environmental Engineering", McGraw Hill, (1994).*
5. *Jack Barrett, "Chemistry in your Environment", Albion Publishing Ltd., (1994).*
6. *Thomas G Spiro and William M Stigliani, "Chemistry of the Environment", Prentice Hall, (2002).*
7. *Kudisia VP and Ritu, "Environmental Chemistry", Pragati Prakashan, Meerut, (2000).*

CHY259 INSTRUMENTAL METHODS OF ANALYSIS 3 0 0 3

Unit 1

Error Analysis and Sampling: Accuracy - Precision - Classification of Errors - Minimization of errors - Standard deviation - Coefficient of variance - F-test - t-test - Significant figures. Sampling - Basis of sampling, Sampling and physical state -

Safety measures of sampling.

Separation Techniques: Brief out line of column, paper and thin layer chromatography - Ion exchange methods - principle and application – HPLC.

Unit 2

Gas chromatography - principle and applications – gel chromatography.

Electro analytical techniques: Potentiometry - Potentiometric titration - determination of equivalence point - acid base, complexometric, redox and precipitation titrations - merits and demerits. Voltammetry - Cyclic voltammetry - basic principle and application - Polarography - introduction - theoretical principles - migration current - residual current - half wave potential - instrumentation - analytical applications.

Unit 3

Spectro-chemical techniques: UV-VIS spetrophotometry - principle - Beer's Law application - photometric titration - single and double beam spectrophotometer - instrumentation of IR - sample handling - IR applications - H - NMR - Instrumentation and applications - principle - instrumentation - applications of atomic absorption spectroscopy.

Thermal and Diffraction techniques: Principles and applications of DTG - DTA - DSC - X-ray - Electron Diffraction Studies - SEM, TEM.

TEXTBOOKS:

1. *Willard H W, Merritt JR, "Instrumental Methods of Analysis", 6th edition, Prentice Hall, (1986).*
2. *Skoog Douglas A, West Donald, "Fundamentals of Analytical Chemistry", 7th edition, New York Addison, Wesley, (2001).*

REFERENCES:

1. *"Vogel's Textbook of Quantitative Chemical Analysis", 5th edition, ELBS, (1989).*
2. *Kaur.H, "Instrumental Methods of Chemical Analysis", Goel Publisher, (2001).*

CHY260 ORGANIC SYNTHESIS AND STEREOCHEMISTRY 3 0 0 3

Unit 1

Nomenclature of Organic compounds: Polyenes, Alkynes with and without functional groups by IUPAC nomenclature. Aromatic and Heteroaromatic systems - nomenclature of heterocycles having not more than two hetero atoms such as oxygen, sulphur, nitrogen.

Stereochemistry: Tacticity, R/S system of nomenclature of central and axial molecules.

Unit 2

Atropisomerism - isomerism of biphenyls - allenes and spiranes - ansa compounds

- Geometrical isomerism, E, Z Isomerism. Asymmetric synthesis.

Conformational Analysis: Optical activity and chirality - Conformational Analysis of cyclic and acyclic system - Conformational effects on reactivity of acyclic systems only.

Unit 3

Asymmetric synthesis: Stereo selective - Stereo specific - Regioselective and Regiospecific reactions. Principle of protection of alcohol, amine, carboxyl and carbonyl groups - Functional group inter conversions - Disconnection approach - Reversal of polarity - reagents in synthesis.

TEXT BOOKS:

1. *E. L. Eliel, "Stereochemistry of Carbon Compounds", Mc Graw-Hill Book Co, (2000).*
2. *Jerry March, "Advanced Organic Chemistry", 4th edition, John Wiley & Sons, (1992).*

REFERENCES:

1. *S. Warren, "Designing Organic Synthesis", Wiley & Sons, (1998).*
2. *Finar I.L, "Organic Chemistry: Stereochemistry and the Chemistry of Natural Products", 5th edition, ELBS, (2000).*

CHY261 UNIT PROCESSES IN ORGANIC SYNTHESIS 3 0 0 3

Unit 1

Application of Thermodynamics in Organic Unit Processes: free energy, bond energies and entropy. Concepts of aromaticity - Huckel's rule - anisotropy. Intermediates - carbocations, carbanions, free radicals, carbenes and nitrenes. Reagents in organic synthesis: Grignard reagents, Organolithium reagents, selenium dioxide, chromium trioxide, lead tetraacetate, sodium borohydride, lithium borohydride, sulphur carbanions.

Unit 2

Organic reactions and mechanisms: Substitution reaction - aliphatic nucleophilic, aromatic elecrophilic and nucleophilic substitution. Elimination and addition reaction - Halogenation .Nitration – aromatic nitration – mechanism – Technical nitration – mixed acid nitration. Hydrocarbon synthesis and Hydroformylation (Catalysis) Various catalysts used – technology of Fischer - Tropsch operation – methanation - Hydroformylation, Monsanto acetic acid, Wacker process and synthetic gasoline. Alkylation – types – alkylating agents – factors controlling alkylation – technical alkylation.

Unit 3

Sulphonation and sulfation: Sulphonating and sulphating agents – their principal applications – chemical and physical factors in sulphaonation and sulphation – kinetic, thermodynamics and mechanism – the desulphonation reaction.

Amination: Amination by reduction – methods of reduction – catalytic, metal and acid, sulphide and electrolytic reductions – amination by ammonolysis- aminating agents – catalysts used in amination reactions – technical manufacture of amino compounds – ammonia recovery system.

Catalysis by organometallic compounds: Synthesis gas (Ruthenium and Rhodium metal catalyst).

TEXTBOOK:

P.H.Groggins, "Unit Processes in Organic synthesis", Mc Graw Hill, (Fifth edition), 1952.

REFERENCES:

1. *B C Bhattacharya, C M Narayanan, "Unit Operations and Unit Processes", Mc Graw Hill, (1994).*
2. *Dryden, "Dryden's Outlines of Chemical Technology", East West, (1988).*
3. *Carey. F and Sundberg R, "Advanced Organic Chemistry, Part A & B", Kluwer, (2000).*

CHY262 MEDICINAL ORGANIC CHEMISTRY 3 0 0 3

Unit 1

Medicinal Chemistry: Introduction, drugs - classification of drugs - mechanism of drug action. Drug-receptor complex nomenclature - agonist, antagonist.

Physicochemical properties in relation to biological action: solubility, partition coefficient, dissociation constant, hydrogen bonding, ionization, drug shape, surface activity, complexation, protein binding, molar refractivity, bioisosterism - Stereo chemical aspects of drug action-stereo isomerism-optical isomerism.

Unit 2

Enzymes and hormones: Enzymes - nomenclature, classification and characteristics of enzymes - mechanism of enzyme action, factors affecting enzyme action, cofactors and co-enzymes, enzyme inhibition, enzymes in organic synthesis. Hormones and vitamins - representative cases.

Medicinal agents from natural products: Natural products as therapeutic agents, medicinal plants, animal products as medicine, isolation methods of alkaloids, terpenes, anti-oxidants.

Unit 3

Medicinal agents: Medicinal agents belonging to steroids, polypeptides, modified nucleic acid bases, sulphonamide and sulpha drugs, antibiotics, antifungal, antiseptics and disinfectants, anesthetics, antihypertensive drugs, analgesics, histamine and anti-histamine agents.

TEXTBOOKS:

1. *Rama Rao Nadendla, "Principles of Organic Medicinal Chemistry", 1st edition, New age internationals (P) limited, (2005).*

2. *Thomas Nogrady and Donald F. Weaver, "Medicinal chemistry: A Molecular and Biochemical Approach", 3rd edition, Oxford university press, (2005).*

REFERENCES:

1. *Wilson C O, Gisvold O and Deorge R F, "Text book of organic, medicinal and Pharmaceutical chemistry", 7th edition, J.B.Lippincott company, Philadelphia, (1977).*
2. *Burger A, "Medicinal Chemistry", 3rd edition, Wiley Interscience, Newyork, (1970).*
3. *Graham L P, "An Introduction to Medicinal Chemistry", 3rd edition, Oxford university Press, (2005).*

CHY263 ORGANIC REACTION MECHANISMS 3 0 0 3

Unit 1

Introduction to organic chemistry: Lewis structure and formal charges of organic compounds - electro negativities and dipoles, resonances, aromaticity and anti aromaticity - equilibrium, tautomerism and hyper conjugation - acidity and basicity - pKa, nucleophiles and electrophiles - hydrogen bonding - different types of organic reaction - addition, substitution, elimination and rearrangement - oxidations and reductions - general principles of writing organic reaction mechanism - reactive intermediates.

Reaction of nucleophiles and bases: Nucleophilic substitution - S_N1 and S_N2 reactions, nucleophilic substitution at aliphatic sp2 carbon and aromatic carbon - nucleophilic addition to carbonyl compounds - addition of grignard and organo lithium reagents - reactions of nitrogen containing nucleophiles with aldehyde and ketones - aldol condensation.

Unit 2

Michael and 1,4-addition reaction - Favorskii rearrangement - benzilic acid rearrangement - reaction mechanism in basic media - Mannich reaction - enols and enolates.

Reaction involving acids and other eletrophiles: Carbocations - formation and rearrangements - cationic rearrangement involving electron deficient nitrogen atom - Beckmann rearrangement - Curtius, Lossen and Schmidt rearrangement - electrophilic additions - acid catalyzed reaction of carbonyl compounds - hydrolysis of carbocyclic acid derivatives - electrophilic aromatic substitution - carbenes and benzynes - Baeyer-Villeger reactions - Dienone-phenol rearrangement - pinacol rearrangement.

Unit 3

Radical and radical ions: Formation of radicals, radical chain processes, radical addition, reaction with and without cyclisation - fragmentation reaction - rearrangement of radicals - $S_{RN}1$ reaction - radical ions - Birch reduction - Hofmann-Loffler-Freytag reaction - Barton reaction - McMurry reaction.

Pericyclic reaction: Representative of molecular orbitals of ethylene, butadiene and hexatriene molecules - Woodward - Hofmann rules of symmetry - electrocyclic reaction, cycloadditions - diels-Alder reaction - other thermal cycloadditions - photochemical [2+2] cycloaddition - 1,3-dipolar cycloadditions - Sigmatropic reactions, notations and directions of [3,3] sigmatropic rearrangements - Cope and oxy-Cope rearrangement [2,3] sigmatropic reaction - ene reaction.

TEXTBOOK:

Jerry March, "Advanced Organic Chemistry", 4th edition, John Wiley & Sons, (1992).

REFERENCES:

1. *Carey F and Sundberg R, "Advanced Organic Chemistry - Part A & B", Kluwer, (2000).*
2. *Peter Sykes, "Organic reaction mechanism", 6th edition, Pearson education (Singapore) Pte. Ltd.,(2005).*
3. *Michael B.Smith, "Organic Synthesis", 2nd edition, Mc Graw Hill, (2004).*

CHY264 GREEN CHEMISTRY AND TECHNOLOGY 3 0 0 3

Unit 1

Our environment and its protection, chemical pollution and environmental regulations, environmental chemistry, pollution prevention strategies, challenges to the sustainability of chemical industry, Pollution Prevention Act 1990, USA, Green Chemistry and its 12 principles, toxicity of chemicals, material safety data sheet (MSDS), concept of zero pollution technologies, atom economy, functional toxicity vs non-functional toxicity, alternative solvents, energy minimization, microwave and sonochemical reactions, renewable feed stock, carbon dioxide as a feed stock,.

Unit 2

Greener strategies of the synthesis of ibuprofen synthesis, teriphthalic acid etc. phase behavior and solvent attributes of supercritical CO_2, use of supercritical carbon dioxide as a medium chemical industry, use of ionic liquids as a synthetic medium, gas expanded solvents, superheated water, etc. Synthesis of various chemicals from bio mass, polycarbonate synthesis and CO_2 fixation, green plastics, green oxidations, etc.

Unit 3

Processes involving solid catalysts – zeolites, ion exchange resins, Nafion/silica nano composites and enhanced activity. Polymer supported reagents, green oxidations using TAML catalyst, membrane reactors. Green chemistry in material science, synthesis of porous polymers, green nanotechnology.

REFERENCES:

1. *Hand Book of Green Chemistry and Technology; by James Clarke and Duncan Macquarrie; Blakwell Publishing.*
2. *Anastas, P. T., Warner, J. C. Green Chemistry: Theory and Practice, Oxford University Press Inc., New York, 1998.*
3. *Matlack, A. S. Introduction to Green Chemistry Marcel Dekker: New York, NY, 2001.*

CHY270 CORROSION SCIENCE 3 0 0 3

Unit 1

Basic principles: Free energy concept of corrosion - different forms of corrosion - Thermodynamic & Kinetic aspects of corrosion: The free energy criterion of corrosion possibility - Mechanism of Electrochemical corrosion - Galvanic and Electrochemical series and their significance.

Corrosion Control: Materials selection - metals and alloys - metal purification - non metallic - changing medium.

Unit 2

Anodic and cathodic protection methods - Coatings - metallic and other inorganic coatings - organic coatings - stray current corrosion - cost of corrosion control methods.

Corrosion protection by surface treatment: CVD and PVD processes - Arc spray - Plasma spray - Flame spray.

Corrosion Inhibitors: Passivators - Vapour phase inhibitor.

Unit 3

Stress and fatigue corrosion at the design and in service condition - control of bacterial corrosion.

Corrosion protection: Automobile bodies – engines – building construction.

TEXTBOOKS:

1. *Fontana and Mars G, "Corrosion Engineering", 3rd edition, Mc Graw-Hill, (1987).*
2. *Uhlig H H and Reviees R W, "Corrosion and its Control", Wiley, (1985).*

REFERENCES:

1. *ASM Metals Handbook, "Surface Engineering", Vol 5, ASM Metals Park, Ohio, USA, (1994).*
2. *ASM Metals Handbook, "Corrosion", Vol 13, ASM Metals Park, Ohio, USA, (1994).*
3. *Brain Ralph, "Material Science and Technology", CRC Series, Boston, New York.*

CHY271 ELECTROCHEMICAL ENERGY SYSTEMS AND PROCESSES 3 0 0 3

Unit 1

Background Theory: Origin of potential - electrical double layer - reversible electrode potential - standard hydrogen electrode - emf series - measurement of potential - reference electrodes (calomel and silver/silver chloride) indicator and ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler-Volmer equation - Overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafel plots - exchange current density and transfer coefficients.

Unit 2

Batteries: Primary batteries: The chemistry, fabrication and performance aspects, packing classification and rating of the following batteries: (The materials taken their function and significance, reactions with equations, their performance in terms of discharge, capacity, and energy density to be dealt with). Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air, zinc-silver oxide batteries; lithium primary cells - liquid cathode, solid cathode and polymer electrolyte types and lithium-ferrous sulphide cells (comparative account).

Secondary batteries: ARM (alkaline rechargeable manganese) cells, Lead acid and VRLA (valve regulated (sealed) lead acid), nickel-cadmium, nickel-zinc, nickel-metal hydride batteries, lithium ion batteries, ultra thin lithium polymer cells (comparative account) Advanced Batteries for electric vehicles, requirements of the battery - sodium-beta and redox batteries.

Unit 3

Reserve batteries and Fuel cells: Reserve batteries - water activated, electrolyte activated and thermally activated batteries - remote activation - pyrotechnic materials. Fuel Cells: Principle, chemistry and functioning - carbon, hydrogen-oxygen, proton exchange membrane (PEM), direct methanol(DMFC), molten carbonate electrolyte (MCFC) fuel cells and outline of biochemical fuel cells.

Electrochemical Processes: Principle, process description, operating conditions, process sequence and applications of Electroforming – production of waveguide and plated through hole (PTH) printed circuit boards by electrodeposition; Electroless plating of nickel, copper and gold; Electropolishing of metals; Anodizing of aluminium; Electrochemical machining of metals and alloys.

TEXTBOOKS:

1. *Derek Pletcher and Frank C. Walsh, "Industrial Electrochemistry", Blackie Academic and Professional, (1993).*
2. *Dell, Ronald M Rand, David AJ, "Understanding Batteries", Royal Society of Chemistry, (2001).*

REFERENCES:

1. *Christopher M A, Brett, "Electrochemistry – Principles, Methods and Applications", Oxford University, (2004).*
2. *Watanabe T, "Nano-plating: microstructure control theory of plated film and data base of plated film microstructure", Elsevier, Oxford, UK (2004).*
3. *Kanani N, "Electroplating and electroless plating of copper and its alloy", ASM International, Metals Park, OH and Metal Finishing Publications, Stevenage, UK (2003).*
4. *Lindon David, "Handbook of Batteries", McGraw Hill, (2002).*
5. *Curtis, "Electroforming", London, (2004).*
6. *Rumyantsev E and Davydov A, "Electrochemical machining of metals", Mir, Moscow, (1989).*

CHY272 COMPUTATIONAL CHEMISTRY AND MOLECULAR MODELLING 3 0 0 3

Unit 1

Introduction: Stability, symmetry, homogeneity and quantization as the

requirements of natural changes - Born - Haber cycle – Energetic – kinetics - Principles of spectra.

Computational techniques: Introduction to molecular descriptors, computational chemistry problems involving iterative methods, matrix algebra, Curve fitting.

Molecular mechanics: Basic theory - Harmonic oscillator – Parameterization - Energy equations - Principle of coupling - Matrix formalism for two masses - Hessian matrix - enthalpy of formation-enthalpy of reactions.

Introduction to Quantum mechanics - Schrodinger equation - Position and momentum - MO formation - Operators and the Hamiltonian operator - The quantum oscillator - Oscillator Eigen value problems - Quantum numbers - labeling of atomic electrons.

Unit 2

Molecular Symmetry: Elements of symmetry - Point groups - Determination of point groups of molecules.

Huckel's MO theory: Approximate and exact solution of Schrodinger equation - Expectation value of energy - Huckel's theory and the LCAO approximation - Homogeneous simultaneous equations - Secular matrix - Jacobi method - Eigen vectors: Matrix as operator - Huckel's coefficient matrix - Wheeland's method - Hoffmann's EHT method - Chemical applications such as bond length, bond energy, charge density, dipole moment, Resonance energy.

Unit 3

Self consistent fields: Elements of secular matrix - Variational calculations - Semi empirical methods - PPP self consistent field calculation - Slater determinants - Hartree equation - Fock equation – Roothaan - Hall equation - Semi empirical models and approximations.

Ab-initio calculations: Gaussian implementations – Gamess - Thermodynamic functions - Koopman's theorem - Isodesmic reactions, DFT for larger molecules - Computer aided assignments/mini projects with softwares - Introduction to HPC in Chemical calculations.

Molecular modelling software engineering - Modeling of molecules and processes - Signals and signal processing in Chemistry - QSAR studies and generation of molecular descriptors - Applications of chemical data mining - Familiarization with open source softwares useful for molecular modeling - Introduction to molecular simulation - M.D. simulation.

TEXTBOOKS:

1. *Namboori P.K., Deepa Gopakumar and K.I. Ramachandran (In press) "Computational Chemistry and Molecular Modeling", Krishnan.*
2. *Donald W Rogers, "Computational Chemistry Using PC", Wiley, (2003).*
3. *Alan Hinchliffe, "Chemical Modeling from atoms to liquids", Wiley, (2005).*

REFERENCES:

1. *James B Forseman and Aeleen Frisch-Gaussian, "Exploring Chemistry with Electronic Structure Method", Inc., Pittsburgh, PA, 2nd edition, (2006).*
2. *A C Philips, "Introduction to Quantum mechanics", Wiley, (2003).*
3. *Wolfram Koch, Max C. Holthausen, "A Chemist's guide to Density Functional Theory", Wiley, VCH, 2nd edition, (2001).*

CHY273 FUEL CELLS - PRINCIPLES AND APPLICATIONS 3 0 0 3

Unit 1

Introduction: relevance, importance and classification of fuel cells.

Background Theory: Thermodynamic aspects of electrochemistry energy conversion and its efficiency - factors affecting the efficiency - electrode kinetics of electrochemical energy conversion.

Unit 2

Description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate, direct methanol fuel cells.

Proton Exchange Membrane Fuel cells: basic aspects - working and high temperature operation – recent development in technology.

Unit 3

Hydrogen: sources of hydrogen and preparation - clean up and storage - use as fuel in cells.

Energy and Environment - future prospects: Renewable energy and efficiency of renewable fuels - economy of hydrogen energy - life cycle assessment of fuel cell systems.

TEXTBOOK:

M.Aulice Scibioh and B.Viswanathan? "Fuel Cells – principles and applications", University Press, India, (2006).

REFERENCES:

1. *F. Barbir, "PEM fuel cells: theory and practice", Elsevier, Burlington, MA, (2005).*
2. *J.S. Newman and K.E. Thomas-Alyea, "Electrochemical systems", 3rd edition, Wiley, Hoboken, (2004).*
3. *G. Hoogers, "Fuel cell handbook", CRC, Boca Raton, FL, (2003).*

CHY274 SOLID STATE CHEMISTRY 3 0 0 3

Unit 1

Symmetry in Crystal Systems: Types of symmetry, plane, axis and centre of symmetry, crystal systems and symmetry elements. Law of rational indices, miller

indices, Weiss indices - plane systems, space lattices, unitcells - unitcell dimension, determination. Space lattice - definition and types Bravais lattice - kinds of bravais lattices, number of atoms in SC, BCC, FCC lattices, void space, Radius ratio rule and application. Crystal defects - types of defects in crystals - stoichiometric defect - schottky and frenkel defects - Non-stoichiometric defects - metal excess and metal deficiency defects, influence of defects on the properties of solids.

Unit 2

Electrical and Magnetic Properties: Development of free electron theory to band theory of solids - metals and their properties; semiconductors - extrinsic and intrinsic, Hall effect; Insulators - dielectric, ferroelectric, pyroelectric and peizoelectric properties and the relationship between them. Dia, para, ferro, ferri, antiferro and antiferri magnetic types - selected magnetic materials such as spinels, garnets and perovskites, superconductors.

Diffraction Methods: X-ray diffraction - various methods of X-ray analysis of structure-ray diffraction pattern, X-ray scattering factor. Results and uses of X-ray diffraction. Limitations of X-ray diffractions.

Unit 3

Neutron diffraction - principles, electron diffraction patterns, limitations - applications of electron diffraction - structural elucidation. Distinction between X-ray, Neutron and electron diffraction. Structure factor - definition, factors influencing structure factor. Uses of structure factor. Fourier synthesis - definition, applications of fourier synthesis in crystal structure analysis of S-Tetrazine. Structure of Rutile, Fluorite, Antifluorite, Zinc blende, Wurtzite, diamond and graphite.

REFERENCES:

1. *Cotton F.A, Wilkinson G and Gaus P, "Basic Inorganic Chemistry", 3rd edition, John Wiley and Sons, (2003).*
2. *Shriver D.F and Atkins P.W, "Inorganic Chemistry", 3rd edition, ELBS, Oxford University Press, Oxford, (2004).*
3. *Huheey J.E, Keiter E.A and Keiter R.L, "Inorganic Chemistry", 4th edition, Addison-Wesley Pub. London, (1993).*
4. *Cotton F.A, Wilkinson G, Murillo C.A and Bochmann M, "Advanced Inorganic Chemistry", 6th edition, John Wiley and Sons, New York, (2003).*
5. *Jolly W.L, "Modern Inorganic Chemistry", 2nd edition, McGraw-Hill, Inc., (1991).*
6. *Miessler GL and Tarr D.A, "Inorganic Chemistry", 3rd edition, Pearson Education, Singapore, (2004).*

CSE100 COMPUTER PROGRAMMING 3 0 0 3

Unit 1

Introduction to problem solving - algorithm development, flowcharting. C fundamentals, datatypes, variables, constants, enumerations, operators, bitwise operators, expressions, type cast, data input and output statements - formatted &

unformatted, control structures - if, if else, switch.. case, while loop, do.. while, for loop, continue, break, goto. Arrays – defining an array, processing an array, multidimensional arrays.

Unit 2

Strings, string handling functions. User defined functions - defining a function, function prototypes, calling a function, passing arguments to a function, recursion. Variable scope - auto, extern, static, register. Pointers - declarations, call by reference, functions returning pointer, pointer arithmetic. Pointer to pointer, pointers and arrays - pointer to array, array of pointers, dynamic memory allocation - malloc(), calloc(), free().

Unit 3

Structures - declaration, initialization, bitfields, operations on structures. Arrays, pointers and structures as members of structure. Array of structures, structures and functions, pointers to structures. Files - file operations for binary and text files, file I/O statements - fscanf, fprintf, fread, fwrite. Random file access - rewind, ftell, fseek. Command line arguments. Preprocessor - macros.

TEXTBOOK:

Byron S Gottfried, "Schaum's Outline of Theory and Problems of Programming with C", Second Edition, TMH publishers, 1996.

REFERENCES:

1. *Herbert Schildt, "The Complete reference, C" Fourth Edition, Tata-McGraw-Hill, 2000.*
2. *Kernighan Brian W and Ritchie Dennis M, "C Programming language", Second Edition, TMH, 1992.*
3. *Yashavant Kanetkar, "Let us C", Second Edition, TMH, 1996.*
4. *Cooper Herbert,"Spirit of C: Introduction to modern Programming", TMH, 1983.*

CSE180 COMPUTER PROGRAMMING LAB. 0 0 3 1

1. Programs using various input/output statements (scanf, printf, getchar, gets, puts, putchar)
2. Programs using bitwise operators and enumerated data types
3. Programs using control structures (if, if else, switch, & loops)
4. Programs using numeric one dimensional array
5. Programs using numeric multidimensional array
6. Programs using strings & string handling functions
7. Functions using static, external and auto variables
8. Programs using recursive functions
9. Programs using call by reference and pointer arithmetic
10. Pointer to array & array of pointers using dynamic memory allocation
11. Structures – arrays, structure within structure

12. Array of structures, unions
13. Programs using text files
14. Programs using binary files
15. Programs using random access of files
16. Programs using command line arguments

CUL101 CULTURAL EDUCATION I 2 0 0 2

Unit 1

Introduction to Indian Culture; Introduction to Amma's life and Teachings; Symbols of Indian Culture;

Unit 2

Science and Technology in Ancient India; Education in Ancient India; Goals of Life – Purushurthas; Introduction to Vedanta and Bhagavad Gita;

Unit 3

Introduction to Yoga; Nature and Indian Culture; Values from Indian History; Life and work of Great Seers of India (1)

TEXTBOOKS:

1. *The Glory of India (in-house publication)*
2. *The Mother of Sweet Bliss, (Amma's Life & Teachings)*

CUL102 CULTURAL EDUCATION II 2 0 0 2

Unit 1

Bhagavad Gita and Life Management; Historicity of Ramayana and Mahabharata; Overview of Patanjali's Yoga Sutras;

Unit 2

Highlights of Indian Mythology; Indian Society: Its Strengths and Weaknesses; Role & Position of Women in Indian Society;

Unit 3

Indian Models of Economy, Business and Management; Health and Lifestyle related issues; Conservation of cultural heritage; Life and work of Great Seers of India (2)

TEXTBOOKS:

1. *The Glory of India (in-house publication)*
2. *Sanatana Dharma (A compilation of Amma's teachings on Indian Culture)*

CUL151 ACHIEVING EXCELLENCE IN LIFE - AN INDIAN PERSPECTIVE 1 0 2 2

Objectives: *The course offers to explore the seminal thoughts that influenced the Indian Mind on the study of human possibilities for manifesting excellence in life. This course presents to the students, an opportunity to study the Indian perspective of Personality Enrichment through pragmatic approach of self analysis and application.*

Unit 1

Goals of Life – Purusharthas

What are Purusharthas (Dharma, Artha, Kama, Moksha); Their relevance to Personal life; Family life; Social life; & Professional life; Followed by a Goal setting workshop;

Yogic way of Achieving Life Goals – (Stress Free & Focused Life)

Introduction to Yoga and main schools of Yoga; Yogic style of Life & Time Management (Work Shop);

Experiencing life through its Various Stages

Ashrama Dharma; Attitude towards life through its various stages (Teachings of Amma);

Unit 2

Personality Development

What is Personality – Five Dimensions – PanchaKosas (Physical/ Energy/Mental/ Intellectual/ Bliss); Stress Management &Personality; Self Control & personality; Fundamental Indian Values & Personality;

Learning Skills (Teachings of Amma)

Art of Relaxed Learning; Art of Listening; Developing 'Sraddha' – a basic qualification for obtaining Knowledge;

Communication Skills - An Indian Perspective;

Unit 3

Developing Positive Attitude & Friendliness- (Vedic Perspective);

Achieving Work Excellence (Karma Yoga by Swami Vivekananda & teachings based on Amma);

Leadership Qualities – (A few Indian Role models & Indian Philosophy of Leadership);

REFERENCE BOOKS:

1. *Awaken Children (Dialogues with Sri Mata Amritanandamayi) Volumes 1 to 9*
2. *Complete works of Swami Vivekananda (Volumes 1 to 9)*
3. *Mahabharata by M.N Dutt published by Parimal publications – New Delhi (Volumes 1 to 9)*
4. *Universal message of Bhagavad-Gita (An exposition of Gita in the light of modern thought and Modern needs) by Swami Ranganathananda. (Volumes 1 to 3)*

5. *Message of Upanishads, by Swami Ranaganathananda published by Bharatiya Vidya Bhavan, Bombay.*
6. *Personality Development – Swami Vivekananda published by Advaitha Ashram, Kolkatta.*
7. *Art of Man Making - Swami Chinmayananda published by Chinmaya Mission, Bombay*
8. *Will Power and its Development- Swami Budhananda published by Advaitha Ashram, Kolkatta*
9. *Ultimate Success - Swami Ramakrishnananada Puri published by Mata Amritanandamayi Math, Kollam*
10. *Yoga In Daily Life - Swami Sivananda – published by Divine LIife Society*
11. *Hindu Dharma - H.H. Sri Chandrasekharandra Saraswati published by Bharatiya Vidya Bhavan, Bombay*
12. *All about Hinduism – Swami Sivananda - Published by Divine Life Society*
13. *The Mind and its Control by Swami Budhananda published by Advaitha Ashram, Kolkatta*
14. *Krida Yoga - Vivekananda Kendra, Publication.*
15. *Valmiki Ramayana – Four volumes- published by Parimal Publications, Delhi*
16. *New perspectives in Stress Management - Dr H R Nagendra & Dr R Nagaratna published by Swami Vivekananda Yoga Prakashana, Bangalore.*
17. *Mind Sound Resonance Technique (MSRT) published by Swami Vivekananda Yoga Prakashana, Bangalore.*
18. *Yoga & Memory - Dr H R Nagendra & Dr.Shirley Telles, published by Swami Vivekananda Yoga Prakashana, Bangalore.*

CUL152 EXPLORING SCIENCE AND TECHNOLOGY IN ANCIENT INDIA 1 0 2 2

Objectives: This course offers a journey of exploration through the early developments in India of astronomy, mathematics, technologies and perspectives of the physical world. With the help of many case studies, the students will be equipped to understand concepts as well as well as actual techniques.

Unit 1

1. General introduction: principles followed and sources;
2. Astronomy & mathematics from the Neolithic to the Indus civilization;
3. Astronomy & mathematics in Vedic literature;
4. *Vedanga Jyotisha* and the first Indian calendars;
5. *Shulba Sutras* and the foundations of Indian geometry;

Unit 2

6. Astronomy & mathematics in Jain and Buddhist literature;
7. The transition to the Siddhantic period; Aryabhata and his time;
8. The *Aryabhatiya*: concepts, content, commentaries;
9. Brahmagupta and his advances;
10. Other great Siddhantic savants;
11. Bhaskara II and his advances;

Unit 3

12. The Kerala school of mathematics;
13. The Kerala school of astronomy;
14. Did Indian science die out?;
15. Overview of recent Indian scientists, from S. Ramanujan onward;
16. Conclusion: assessment and discussion;

TEXTBOOK:

Indian Mathematics and Astronomy: Some Landmarks, by S. Balachandra Rao

***REFERENCE**:*

IFIH's interactive multimedia DVD on Science & Technology in Ancient India.

CUL153 EXCELLENCE IN DAILY LIFE 1 0 2 2

Unit 1

1 The anatomy of 'Excellence'. What is 'excellence'? Is it judged by external factors l ike wealth?

2 The Great Flaw. The subject-object relationship between individual and world. Promote subject enhance excellence.

3 To work towards excellence, one must know where he is. Our present state.. An introspective analysis. Our faculties within.

Unit 2

4 The play of the mind. Emotions – convert weakness into strength.

5 The indispensible role of the intellect. How to achieve and apply clear thinking?

6 The quagmire of thought.. the doctrine of Karma – Law of Deservance.

7 Increase Productivity, reduce stress.. work patterning.

Unit 3

8 The art of right contact with the world.. assessment, expectations.

9 Myths and Realities on key issues like richness, wisdom, spirituality.

10 Collect yourself, there is no time to waste. The blue-print of perfect action.

REFERENCES:

The Bhaja Govindam and the Bhagavad Gita.

CUL154 YOGA PSYCHOLOGY 1 0 2 2

Objectives: *This course offers the foundation necessary to understand Eastern approaches to psychology and spirituality. The course includes experiential components centering on meditation and spiritual practice.*

Unit 1

Introduction

Introduction to Modern Psychology

A short history of Modern Psychology - Major Schools of Modern Psychology - The three major forces in Western Psychology - Freudian Psychoanalysis; Behaviourism; Humanistic Psychology.

Introduction to Indian Psychology

What is Yoga? - Rise of Yoga Psychology tradition - Various schools of Yoga Psychology - Universal Goal of all Yoga-schools.

Patanjali Yoga Sutra – 1

Introduction to Rishi Patanjali - Bird view of Yoga-Sutra - Definition of Yoga – Vrittis.

Patanjali Yoga Sutra – 2

Five Kinds of Vrittis - Pramanam - sources of right knowledge - Viparyayah – unfolded belief - Vikalpah – Unfolded belief - Smriti – Memory.

Unit 2

Patanjali Yoga Sutra – 3

Two formulae - Necessity of Abhyasah and Vairagyah - Foundation of Abhyasah - Foundation of Vairagyah.

Patanjali Yoga Sutra – 4

Introduction to Samadhi - Samprajnata-Samadhi - Reasoning in Samprajnata-Samadhi - Reflection in Samprajnata-Samadhi - Bliss in Samprajnata-Samadhi - Sense of Individuality in Samprajnata-Samadhi.

Patanjali Yoga Sutra – 5

Main obstacles in the path of Yoga - other obstructions - removal of obstacles by one – pointedness; by controlling Prana - by observing sense experience - by inner illumination - by detachment from matter - by knowledge of dream and sleep - by meditation as desired.

Patanjali Yoga Sutra – 6

How to make mind peaceful? - Cultivating opposite virtues: happiness – friendliness - misery – compassion - virtue – gladness - vice – indifference.

Patanjali Yoga Sutra – 7

Five causes of Pain - avidya – ignorance (Root Cause) - asmita – 'I-Feeling' - raga – attraction - dwesha – repulsion - abhinivesha – clinging to life.

Unit 3

Patanjali Yoga Sutra – 8

Necessity of Yoga practice - eight parts of Yoga practice - five Yamas: ahimsa – satya – asteya – brahmacharyam – aparigraha.

Patanjali Yoga Sutra – 9

Five Niyamas: Soucha – Santhosha – Tapas – Swadyah – Ishwara - Pranidhanam.

Patanjali Yoga Sutra – 10

Asanam – Pranayamah - various kinds of Pranayamah - Pratyaharah - Mastery over the senses.

Report review

Conclusion

REFERENCES:

- *The course book will be "The four chapters of Freedom" written by Swami Satyananda Saraswati of Bihar School of Yoga, Munger, India.*
- *"The message of Upanishads" written by Swami Ranganathananda. Published by Bharathiya Vidya Bhavan.*
- *Eight Upanishads with the commentary of Sankaracharya, Translated by Swami Gambhirananda, Published by Advaita Ashram, Uttaranjal.*
- *'Hatha Yoga Pradipika' Swami Muktibodhananda, Yoga Publications Trust, Munger, Bihar, India*

ECE100 ELECTRONICS ENGINEERING 3 0 0 3

Objective: *To understand the working of basic electronic devices such as diodes, BJTs and FETs; Introduce the student to the operation and design of fundamental building blocks of electronic systems like power supplies, amplifiers and oscillators; Develop skills to analyze specifications of simple electronic circuits and carry out their design.*

Unit 1

Physics of conductors and semiconductors: conductors, semiconductors, silicon crystals, intrinsic semiconductors, two types of flow, doping a semiconductor, two types of extrinsic semiconductors, unbiased diode, forward bias, reverse bias, breakdown, barrier potential and temperature, reverse biased diode, diode approximations.

Rectifiers and diodes: half wave, full wave and Bridge rectifiers. Filters, choke input filter, capacitor input filter, PIV and surge current, Zener diode, loaded Zener regulator, LED, photo diodes, Schottky diode, Varactor diode.

Unit 2

Basics of amplifiers: Introduction to BJT and FET, BJT characteristic curves and regions of operation, emitter and voltage divider bias of BJT, BJT as a switch, LED drivers, JFET characteristics, JFET biasing in Ohmic and active regions, transconductance, JFET amplifiers, depletion mode and enhancement mode MOSFET, CMOS.

Unit 3

Operational amplifiers and linear ICs: differential amplifier, introduction to Opamps, inverting and non-inverting amplifier, comparators, instrumentation amplifier, summing amplifier, voltage follower.

Oscillators: Theory of sinusoidal oscillations, Wein Bridge oscillator, Colpitts oscillator, Quartz Crystal oscillator, introduction to 555 Timer, astable and monostable operation.

TEXTBOOK:

A.P Malvino, "Electronic Principles", Seventh Edition, TMH, 2007

REFERENCES:

1. *J. Millman and C C Halkias, "Electronics Devices & Circuits", TMH Edition, 2005*
2. *David. A. Bell, "Electronics Devices and Circuits", Fifth Edition, Oxford University Press,2008*
3. *I. J. Nagrath, "Electronic Devices and Circuits", Prentice-Hall of India, 2007*

EEE100 ELECTRICAL ENGINEERING 3 0 0 3

Unit 1

Introduction to electrical engineering. System of units. Electric current, Coulomb's law, Ohm's law, Faraday's law of electromagnetic induction, Kirchoff's laws, Ampere's law.

Ideal independent current and voltage-sources; Reference directions and symbols, energy and power; R, L and C- parameters; Series and parallel combination of resistances, capacitances and inductances, series-parallel circuits, superposition theorem, conversion of a voltage source to current source and vice versa, voltage divider and current divider rule. Network reduction by star–delta transformation, analysis of dc circuits by Mesh-current and nodal methods.

Unit 2

Transient analysis with energy storage elements (for RC-, RL- circuits with DC excitations): Writing differential equations for first order circuits, steady state solution of circuits containing inductors and capacitors, initial and final conditions, transient response of RL and RC circuits (rise and decay).

Sinusoidal steady state analysis: Generation of sinusoidal functions, average and effective values of periodic functions, instantaneous and average power, power factor, phasor representation of sinusoids, response of single elements (R, L and C) for sinusoidal excitation; phasor concept and phasor diagram; Impedance and Admittance concepts; The series RL, series RC and series RLC circuits, complex power and power triangle. Introduction to 3-phase systems; Balanced 3-phase systems (STAR and DELTA connections).

Unit 3

Magnetic circuits: MMF, magnetic flux, reluctance, flux density, analogy with electric circuits, analysis of magnetic circuits, self and mutual induced emfs, energy stored in a magnetic circuit.

Transformers; construction and principle of operation of transformers, Emf equation.

Three phase Induction motor: Types, construction, rotating magnetic field, principle of operation, slip, rotor induced emf.
Measuring instruments, Different types of instruments to measure voltage, current power and energy.

TEXTBOOK:

Vincent Del Toro, 'Electrical Engineering Fundamentals', Second Edition, Prentice Hall of India Private Limited, 2003.

REFERENCES:

1. *Giorgio Rizzoni, 'Principles and Applications of Electrical Engineering', Fourth Edition, Tata McGraw-Hill Publishing Company Limited, 2003.*
2. *Hughes, 'Electrical Technology' Seventh edition, Pearson Education Asia, 2000.*

EEE180 WORKSHOP B 1 0 2 2

Electrical workshop:
Study of safety devices such as fuse, MCB, ELCB & earthing – electrical power distribution in domestic installations, study of tools and accessories used in electrical wiring – wiring practice for staircase circuit, fluorescent lamp, hospital wiring and godown lighting – study of domestic appliances like Mixie, fan, Electric iron, Air conditioner, Refrigerator – study of different types of electric lamps like Incandescent lamp, Fluorescent, CFL, Metal halide, Mercury vapour, Sodium vapour and halogen lamp.

Personal computer hardware workshop:
Study of basic components in a computer - study of basic components in a network – study of diagnostic tools for system and study of floppy disk controller – study of hard disk controller – drivers for different components – trouble shooting in printer – communication between two computers with null modem – transferring characters from PC to LCD.

Electronics and basic microprocessor workshop:
Identification of electronic components and study of measuring instruments – PCB fabrication and soldering practice – study of intel 8085 microprocessor trainer kit concepts.

PIC microcontroller workshop:
Introduction to MP lab simulator. Simulating and burning simple programmes on PIC 16F877A.

ENG111 COMMUNICATIVE ENGLISH 2 0 2 3

Objectives:

To make the students communicate their thoughts, opinions, and ideas freely and naturally.
To make them understand the different styles in communication
To make the students understand the aesthetics of reading and writing
To bring in a spirit of enquiry

To motivate critical thinking and analysis
To help them ruminate on human values

Unit 1
Reading: Different styles of communication – reading comprehension - critical thinking and analysis – note-making.

Unit 2
Writing: Prewriting techniques - kinds of paragraphs - basics of continuous writing; Grammar and usage – topics including spelling and number rules (Workbook).

Unit 3
Practical sessions (listening & speaking)**:** Introduction to English pronunciation including minimal pairs and word stress – differences between British and American English – listening comprehension and note-taking.
Activities: Short speeches, seminars, quizzes, language games, debates, discussions and book reviews, etc.

TEXTBOOKS:

1. *Language through Reading: Anthology compiled by Amrita;*
2. *Language through practice: Work book compiled by Amrita*

REFERENCES:

1. *Raymond Murphy. "Murphy's English Grammar", Cambridge Univ. Press, 2004.*
2. *Michael Swan. "Practical English Usage", Oxford Univ. Press, 2000.*
3. *Daniel Jones. "Cambridge English Pronouncing Dictionary" Ed. Peter Roach, Jane Setter and James Hartman, Cambridge Univ Press, 2006.*

ENG112 TECHNICAL COMMUNICATION 2 0 2 3

Objectives:

To introduce the students to the elements of technical style
To introduce the basic elements of formal correspondence
To introduce technical paper writing skills and methods of documentation
To improve oral presentation skills in formal contexts

Unit 1
Mechanics of writing: Grammar rules – punctuation - spelling rules - tone and style - graphical representation.

Unit 2
Different kinds of written documents: Definitions – descriptions – instructions – recommendations - manuals - reports – proposals; Formal correspondence: Letter writing, including job applications with resume.

Unit 2

Technical paper writing: Library research skills - documentation style - document editing – proof reading – formatting.

Practice in oral communication: Group discussion, interviews and technical presentations.

REFERENCES:

1. *Hirish, Herbert. L "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 2002*
2. *Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003*
3. *Strunk,William Jr. and White. EB. "The Elements of Style" New York. Alliyan & Bacon, 1999.*
4. *Riordan, G.Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.*

ENG250 PROFESSIONAL COMMUNICATION 1 0 2 2

Unit 1

Reading Comprehension: Focus will be on understanding of the given information, vocabulary, inference, logical thinking, and decision - making.

Unit 2

Work place Communication: Writing suggestions, recommendations - reports like, incident report, progress report, trip report, feasibility report – resume writing - formal and business letters – memos, circulars, notices - agenda, meetings, minutes.

Unit 3

Practical: Telephonic conversations, interviews, group and panel discussions, and oral presentations.

REFERENCES:

1. *Davis Homer & Peter Strutt. "Words at Work", CUP, 1996.*
2. *Simon Sweeney. "Communicating in Business", CUP, 2000.*
3. *Leo Jones & Richard Alexander. "New International Business English" CUP, 2003.*
4. *Raymond V Lesikar & Marie E. Flatley. "Basic Business Communication", Tata McGraw-Hill Pub. Co. New Delhi, 2005. Tenth Ed.*

ENG251 BUSINESS COMMUNICATION 1 0 2 2

OBJECTIVES:

To introduce business vocabulary

T o introduce business style in writing and speaking

To expose students to the cross-cultural aspects in a globalised world

To introduce the students to the art of persuasion and negotiation in business contexts.

Unit 1

Writing – English grammar & business vocabulary - drafting – notice – agenda – minutes – reports – proposals – memos – letters - writing press releases.

Unit 2

Reading – scanning – comprehension – inference - error detection - listening – pronunciation – information & reporting.

Unit 3

Speaking – conversational practice – telephonic conversations – addressing a gathering – conducting meetings - negotiation & persuasion techniques.

Activities - case studies & role-plays

BOOKS RECOMMENDED:

1. *Jones, Leo & Richard Alexander. New International Business English. CUP. 2003.*
2. *Horner, David & Peter Strutt. Words at Work. CUP. 1996.*
3. *Owen, Roger. BBC Business English. BBC. 1996.*
4. *Henderson, Greta Lafollette & Price R Voiles. Business English Essentials. 7th Edition. Glencoe / McGraw Hill.*
5. *Sweeney, Simon. Communicating in Business. CUP. 2000.*

ENG252 INDIAN THOUGHT THROUGH ENGLISH 1 0 2 2

Objectives:

To expose the students to the greatness of Indian Thought in English

To develop a sense of appreciation for the lofty Indian Thought

To develop an understanding of the eclectic Indian

Unit 1

Poems: Toru Dutt – The Casuarina Tree; Sri Aurobindo – The Tiger and the Deer; Nissim Ezekiel – Farewell Party to Miss Pushpa T S;
Rabindranath Tagore – Upagupta.

Unit 2

Essays and short stories: Jawaharlal Nehru – at Harrow; Swami Vivekananda – The Ideal of a Universal Religion; Dr. S. Radhakrishnan – Philosophy of life;
Gita Hariharan – The Remains of the Feast; Anita Desai – The Winterscape; R.K Narayan – The Blind Dog; Jim Corbett – Lalaji; Ruskin Bond – The Night Train at Deoli; Tagore – The Postmaster.

Unit 3

Drama and Speech: Rabindranath Tagore – Chandalika; Mahashwetadevi – Bayen; Swami Vivekananda – Chicago Address; J.Krishnamurthy / C.N.R Rao - Audio speech.

Short Story:

REFERENCES:

1. *"The Golden Treasury of Indo-Anglian Poetry", Ed. V.K. Gokak (1923-1965)*
2. *"Ten Twentieth Century Indian Poets", by R. Parthasarathy, OUP, 1976.*
3. *"The Remains of the Feast" by Gita Haiharan from In Other Words; New Writing by Indian Women, ed. Urvashi Butalia and Ritu Menon, The Women's Press Limited, 34,Great Sutton Street, London.*
4. *"Three Plays of Rabindranath Tagore", OUP, Madras, 1979.*
5. *"An anthology of Popular Essays and Poems". Ed. A.G. Xavier, Macmillan India Ltd., 1988.*
6. *"Hymns of Darkness", 1976.*
7. *"Letters from a Father to His Daughter", Allahabad Law Journal Co. Ltd., Allahabad.*
8. *Vidya, intranet, Amrita Vishwa Vidyapeetham.*
9. *"Mashi" and Other Stories, Rupa and Co. Paperback – 2002.*
10. *"My India", Oxford University Press, New Delhi – 2000- paperback.*
11. *"Prison and Chocolate Cake", Victor Gollencz, London. Indian Edition, Jaico Publishing, Bombay*
12. *"Twelve Modern Short Stories", Macmillan Publication.*
13. *"Malgudi Days", R.K. Narayan, Indian Thought Publications, 1996, 23rd reprint 2007.*
14. *Diamond Dust and Other Stories, Anita Desai, Published by Vintage, 2001.*
15. *The Complete Works of Swami Vivekananda, Advaita Ashram, Calcutta.*

ENG253 INSIGHTS INTO LIFE THROUGH ENGLISH LITERATURE 1 0 2 2

(Pre-requisite: Nil;Equivalent course in 2007 curriculum: Nil)

Objectives -

· *to expose the students to different genres of Literature*
· *to inculcate reading skills*
· *to provide deeper critical and literary insights*
· *to enhance creative thinking*
· *to help the student develop critical and analytical skills*
· *to promote the aesthetic sense*

Unit 1

Poetry

Seamus Heaney – Digging; Philip Larkin – Ambulances; W.B.Yeats - Prayer for my daughter; W. H Auden - Miss Gee; Peter Porter - Your Attention Please; Rabindranath Tagore 's poems "Defamation" and "Playthings".

Unit 2

Drama

Oscar Wilde - Importance of Being Earnest; Anton Chekov – Proposal; Scenes from the great tragedies of Shakespeare.

Unit 3

Essays

Bibhuti Mishra "When I took over from her"; R.K.Narayan "Junk"; M K Naik " The Postman's Knock",

Practical:

Reviews of novels and short stories; Presentations, Review of Literature, Discussions, Role plays.

REFERENCES:

1. *Gupta, Balram. G. S. Srinath. C. S. ed. Indian Humorous Essays. Chennai: Emarald. 2008. Print.*
2. *Indira . C T. ed. The Pleasures of Poetry. Madras: 2001. Print.*
3. *Rabindranath Tagore et al. Collected Poems and Plays of Rabindranath Tagore. Macmillan India Ltd. 1999. Print.*
4. *Sachithanandan , V. ed. Six English Poets.Madras: Macmillan . 1994. Print.*
5. *Vishwanathan, R. ed . ViewlessWings. Calicut: CU. 1991. Print.*
6. *Wilde, Oscar. The Importance of Being Earnest. Ed. Dr S Sreenivasan. Kollam: Century.2005. Print.*

ENV200 ENVIRONMENTAL STUDIES 3 1 0 4

Unit 1

Overview of the global environmental crisis; Biogeochemical cycles; Climate change and related international conventions and treaties and regulations; Ozone hole and related international conventions and treaties and regulations; Overpopulation; Energy crisis; Water crisis, groundwater hydrogeology, surface water resource development .

Unit 2

Ecology, biodiversity loss and related international conventions, treaties and regulations; Deforestation and land degradation; Food crisis; Water pollution and related international and local conventions, treaties and regulations; Sewage domestic and industrial and effluent treatment; Air pollution and related international and local conventions, treaties and regulations; Other pollution (land, thermal, noise).

Unit 3

Solid waste management (municipal, medical, e-waste, nuclear, household hazardous wastes); Environmental management, environmental accounting, green businesses, eco-labeling, environmental ethics, environmental impact assessment; Constitutional, legal and regulatory provisions; Sustainable development;

TEXTBOOK:

"Environmental Studies - From Crisis to Cure" by R. Rajagopalan, Oxford University Press.2005,ISBN 0-19-567393-X.

REFERENCE BOOKS:

1. *G.T. Miller Jr., "Environmental Science", 11th Edition, Cenage Learning India Pvt. Ltd., 2008.*
2. *Benny Joseph "Environmental Studies", Tata McGraw-Hill Publishing Company Limited, 2006.*

FRE201 PROFICIENCY IN FRENCH LANGUAGE (LOWER) 1 0 2 2

Unit 1 Population - Identity

How to introduce yourself (name, age, address, profession, nationality); Numbers; How to ask questions;

Grammar – Pronouns - subjects; Regular verbs of 1st group (er) in the present; Être (to be) and avoir (to have) in the present; Interrogative sentence; Gender of adjectives.

Unit 2 The suburbs - At the train station

Introduce someone; Buy a train ticket or a cinema ticket; Ask for information; Official time; Ask for a price; The city (church, town hall, post office…)

Grammar – Pronouns - subjects (continuation); Gender of adjectives (continuation); Plural of nouns and adjectives; Definite and indefinite articles; Interrogative adjectives; I would like (Je voudrais).

Unit 3 Paris and the districts - Looking for a room

Locate a room and indicate the way; Make an appointment; Give a price; Ordinal numbers; Usual time; Ask for the time.

Grammar - Imperative mode; Contracted articles (au, du, des); negation.

TEXTBOOK:

Metro St Michel - Publisher: CLE international

FRE202 PROFICIENCY IN FRENCH LANGUAGE (HIGHER) 1 0 2 2

Unit 1 The first room of a student

A party to celebrate the 1st room; Description of a room; furniture; Locate objects: prepositions (devant, derrière, dans…), Read advertisement; Appreciation (I like, I prefer,).

Grammar - Perfect past tense with *avoir;* Possessive adjectives (*mon, ton, son*…); Demonstrative adjectives (*ce, cet, cette*); Yes (*oui, si*).

Unit 2 Small jobs

Conversation on the phone; Give Time indications; Answer a job offer; Describe a job; Suggest a meeting time.

Grammar - Perfect past tense with *être* and *avoir* (continuation); Possessive adjectives (*notre, votre, leur*); Prepositions (*à, pour, avec* …); Pronoun as direct object (*le, la, l', les*).

Unit 3 University Restaurant

Inquiry; Express an opinion; Ask questions (continuation); Food, meals, taste, preferences; Nutrition, diet, choose a menu or diet, Expression of quantities (*beaucoup, peu*).

Grammar - Partitif (expressing quantity) (*du, de la, pas de*….); Comparison (plus ...que, moins….que, autant …que); Interrogation (continuation), inversion, *Est-ce que, qu'est-ce que ?.*

TEXTBOOK:

Metro St Michel - Publisher: CLE international

GER201 PROFICIENCY IN GERMAN LANGUAGE (LOWER) 1 0 2 2

To have an elementary exposure to German language; specifically

1. to have some ability to understand simple spoken German, and to be able to speak it so as to be able to carry on life in Germany without much difficulty (to be able to do shopping, etc.);
2. to be able to understand simple texts, and simple forms of written communication;
3. to have a basic knowledge of German grammar;
4. to acquire a basic vocabulary of 500 words;
5. to be able to translate simple letters with the use of a dictionary; and
6. to have some familiarity with the German life and culture.

(This will not be covered as part of the regular classroom teaching; this is to be acquired by self-study.)

Some useful websites will be given.

GER202 PROFICIENCY IN GERMAN LANGUAGE (HIGHER) 1 0 2 2

The basic vocabulary and grammar learned in the earlier course is mostly still passive knowledge. The endeavour of this course is to activate this knowledge and develop the skill of communication.

Topics are: Airport, railway station, travelling; shopping; invitations, meals, meeting people; around the house; the human body; colours; professions.

Past and future tenses will be introduced. Applying genitive, dative and accusative. Some German culture. Films.

GER211 GERMAN FOR BEGINNERS I 1 0 2 2

Unit 1
Greetings; Introducing one-self (formal and informal context), saying their name, origin, living place, occupation.
Numbers 1-100; Saying the telephone number.
Countries and Languages.
Grammar: Structure – W - Questions and Yes/No questions and statements, personal pronouns, verb conjugations. Articles.
Vocabulary: Professions.

Unit 2
Giving the personal details. Name, age, marital status, year of birth, place of birth, etc.
Numbers till 1000. Saying a year.
Alphabets – spelling a word.
Filling up an application form; In the restaurant – making an order.
Grammar: Definite, indefinite and negative article in nominative.
Accusative: indefinite and negative Article
Vocabulary: Food items

Unit 3
Number above 1000. Orientation in Shopping plazas: asking the price, where do I find what, saying the opinion.
Grammar: Accusative – definite article. Adjectives and plural forms.
Vocabulary: Furniture and currencies.

GER212 GERMAN FOR BEGINNERS II 1 0 2 2

Unit 1
Shopping and orientation in supermarket; Conversation between the customer and salesman; Where one finds what in supermarket; Asking for requests and suggestions.
Grammar: Dative of personal pronouns. Imperative form.
Vocabulary: Consumables and measurements;

Unit 2
Appointments; Work and leisure time activities; Time, weekdays, months and seasons; saying the date; fixing up an appointment.
Grammar: Model verbs; Prepositions with time and place; Ordinal numbers.
Vocabulary: Leisure activities, weekdays, months and seasons.

Unit 3
Family and household; Family and relations; household and daily routine.
Grammar: Possessive articles; Divisible and indivisible verbs.
Vocabulary: Family circle; Household articles.

HUM250 INDIAN CLASSICS FOR THE TWENTY-FIRST CENTURY 1 0 2 2

Unit 1
Introductory study of the Bhagavad Gita and the Upanishads

Unit 2
The relevance of these classics in a modern age –

Unit 3
Goals of human life-existential problems and their solutions in the light of these classics etc.

REFERENCE:
The Bhagavad Gita, Commentary by Swami Chinmayananda

HUM251 INTRODUCTION TO INDIA STUDIES 1 0 2 2

Preamble:
This paper will introduce the students to the multiple dimensions of the contribution of India to the fields of philosophy, art, literature, physical and social sciences. The paper intends to give an insight to the students about the far-reaching contributions of India to world culture and thought during the course of its long journey from the hoary antiquity to the present times. Every nation takes pride in its achievements and it is this sense of pride and reverence towards the achievements that lays the foundation for its all-round progress.

Unit 1
A brief outline of Indian history from prehistoric times to the present times.
Contributions of India to world culture and civilization:
Indian Philosophy and Religion; Art and Literature; Physical and Social Sciences.

Unit 2
Modern India: Challenges and Possibilities –
Scientific and technological progress in post-independence era; Socio-cultural and political movements after independence; Challenges before the nation today - unemployment – corruption – degradation of cultural and moral values - creation of a new system of education; Creation of a modern and vibrant society rooted in traditional values.

Unit 3

Modern Indian Writing in English: Trends in Contemporary Indian Literature in English

TEXTBOOK:

Material given by the Faculty

BACKGROUND LITERATURE:

1) *Selections from The Cultural Heritage of India, 6 volumes, Ramakrishna Mission Institute of Culture (Kolkata) publication.*
2) *Selections from the Complete Works of Swami Vivekananda, Advaita Ashrama publication.*
3) *Invitations to Indian Philosophy, T. M. P. Mahadevan, University of Madras, Chennai.*
4) *Outlines of Indian Philosophy, M. Hiriyanna, MLBD.*
5) *An Advanced History of India, R. C. Majumdar et al, Macmillan.*
6) *India Since 1526, V. D. Mahajan, S. Chand & Company*
7) *The Indian Renaissance, Sri Aurobindo.*
8) *India's Rebirth, Sri Aurobindo.*
9) *On Nationalism, Sri Aurobindo.*
10) *The Story of Civilization, Volume I: Our Oriental Heritage, Will Durant, Simon and Schuster, New York.*
11) *Eternal Values for a Changing Society, Swami Ranganathananda, Bharatiya Vidya Bhavan.*
12) *Universal Message of the Bhagavad Gita, Swami Ranganathananda, Advaita Ashrama.*
13) *Awaken Children: Conversations with Mata Amritanandamayi*
14) *Indian Aesthetics, V. S. Seturaman, Macmillan.*
15) *Indian Philosophy of Beauty, T. P. Ramachandran, University of Madras, Chennai.*
16) *Web of Indian Thought, Sister Nivedita*
17) *Essays on Indian Nationalism, Anand Kumaraswamy*
18) *Comparative Aesthetics, Volume 2, Kanti Chandra Pandey, Chowkhamba, Varanasi*
19) *The Invasion That Never Was, Michel Danino*
20) *Samskara, U. R. Ananthamurthy, OUP.*
21) *Hayavadana, Girish Karnard, OUP.*
22) *Naga-Mandala, Girish Karnard, OUP.*

HUM252 GLIMPSES OF ETERNAL INDIA 1 0 2 2

Unit 1

Introduction

A peep into India's glorious past

Ancient India – the vedas, the vedic society and the Sanatana Dharma – rajamandala and the Cakravartins – Ramarajya – Yudhisthira's ramarajya; Sarasvati - Sindhu Civilization and the myth of the Aryan Invasion; Classical India – Dharma as the bedrock of Indian society – Vaidika Brahmanya Dharma and the rise of Jainism and Buddhism – the sixteen Mahajanapadas and the beginning of Magadhan paramountcy – Kautilya and his Arthasastra – Chandragupta Maurya and the rise of the Mauryan empire – Gupta dynasty Indian art and architecture – classical sanskrit literature –

Harsavardhana; Trade and commerce in classical and medieval India and the story of Indian supremacy in the Indian ocean region; The coming of Islam – dismantling of the traditional Indian polity – the Mughal empire – Vijayanagara samrajya and days of Maratha supremacy.

Unit 2

India's contribution to the world: spirituality, philosophy and sciences

Indian Philosophy – the orthodox (Vaidika) and the heterodox (atheistic) schools; Ramayana and Mahabharata; Bhagavad Gita; Saints and sages of India; Ancient Indian medicine: towards an unbiased perspective; Ancient Indian mathematics; Ancient Indian astronomy; Ancient Indian science and technology.

The arrival of Europeans, British paramountcy and colonization

What attracted the rest of the world to India?; India on the eve of the arrival of European merchants; The story of colonization and the havoc it wrecked on Indian culture and civilization; Macaulay and the start of the distortion of Indian education and history; Indian economy – before and after colonization: a brief survey; The emergence of modern India.

Unit 3

Women in Indian society

The role and position of women in Hindu civilization; Gleanings from the Vedas, Brihadarnyaka Upanishad, Saptasati Devi Mahatmyam, Ramayana, Mahabharata, Manusmriti, Kautilya's Arthasastra and Mrichchhakatikam of Sudraka;

The role and position of Indian women vis-a-vis Islam and European cultures; The great women of India.

Modern India

The national movement for freedom and social emancipation; Swami Vivekananda, Sri Aurobindo, Rabindranath Tagore; Understanding Mahatma Gandhi; A new nation is born as a republic – the pangs of birth and growth; India since Independence – the saga of socio-political movements; Problems facing the nation today; Globalization and Indian Economy; Bharatavarsha today and the way ahead: Regeneration of Indian National Resources.

Conclusion

The Wonder that was India; The 'politics' and 'purpose' of studying India

REFERENCES:

1. *Parameswaran, S. The Golden Age of Indian Mathematics. Kochi: Swadeshi Science Movement.*
2. *Somayaji, D.A. A Critical Study of Ancient Hindu Astronomy. Dharwar: 1972.*
3. *Sen, S.N. & K.V. Sarma eds. A History of Indian Astronomy. New Delhi, 1985.*
4. *Rao, S. Balachandra. Indian Astronomy: An Introduction. Hyderabad: Universities Press, 2000.*
5. *Bose, D.M. et. al. A Concise History of Science in India. New Delhi: 1971.*
6. *Bajaj, Jitendra & M.D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.*

7. *Bajaj, Jitendra & M.D. Srinivas. Timeless India, Resurgent India. Chennai: Centre for Policy Studies.*
8. *Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies,2008.*
9. *The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture.*
10. *Vivekananda, Swami. Selections from the Complete Works of Swami Vivekananda. Kolkata: Advaita Ashrama.*
11. *Mahadevan, T.M.P. Invitations to Indian Philosophy. Madras: University of Madras.*
12. *Hiriyanna, M. Outlines of Indian Philosophy. Motilal Banarsidass.*
13. *Tagore, Rabindranath. The History of Bharatavarsha / On Nationalism / Greater India.*
14. *Majumdar, R.C. et. al. An Advanced History of India. Macmillan.*
15. *Mahajan, V.D. India Since 1526. New Delhi: S. Chand & Company.*
16. *Durant, Will. The Case for India. Bangalore: Strand Book Stall, 2008.*
17. *Aurobindo, Sri. The Indian Renaissance / India's Rebirth / On Nationalism.*
18. *Nivedita, Sister. The Web of Indian Life. Kolkata: Advaita Ashrama.*
19. *Durant, Will. The Story of Civilization. Volume 1 – Our Oriental Heritage. New York: Simon & Schuster.*
20. *Ranganathananda, Swami. Eternal Values for A Changing Society. Bombay: Bharatiya Vidya Bhavan.*
21. *Ranganathananda, Swami. Universal Message of the Bhagavad Gita. Kolkata: Advaita Ashrama.*
22. *Seturaman, V.S. Indian Aesthetics. Macmillan.*
23. *Coomaraswamy, Ananda K. The Dance of Shiva. New Delhi: Sagar Publications.*
24. *Coomaraswamy, Ananda K. Essays on Indian Idealism. New Delhi: Munshiram Manoharlal.*
25. *Danino, Michel. The Invasion That Never Was.*
26. *Kautilya. Arthasastra.*
27. *Altekar, A.S. State and Government in Ancient India. New Delhi: Motilal Banarsidass.*
28. *Altekar, A.S. The Position of Women in Hindu Civilization. New Delhi: Motilal Banarsidass.*
29. *Sircar, D.C. Studies in the Religious Life of Ancient and Medieval India. New Delhi: Motilal Banarsidass.*
30. *Sircar, D.C. Studies in the Political and Administrative Systems in Ancient and Medieval Times.New Delhi: Motilal Banarsidass.*
31. *Madhavananda, Swami & R.C. Majumdar eds. The Great Women of India. Kolkata: Advaita Ashrama.*
32. *Dutt, R.C. The Economic History of India. London, 1902.*
33. *Dharampal. Collected Works.*
34. *Dharampal. Archival Compilations (unpublished)*

HUM253 GLIMPSES INTO THE INDIAN MIND: THE GROWTH OF MODERN INDIA 1 0 2 2

Unit 1

Introduction

General Introduction; 'His + Story' or 'History'?; The concepts of 'nation', 'national identity' and 'nationalism'; Texts and Textualities: Comparative Perspectives

Unit 2

Selected writings / selections from the complete works of the following authors will be taken up for study in a chronological order:

Raja Ram Mohan Roy; Dayananda Saraswati; Bal Gangadhar Tilak; Rabindranath Tagore;

Unit 3

Selected writings / selections from the complete works of the following authors will be taken up for study in a chronological order:

Swami Vivekananda; Sri Aurobindo; Ananda K. Coomaraswamy; Sister Nivedita; Mahatma Gandhi; Jawaharlal Nehru; B.R. Ambedkar; Sri Chandrasekharendra Saraswati, the Paramacharya of Kanchi; Dharampal; Raja Rao; V.S. Naipaul.

Conclusion

REFERENCES:

1. *Tilak, Bal Gangadhar. The Orion / Arctic Home in the Vedas.*
2. *Tagore, Rabindranath. The History of Bharatavarsha / On Nationalism / Greater India.*
3. *Vivekananda, Swami. "Address at the Parliament of Religions"/"The Future of India"/"In Defence of Hinduism" from Selections from the Complete Works of Swami Vivekananda.*
4. *Aurobindo, Sri. The Renaissance in India / On Nationalism.*
5. *Coomaraswamy, Ananda K. Essays in Indian Idealism (any one essay) / Dance of Shiva.*
6. *Nivedita, Sister. "Noblesse Oblige: A Study of Indian Caste" / "The Eastern Mother" from The Web of Indian Life.*
7. *Gandhi, Mahatma. Hind Swaraj.*
8. *Nehru, Jawaharlal. "The Quest" from Discovery of India.*
9. *Ambedkar, B.R. "Buddha and His Dhamma" from Collected Works.*
10. *Saraswati, Chandrasekharendra. "The Sastras and Modern Life" from The Hindu Dharma.*
11. *Dharampal. Bharatiya Chitta, Manas and Kala / Understanding Gandhi.*
12. *Naipaul, V.S. India: A Wounded Civilization / India: A Million Mutinies Now.*

HUM254 GLIMPSES OF INDIAN ECONOMY AND POLITY 1 0 2 2

Unit 1

Introduction

General Introduction; Primitive man and his modes of exchange – barter system; Prehistoric and proto-historic polity and social organization.

Ancient India – up to 600 B.C.

Early India – the vedic society – the varnashramadharma – socio-political structure of the various institutions based on the four purusarthas; The structure of ancient Indian polity – Rajamandala and Cakravartins – Prajamandala; Socio-economic elements from the two great Epics – Ramayana and Mahabharata – the concept of the ideal King (Sri Rama) and the ideal state (Ramarajya) – Yudhisthira's ramarajya;

Sarasvati - Sindhu civilization and India's trade links with other ancient civilizations; Towards chiefdoms and kingdoms – transformation of the polity: kingship – from gopati to bhupati; The mahajanapadas and the emergence of the srenis – states and cities of the Indo-Gangetic plain.

Unit 2

Classical India: 600B.C. – 1200 A.D.

The rise of Magadha, emergence of new religions – Buddhism and Jainism – and the resultant socio-economic impact; The emergence of the empire – the Mauryan Economy and Kautilya's *Arthasastra;* Of Politics and trade – the rise of the Mercantile Community; Elements from the age of the Kushanas and the Great Guptas; India's maritime trade; Dharma at the bedrock of Indian polity – the concept of Digvijaya: dharma-vijaya, lobha-vijaya and asura-vijaya; Glimpses into the south Indian economies: political economies of the peninsula – Chalukyas, Rashtrakutas and Cholas

Medieval India: 1200 A.D. – 1720 A.D.

Advent of Islam – changes in the social institutions; Medieval India – agrarian economy, non-agricultural production and urban economy, currency system; Vijayanagara samrajya and maritime trade – the story of Indian supremacy in the Indian Ocean region; Aspects of Mughal administration and economy; The Maratha and other provincial economies.

Unit 3

Modern India: 1720 - 1947

the Indian market and economy before the arrival of the European traders; Colonisation and British supremacy (dismantling of everything that was 'traditional' or 'Indian') – British attitude towards Indian trade, commerce and economy and the resultant ruining of Indian economy and business – man-made famines – the signs of renaissance: banking and other business undertakings by the natives (the members of the early Tagore family, the merchants of Surat and Porbander, businessmen of Bombay, etc. may be referred to here) – the evolution of the modern banking system; Glimpses into British administration of India and administrative models; The National movement and nationalist undertakings in business and industry: the Tatas and the Birlas; Modern India: the growth of large-scale industry – irrigation and railways – money and credit – foreign trade; Towards partition – birth of two new nations – division of property; The writing of the Indian Constitution – India becomes a democratic republic – a new polity is in place.

Independent India – from 1947

India since Independence – the saga of socio-political movements; Indian economy since Independence – the fiscal system – the five year plans – liberalisation – the GATT and after; Globalisation and Indian economy; Impact of science and (new/ emerging) technology on Indian economy; Histories of select Indian business houses and business entrepreneurship.

Conclusion

REFERENCES:

1. *The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture.*
2. *Kautilya. Arthasastra.*
3. *Altekar, A.S. State and Government in Ancient India. New Delhi: Motilal Banarsidass.*
4. *Sircar, D.C. Studies in the Political and Administrative Systems in Ancient and Medieval Times. New Delhi: Motilal Banarsidass.*
5. *Dutt, R.C. The Economic History of India. London,1902.*
6. *Dharampal. Collected Works (Volumes IV & V).*
7. *Dharampal. Archival Compilations (unpublished).*
8. *Bajaj, Jitendra & M.D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.*
9. *Bajaj, Jitendra & M.D. Srinivas. Timeless India, Resurgent India. Chennai: Centre for Policy Studies.*
10. *Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies, 2008.*
11. *Tripathi, Dwijendra. The Oxford History of Indian Business. New Delhi: Oxford University Press, 2004.*
12. *McGuire, John, et al, eds. Evolution of World Economy, Precious Metals and India. New Delhi: Oxford University Press, 2001.*
13. *Tripathi, Dwijendra and Jyoti Jumani. The Concise Oxford History of Indian Business. New Delhi: Oxford University Press, 2007.*
14. *Kudaisya, Medha M. The Life and Times of G.D. Birla. New Delhi: Oxford University Press, 2003.*
15. *Raychaudhuri, Tapan and Irfan Haib, eds. The Cambridge Economic History of India. Volume 1. New Delhi: Orient Longman, 2004.*
16. *Kumar, Dharma, ed. The Cambridge Economic History of India. Volume 2. New Delhi: Orient Longman, 2005.*
17. *Sabavala, S.A. and R.M. Lala, eds. J.R.D. Tata: Keynote. New Delhi: Rupa & Co., 2004.*
18. *Mambro, Arvind ed. J.R.D. Tata: Letters. New Delhi: Rupa & Co., 2004.*
19. *Lala, R.M., For the Love of India: The Life and Times of Jamsetji Tata. New Delhi: Penguin, 2006.*
20. *Thapar, Romila. The Penguin History of Early India: From the Origins to AD 1300. New Delhi Penguin, 2002.*
21. *Majumdar, R.C., et. al. An Advanced History of India. Macmillan.*

HUM255 SCIENCE AND SOCIETY – AN INDIAN PERSPECTIVE* 1 0 2 2

Unit 1

Introduction

Western and Indian views of science and technology

Introduction; Francis Bacon: the first philosopher of modern science; The Indian tradition in science and technology: an overview.

Unit 2

Indian sciences

Introduction; Ancient Indian medicine: towards an unbiased perspective;

Indian approach to logic; The methodology of Indian mathematics; Revision of the traditional Indian planetary model by Nilakantha Somasutvan in circa 1500 AD
Science and technology under the British rule
Introduction; Indian agriculture before modernization; The story of modern forestry in India; The building of New Delhi

Unit 3
Science and technology in Independent India
Introduction; An assessment of traditional and modern energy resources; Green revolution: a historical perspective; Impact of modernisation on milk and oilseeds economy; Planning without the spirit and the determination.
Building upon the Indian tradition
Introduction; Regeneration of Indian national resources; *Annamahatmyam and Annam Bahu Kurvita:* recollecting the classical Indian discipline of growing and sharing food in plenty and regeneration of Indian agriculture to ensure food for all in plenty.
Conclusion

REFERENCES:

1. *Joseph, George Gheverghese. The Crest of the Peacock: Non-European Roots of Mathematics. London: Penguin (UK),2003.*
2. *Iyengar, C.N. Srinivasa. History of Hindu Mathematics. Lahore: 1935, 1938 (2 Parts).*
3. *Amma, T.A. Saraswati. Geometry in Ancient and Medieval India. Varanasi: Motilal Banarsidass, 1979.*
4. *Bag, A.K. Mathematics in Ancient and Medieval India. Varanasi: Motilal Banarsidass, 1979.*
5. *Sarma K.V. & B.V. Subbarayappa. Indian Astronomy: A Source-Book. Bombay: Nehru Centre, 1985.*
6. *Sriram, M.S. et. al. eds. 500 Years of Tantrasangraha: A Landmark in the History of Astronomy. Shimla: Indian Institute of Advanced Study, 2002.*
7. *Bajaj, Jitendra & M.D. Srinivas. Restoring the Abundance: Regeneration of Indian Agriculture to Ensure Food for All in Plenty.Shimla: Indian Institute of Advanced Study, 2001.*
8. *Bajaj, Jitendra ed. Report of the Seminar on Food for All: The Classical Indian Discipline of Growing and Sharing Food in Plenty. Chennai: Centre for Policy Studies, 2001.*
9. *Bajaj, Jitendra & M.D. Srinivas. Annam Bahu Kurvita: Recollecting the Indian Discipline of Growing and Sharing Food in Plenty. Madras: Centre for Policy Studies, 1996.*
10. *Parameswaran, S. The Golden Age of Indian Mathematics. Kochi: Swadeshi Science Movement.*
11. *Somayaji, D.A. A Critical Study of Ancient Hindu Astronomy. Dharwar: 1972.*
12. *Sen, S.N. & K.V. Sarma eds. A History of Indian Astronomy. New Delhi, 1985.*
13. *Rao, S. Balachandra. Indian Astronomy: An Introduction. Hyderabad: Universities Press, 2000.*
14. *Bose, D.M. et. al. A Concise History of Science in India. New Delhi: 1971.*
15. *Bajaj, Jitendra & M.D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.*
16. *Bajaj, Jitendra & M.D. Srinivas. Timeless India, Resurgent India. Chennai: Centre for Policy Studies.*
17. *Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies, 2008.*

18. *The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture.*

** The syllabus and the study material in use herein has been developed out of a 'summer programme' offered by the Centre for Policy Studies (CPS), Chennai at the Indian Institute of Advanced Study (IIAS), Rashtrapati Nivas, Shimla, sometime ago. The same has been very kindly made available to us by Professors Dr M.D. Srinivas (Chairman) and Dr J.K. Bajaj (Director) of the CPS.*

JAP201 PROFICIENCY IN JAPANESE LANGUAGE (LOWER) 1 0 2 2

This paper will introduce the basics of Japanese language. Students will be taught the language through various activities like writing, reading, singing songs, showing Japanese movies etc. Moreover this paper intends to give a thorough knowledge on Japanese scripts that is *Hiragana* and *Katakana.* Classes will be conducted throughout in Japanese class only. Students will be able to make conversations with each other in Japanese. Students can make self-introduction and will be able to write letters in Japanese. All the students will be given a text on Japanese verbs and tenses.

Students can know about the Japanese culture and the lifestyle. Calligraphy is also a part of this paper. Informal sessions will be conducted occasionally, in which students can sing Japanese songs, watch Japanese movies, do *Origami* – pattern making using paper.

JAP202 PROFICIENCY IN JAPANESE LANGUAGE (HIGHER) 1 0 2 2

Students will be taught the third and the most commonly used Japanese script, *Kanji.* Students will be taught to write as well as speak.

Students will be given detailed lectures on Calligraphy.

This version of the course includes a new project where the students should make a short movie in Japanese language selecting their own topics.
By the end of the semester they the students will master the subject in all means. They will be able to speak Japanese as fluently as they speak English. Students will be encouraged to write stories and songs in Japanese language themselves.

MAT111 CALCULUS, MATRIX ALGEBRA AND ORDINARY DIFFERENTIAL EQUATIONS 3 1 0 4

Unit 1
Linear systems of equations, Gauss elimination, rank of a matrix, linear dependence. Solutions of linear systems: existence, uniqueness, general form, eigen values,

eigen vectors, some applications of eigen value problems, symmetric, skew-symmetric and orthogonal matrices, complex matrices: Hermitian, Skew Hermitian, unitary, similarity of matrices, basis of eigen vectors, diagonalization. (Sections: 6.3, 6.4, 6.5, 7.1, 7.2, 7.3, 7.4, and 7.5)
Limits and continuity. (Sections (in textbook 1): 2.2, 2.3, 2.4, 2.5, 2.6)

Unit 2
Derivatives, curve sketching, improper integral. (Sections (in textbook 1): 3.1, 4.1, 4.3, 4.4, 8.8)
Basic concepts and ideas, exact differential equations, integrating factors, orthogonal trajectories of curves. (Sections: 1.1, 1.5, 1.8)

Unit 3
Reviewof linear differential equations and Bernoulli equation, modelling: mixing problem, electric circuits. Review of homogeneous linear equations of second order, Euler-Cauchy equations, solution by undetermined coefficients, solution by variation of parameters. System of linear equation, basic concepts and theory, homogeneous systems with constant coefficients, phase plane, critical points. Criterion for critical points and stabilty. (Sections: 1.6, 1.7, 2.1, 2.2, 2.3, 2.6, 2.9, 2.10, 3.1, 3.2, 3.3, 3.4)

TEXTBOOKS:

1. *'Calculus', G.B. Thomas Pearson Education, 2009, Eleventh Edition.*
2. *'Advanced Engineering Mathematics', E Kreyszig, John Wiley and Sons, 2002, Eighth Edition.*

MAT112 VECTOR CALCULUS, FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS 3 1 0 4

Unit 1
Vector and scalar functions, derivatives, curves, tangents, arc Length, curves in mechanics, velocity and acceleration, gradient of a scalar field, directional derivative, divergence of a vector field, curl of a vector field. (Sections: 8.4, 8.5, 8.6, 8.9, 8.10, 8.11)
Line integral, line integrals independent of path (Sections: 9.1, 9.2)

Unit 2
Green's theorem in the plane, surfaces for surface integrals, surface integrals, triple integrals – Gauss divergence theorem, Stoke's theorem. (Sections: 9.4, 9.5, 9.6, 9.7, 9.9)

Unit 3
Periodic functions, trigonometric series, Fourier series, functions of any period p =

2L, even and odd functions, half range expansions (theorem statement only), complex Fourier series, applications of Parseval's identity. (Sections: 10.1 to 10.5)
Basic concepts, modeling; vibrating string, wave equation, separation of variables, use of Fourier series, d'Alembert's solution of the wave equation, heat equation; solution by Fourier series. (Sections: 11.1 to 11.5)

TEXTBOOK:

'Advanced Engineering Mathematics', E Kreyszig, John Wiley and Sons, 2002, Eighth Edition.

MAT211 INTEGRAL TRANSFORMS AND COMPLEX ANALYSIS 3 1 0 4

Unit 1
Complex numbers, complex plane, polar form of complex numbers. Powers and roots, derivative. Analytic functions, Cauchy-Riemann equations, Laplace equation, conformal mapping, exponential function, trigonometric functions, hyperbolic functions, logarthims, general power, linear fractional transformation. (Sections: 12.1, 12.2, 12.3, 12.4, 12.5, 12.6, 12.7, 12.8,12.9)

Unit 2
Complex line integral, Cauchy integral theorem, Cauchy integral formula, derivatives of analytic functions. (Sections: 13.1, 13.2, 13.3, 13.4,)
Power series, Taylor series and Maclaurin series. Laurent series, zeros and singularities, residues, Cauchy residue theorem, evaluation of real integrals using residue theorem. (Sections: 14.4, 15.1, 15.2, 15.3, 15.4)

Unit 3
Laplace transforms, inverse transforms, linearity, shifting, transforms of derivatives and Integrals, differential equations, unit step function, second shifting theorem, Dirac's delta function. Differentiation and integration of transforms. Convolution, integral equations, partial fractions, differential equations, systems of differential equations. (Sections: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7)
Fourier integrals (Fourier integral theorem statement only), Fourier cosine and sine transforms, Fourier transforms. (Sections: 10.8 to 10.10)

TEXTBOOK:

'Advanced Engineering Mathematics', E Kreyszig, John Wiley and Sons, 2002, Eighth Edition.

MAT212 MATHEMATICALSTATISTICSANDNUMERICALMETHODS 3 1 0 4

Unit 1
Probability, random variables, probability distributions (continuous and discrete), mean and variance of a distribution, expectation and moment generating functions, binomial, poisson and normal distributions, random sampling, estimation of parameters. (Sections: 22.3, 22.5, 22.6, 22.7, 22.8, 23.1, 23.2)

Unit 2

Confidence interval and central limit theorem, testing of hypothesis. (Sections: 23.3, 23.4)

Solution of equations by iterative methods, interpolation. (Sections: 17.2, 17.3)

Unit 3

Numerical integration and differentiation, solution of linear systems by iterative methods, Eigen values of matrices by iterative methods. Numerical solutions for ordinary differential equations and partial differential equations. (Sections: 17.5, 18.3, 18.8, 19.1, 19.4)

TEXTBOOK:

'Advanced Engineering Mathematics', E Kreyszig, John Wiley and Sons, 2002, Eighth Edition.

MEC100 ENGINEERING MECHANICS 3 1 0 4

Unit 1

Principles of statics: Introduction to vector approach – free body diagrams - forces in plane – forces in space - concurrent forces – resolution of forces - equilibrium of particle.

Statics of rigid bodies in two dimensions and three dimensions: Moment of a force about a point - moment of a force about an axis - moment of a couple – equivalent force - couple system - rigid body equilibrium – support reactions.

Unit 2

Applications of statics: Friction – ladder friction – wedge friction - analysis of trusses – method of joints – method of sections.

Centroid and centre of gravity: Centroids of lines, areas and volumes – composite bodies.

Second moment of area – polar moment of inertia - mass moment of inertia - radius of gyration.

Unit 3

Dynamics of particles: Kinematics of particles – rectilinear motion – relative motion - position, velocity and acceleration calculations in cylindrical coordinates.

Dynamics of rigid bodies: General plane motion - translation and rotation of rigid bodies – Chasle's theorem – velocity and acceleration calculations in moving frames of references – Coriolis acceleration.

TEXTBOOKS:

1. *Shames, I. H, "Engineering Mechanics - Statics and Dynamics", 4/e, Prentice-Hall of India Pvt. Ltd., 2003.*
2. *Beer, F.P. & Johnston, E.R., "Vector Mechanics for Engineers - Statics and Dynamics", 8/e, McGraw Hill International Book Co., 2008.*

REFERENCES:

1. *Hibbeler, R.C., "Engineering Mechanics", 12/e, Pearson Education Pvt. Ltd., 2007.*
2. *Meriam, J.L., "Dynamics", 5/e, John Wiley & sons, 2003.*
3. *K. L. Kumar, "Engineering Mechanics", 3/e, Tata McGraw Hill, 2003.*

MEC180 WORKSHOP A 1 0 2 2

Product detailing workshop: (Study of simple mechanical and electromechanical system)

Disassemble the product or sub assembly – measure various dimensions using measuring instruments – free hand rough sketch of the assembly and components – name the components and indicate the various materials used – study the functioning of the assembly and parts – study the assembly and components design for compactness, processing, ease of assembly and disassembly – assemble the product or subassembly.

Pneumatics and PLC workshop:

Study of pneumatic elements – design and assembly of simple circuits using basic pneumatic elements – design and assembly of simple circuits using electro-pneumatics. Study of PLC and its applications – simple programming using ladder diagrams.

Sheet metal workshop:

Study of tools and equipment – draw development drawing of simple objects on sheet metal (cone, cylinder, pyramid, prism, tray, etc.) – fabrication of components using small shearing and bending machines – riveting and painting practice.

Welding workshop:

Study of tools and equipment – study of various welding methods – arc welding practice and demonstration of gas welding and cutting.

Demo and practice workshop:

Fitting: Study of tools, practice in chipping, filing and making joints.

Carpentry: Study of tools, planning practice and making joints.

REFERENCES:

Concerned Workshop Manual

MEC181 ENGINEERING DRAWING 1 0 3 2

Use of drawing instruments – drawing practice – lettering – dimensioning – sketching.

Orthographic projections – projection of points; projection of lines; projection of planes; projection of solids.

Section of solids; Intersection of solids; development of surfaces.

Orthographic views of three-dimensional solids.

Isometric projection.

TEXTBOOK:

John, K. C., Engineering Graphics for Degree, PHI Learning, 2010.

REFERENCES:

1. *Bhat N.D. and Panchal V.M. – Engineering Drawing – Plane and solid Geometry, 42e, Charoatar Publishing House, 2000*
2. *James D. Bethune, Engineering Graphics with AutoCAD, 2002, Pearson Education, First reprint, 2003*
3. *Narayana K.L. & Kannaiah P, Engineering Graphics, SciTech publications, Chennai, 2003*
4. *Waran J Luzadder and John M Duff, Fundamentals of Engineering Drawing, 11e, Prentice Hall of India, New Delhi, 1995*
5. *K. R. Gopalakrishna, Engineering Drawing, 2003, Subhas Publications*

MEC182 COMPUTER AIDED DRAWING 1 0 3 2

Introduction to CAD
Preparation of drawings using CAD Tools
Introduction to VBA / LISP
Introduction to 3D modeling and Surface Modeling

TEXTBOOKS:

1. *Sham Tickoo, AutoCAD 2011 – a Problem solving approach, Autodesk Press, 2011.*
2. *John, K. C., Engineering Graphics for Degree, PHI Learning, 2010.*

REFERENCES:

CADian Manual

MEC353 OPTIMIZATION TECHNIQUES IN ENGINEERING 3 0 0 3

Unit 1

Introduction to optimization: Engineering application of optimization – statement of an optimization problem - optimal problem formulation - classification of optimization problem. Optimum design concepts: definition of global and local optima – optimality criteria - review of basic calculus concepts – global optimality.

Linear programming methods for optimum design: review of linear programming methods for optimum design – post optimality analysis - application of LPP models in design and manufacturing.

Unit 2

Optimization algorithms for solving unconstrained optimization problems – gradient based method: Cauchy's steepest descent method, Newton's method, conjugate gradient method.

Optimization algorithms for solving constrained optimization problems – direct methods – penalty function methods – steepest descent method - engineering applications of constrained and unconstrained algorithms.

Unit 3

Modern methods of optimization: Genetic algorithms - simulated annealing - ant colony optimization - Tabu search – neural-network based optimization – fuzzy optimization techniques – applications. Use of Matlab to solve optimization problems.

TEXTBOOK:

Rao, S. S., 'Engineering Optimization, Theory and Practice", 4e, New Age International publishers, 2009.

REFERENCES:

1. *Deb, K., 'Optimization for Engineering Design Algorithms and Examples', PHI, 2000.*
2. *Arora, J., 'Introduction to Optimization Design', Elsevier Academic Press, New Delhi, 2004.*
3. *Saravanan, R, 'Manufacturing Optimization through intelligent techniques', Taylor & Fransis (CRC Press), 2006.*
4. *Hardley, G., 'Linear Programming', Narosa Book Distributors Private Ltd 2002.*

MNG400 PRINCIPLES OF MANAGEMENT 3 0 0 3

Unit 1

HISTORICAL DEVELOPMENT: definition of management – science or art – management and administration – development of management thought – contribution of Taylor and Fayol – functions of management – types of business organisations.

PLANNING: nature & purpose – steps involved in planning – objectives – setting objectives – process of managing by objectives – strategies, policies & planning premises - forecasting – decision-making.

Unit 2

ORGANISING: nature and purpose – formal and informal organization – organization chart – structure and process – departmentation by difference strategies – line and staff authority – benefits and limitations – de-centralization and delegation of authority – staffing – selection process - techniques – HRD – managerial effectiveness.

DIRECTING: scope – human factors – creativity and innovation – harmonizing objectives – leadership – types of leadership motivation – hierarchy of needs – motivation theories – motivational techniques – job enrichment.

Unit 3

Communication: process of communication – barriers and breakdown – effective communication – electronic media in communication.

CONTROLLING: system and process of controlling – requirements for effective control – the budget as control technique – information technology in controlling – use of computers in handling the information – productivity – problems and management – control of overall performance – direct and preventive control – reporting – the global environment – globalization and liberalization – international management and global theory of management.

TEXTBOOKS:

1. *Harold Kooritz & Heinz Weihrich "Essentials of Management", Tata McGraw-Hill, 1998*
2. *Joseph L Massie "Essentials of Management", Prentice Hall of India, (Pearson) Fourth Edition, 2003.*

REFERENCES BOOKS:

1. *Tripathy P C and Reddy P N, "Principles of Management", Tata McGraw-Hill, 1999.*
2. *Decenzo David, Robbin Stephen A, "Personnel and Human Reasons Management", Prentice Hall of India, 1996*
3. *JAF Stomer, Freeman R. E and Daniel R Gilbert, "Management", Pearson Education, Sixth Edition, 2004.*
4. *Fraidoon Mazda, "Engineering Management", Addison Wesley, 2000.*

PHY100 PHYSICS 3 0 0 3

Unit 1

Special theory of relativity: Frames of reference, postulates of special theory of relativity, time dilation, length contraction, relativistic mass, relativistic momentum, mass and energy, Lorentz transformation, velocity addition, Doppler effect.

Physical background for quantum mechanics: Black body radiation, photoelectric effect, Compton effect, X-ray diffraction, pair production, de-Broglie waves, uncertainty principle.

Unit 2

Quantum mechanics: Wave function, wave equation, Schrodinger equation (time dependent), expectation values-operators, eigen functions and eigen values, Schrodinger equation(steady state), particle in a box-finite potential, tunneling effect, quantum theory of hydrogen atom.

Unit 3

Classical and quantum statistics: Statistical distribution, Maxwell Boltzmann's statistics, molecular energies in an ideal gas, quantum statistics, Rayleigh Jean's formula, Planck's radiation law, free electron in a metal, electron energy distribution, specific heat of solids, evolution of stars.

Solid state physics: Crystalline and amorphous solids - ionic crystals - covalent crystals - Van der Walls bond - metallic bond - Band theory of solids - semiconductor devices.

TEXTBOOK:

Arthur Beiser, "Concepts of Modern Physics", Tata Mcgraw Hill, 2003 (6 th edition).

REFERENCES:

1. *T.Thornton and A.Rex, "Modern Physics for Scientists and Engineers", Fort Worth: Saunders, 2000 (2 nd edition).*
2. *P.A.Tipler and R. A. Llewellen, "Modern Physics", New York: Freeman, 1999 (3 rd edition).*
3. *S.H.Patil, "Elements of Modern Physics", Tata Mc Graw Hill, 1989.*
4. *F.K.Richtmyer, H.Kennard, John N.Copper, "Modern Physics", Tata Mc Graw Hill, 1995.*

PHY181 PHYSICS LAB. 0 0 3 1

Experiments on mechanics

1. Torsional pendulum.
2. Co-efficient of viscosity of liquid.
3. Young's modulus - non-uniform bending.

Experiments on optics

1. Determination of lycopodium powder particle size using laser.
2. Dispersive power of prism.
3. Newton's ring.

Experiments on electricity

1. Meter bridge / energy gap.
2. Frequency of AC current.
3. Temperature co-efficient of resistance.

TEXTBOOK:

The manual for experiments prepared by the Department of Physics, AVVP. Experiments will be renewed as an when feasible.

REFERENCE:

D.P.Khandelwal, "A Laboratory Manual of Physics", Vikas Publishing House Pvt LTd., New Delhi,1985.

PHY250 ELECTRICAL ENGINEERING MATERIALS 3 0 0 3

Unit 1

Conducting materials: The nature of chemical bond, crystal structure Ohm's law and the relaxation time, collision time, electron scattering and resistivity of metals, heat developed in a current carrying conductor, thermal conductivity of metals, superconductivity.

Semiconducting materials: Classifying materials as semiconductors, chemical bonds in Si and Ge and it's consequences, density of carriers in intrinsic semiconductors, conductivity of intrinsic semiconductors, carrier densities in n type semiconductors, n type semiconductors, Hall effect and carrier density.

Unit 2

Magnetic materials: Classification of magnetic materials, diamagnetism, origin of permanent, magnetic dipoles in matter, paramagnetic spin systems, spontaneous magnetization and Curie Weiss law, ferromagnetic domains and coercive force, anti ferromagnetic materials, ferrites and it's applications.

Unit 3

Dielectric materials: Static dielectric constant, polarization and dielectric constant, internal field in solids and liquids, spontaneous polarization, piezoelectricity.

PN junction: Drift currents and diffusion currents, continuity equation for minority carriers, quantitative treatment of the p-n junction rectifier, the n-p-n transistor.

TEXTBOOK:

A J Decker, "Electrical Engineering materials", PHI, New Delhi, 1957.

REFERENCES:

1. *A J Decker, "Solid State Physics", Prentice Hall, Englewood Cliffs, N J 1957.*
2. *C Kittel, "Introduction to solid state Physics", Wieley, New York, 1956 (2 nd edition).*
3. *Allison, Electronic Engineering materials and Devices, Tata Mc Graw Hill*
4. *F K Richtmyer E H Kennard, John N Copper, "Modern Physics", Tata Mc Graw Hill, 1995 (5 th edition).*

PHY251 OPTOELECTRONIC DEVICES 3 0 0 3

Unit 1

Properties of semiconductors: Electron and photon distribution: density of states, effective mass and band structure, effect of temperature and pressure on band gap, recombination processes.

Basics of semiconductor optics: Dual nature of light, band structure of various semiconductors, light absorption and emission, photoluminescence. electro luminescence, radioactive and non-radiative recombination, wave trains.

Unit 2

Semiconductor light-emitting diodes: Structure and types of LEDs and their characteristics, guided waves and optical modes, optical gain, confinement factor, internal and external efficiency, semiconductor heterojunctions, double-heterostructure LEDs.

Semiconductor lasers: Spontaneous and stimulated emission, principles of a laser diode, threshold current, effect of temperature, design of an edge-emitting diode, emission spectrum of a laser diode, quantum wells, quantum-well laser diodes**.**

Unit 3

Semiconductor light modulators: Modulating light (direct modulation of laser diodes, electro-optic modulation, acousto-optic modulation), isolating light (magneto-optic isolators), inducing optical nonlinearity (frequency conversion, switching)

Semiconductor light detectors: I-V characteristics of a p-n diode under illumination, photovoltaic and photoconductive modes, load line, photocells and photodiodes, *p-i-n* photodiodes, responsivity, noise and sensitivity, photodiode materials, electric circuits with photodiodes, solar cells.

REFERENCES:

1. *Semiconductor Optoelectronics: Physics and Technology, Jasprit Singh, McGraw-Hill Companies, ISBN 0070576378*
2. *Optoelectronics, E. Rosencher and B. Vinter, Cambridge Univ. Press, ISBN 052177813.*

3. *Photonic Devices, J. Liu, Cambridge Univ. Press, ISBN 0521551951.*
4. *Semiconductor Optoelectronic Devices 2nd Edition", P. Bhattacharya, Prentice Hall, ISBN 0134956567.*
5. *Physics of Semiconductor Devices, by S.M. Size (2nd Edition, Wiley, New York, 1981).*

PHY252 PHYSICS OF SEMICONDUCTOR DEVICES 3 0 0 3

Unit 1

Introduction: Unit cell, Bravais lattices, crystal systems, crystal planes and Miller indices, symmetry elements. Defects and imperfections – point defects, line defects, surface defects and volume defects.

Electrical conductivity: Classical free electron theory – assumptions, drift velocity, mobility and conductivity, drawbacks. quantum free electron theory – Fermi energy, Fermi factor, carrier concentration. Band theory of solids – origin of energy bands, effective mass, distinction between metals, insulators and semiconductors**.**

Unit 2

Theory of semiconductors: Intrinsic and extrinsic semiconductors, band structure of semiconductors, carrier concentration in intrinsic and extrinsic semiconductors, electrical conductivity and conduction mechanism in semiconductors, Fermi level in intrinsic and extrinsic semiconductors and its dependence on temperature and carrier concentration. Carrier generation-recombination, mobility, drift-diffusion current. Hall effect.

Theory of p-n junctions – *diode and transistor*: p-n junction under thermal equilibrium, forward bias, reverse bias, carrier density, current, electric field, barrier potential. V-I characteristics, junction capacitance and voltage breakdown**.**

Unit 3

Bipolar junction transistor, p-n-p and n-p-n transistors: principle and modes of operation, current relations. V-I characteristics. Fundamentals of MOSFET, JFET. Heterojunctions – quantum wells.

Semiconducting devices: *Optical devices:* optical absorption in a semiconductor, e^--hole generation. Solar cells – p-n junction, conversion efficiency, heterojunction solar cells. Photo detectors – photo conductors, photodiode, p-i-n diode. Light emitting diode (LED) – generation of light, internal and external quantum efficiency. *Modern semiconducting devices*: CCD - introduction to nano devices, fundamentals of tunneling devices, design considerations, physics of tunneling devices.

TEXTBOOKS:

1. *C Kittel, "Introduction to Solid State Physics", Wiley, 7th Edn., 1995.*
2. *DA Neamen, "Semiconductor Physics and Devices", TMH, 3rd Edn., 2007.*

REFERENCES:

1. *SM Sze, "Physics of Semiconductor Devices", Wiley, 1996.*
2. *P Bhattacharya, "Semiconductor Opto- Electronic Devices", Prentice Hall, 1996.*
3. *MK achuthan & KN Bhat, "Fundamentals of Semiconductor Devices", TMH, 2007.*
4. *J Allison, "Electronic Engineering Materials and Devices", TMH, 1990.*

PHY253 ELECTROMAGNETIC FIELDS AND WAVES 3 0 0 3

Unit 1

Electrostatics: Coulombs law and electric field intensity, field due to a continuous volume charge distribution, field of a line charge, field of sheet of charge, electric flux density, Gauss's law, application of Gauss's law, Maxwell's first equation.

Poisson's and Laplace's equations: The potential field of a point charge, potential field of a system of charges :conservative property, potential gradient, the dipole.

Unit 2

Poisson's and Laplace's equations, uniqueness theorem, examples of the solution of Laplace's equation, solution of Poisson's equation.

Electromagnetics: Biot Savart law, magnetic flux and magnetic flux density, scalar and vector magnetic potentials, derivation of steady magnetic field laws, Faraday's laws, displacement current, Maxwells equations in point and integral form, retarded potentials

Unit 3

Electromagnetic waves: EM wave motion in free space, wave motion in perfect dielectrics, plane wave in lossy dielectrics, Poynting vector and power consideration, skin effect, reflection of uniform plane waves, standing wave ratio. Transmission line equations, line parameters-examples, dipole radiation, retarded potentials, electric dipole radiation.

TEXTBOOK:

William H Hayt , "Engineering Electromagnetics", Tata Mc Graw Hill , New Delhi, 2002 (5th edition).

REFRENCES:

1. *David J Griffiths, "Introduction to Electrodyanamics", Prentice-Hall of India, New Delhi, 1999 (2nd edition).*
2. *J D Jackson, "Classical Electrodynamics", Weiley Eastern, 2004 (2nd edition).*
3. *B.Chakraborty, "Principles of Electrodynamics", Books and Allied Publishers, 2002*

PHY254 MICROELECTRONIC FABRICATION 3 0 0 3

Unit 1

Introduction to semiconductor fabrication – scaling trends of semiconductor devices; crystal structure of semiconductor materials, crystal defects, phase diagrams and

solid solubility; physics of Czochralski growth of single crystal silicon, Bridgeman method for GaAs, float zone process; diffusion science: Ficks laws of diffusion, atomistic models of diffusion, dopant diffusion mechanisms; kinetics of thermal oxidation, Deal-Grove Model, nitridation of silicon, structure and characteristics of oxides, effect of dopants on oxidation kinetics, dopant redistribution;

Unit 2

Physics of ion implantation: Coulombic scattering and projected range, nuclear and electronic stopping, channeling, implantation damage removal, dopant activation by rapid thermal annealing; principles of optical lithography – optics and diffraction, light sources and spatial coherence, physics of pattern transfer, nodulation transfer function; chemistry of lithographic processes: organic and polymeric photoresists, developing and exposure, contrast; principles of non-optical lithography: electron beam, X-ray lithography, resists, sources; etching: Chemistry of wet etching, plasma physics, chemistry of plasma etching and reactive ion etching; chemical mechanical polishing.

Unit 3

Vacuum science: Kinetic theory of gases, gas flow and conductance, vacuum pumps and seals; deposition of thin films: physics of sputtering and evaporation, step coverage and morphology of deposited films, chemical vapor deposition: chemical equilibrium and law of mass action, gas flow and boundary layers, types of CVD, plasma assisted CVD; thermodynamics of epitaxial growth, types molecular beam epitaxy, isolation and contact formation – LOCOS and trench, silicides, metallization with Al and Cu; process Integration: CMOS, bipolar process flow.

TEXTBOOK:

Stephen Campbell, Science and Engineering of Microelectronic Fabrication, Oxford University Press, 2001

REFERENCE:

1. *S K Gandhi, VLSI Fabrication Principles, John Wiley & Sons, 1994*
2. *Gary S May and Simon M Sze, Fundamentals of Semiconductor Fabrication, John Wiley, 2003.*
3. *S Wolfe, Silicon Processing for the VLSI Era, Lattice Press, 1998.*

PHY255 ELECTRONIC MATERIALS SCIENCE 3 0 0 3

Unit 1

Types of bonding in solids, Crystallography and crystalline defects: Crystallography, Directions and planes, Crystalline defects, line defects, Planar defects, Volume defects; Binary and Ternary Phase Diagrams: Lever rule and phase rule, Eutectic, peretectic and Eutectoid systems, Applications of Phase diagrams; Basic Quantum Physics - atomic structure, Use of band theory and occupation statistics to explain existence and basic properties of metals and nonmetals. Working of Semiconductor Devices using band diagrams and their electrical characteristics: pn junctions, BJT, MOSFET.

Unit 2

Use of band theory to explain optoelectronic properties of materials and optoelectronic devices: LEDs, Solar Cells, Lasers, pin diodes, photodiodes; Magnetic properties and Superconductivity: Magnetic moments and Magnetic Permeability, types of magnetism, saturation magnetization, magnetic domains, soft and hard magnetic materials, superconductivty and its origin, Giant Magneto Resistance, Josephson effect, Energy band diagrams and Magnetism, Applications of magnetic materials- Magnetic recording materials, etc.

Unit 3

Optical Properties of Materials: Reflection, Refraction, Dispersion, Refractive Index, Snells Law, Light Absorption and Emission, Light Scattering, Luminescence, Polarization, Anisotropy, Birefringerence; Dielectric Properties of Materials: Polarization and Permittivity, Mechanisms of polarization, dielectric properties- dielectric constant, dielectric loss, dielectric strength and breakdown, Piezoelectricity, Ferreoelectricity, and Pyroelectricity, Dielectric Materials

TEXTBOOK:

S.O. Kasap, Principles of Electronic Materials and Devices, 2006, 3rd edition, Tata McGraw Hill.

REFERENCE:

D. Jiles: Introduction to the Electronic Properties of Materials, Chapman & Hall. 1994.

PHY260 PHYSICS OF LASERS AND APPLICATIONS 3 0 0 3

Unit 1

Review of some basic concepts and principle of laser.

Introduction to light and its properties: Reflection, refraction, interference, diffraction and polarization. Photometry – calculation of solid angle. Brewster's law. Snell's law and, its analysis.

Introduction to LASERS: Interaction of radiation with matter - induced absorption, spontaneous emission, stimulated emission. Einstein's co-efficient (derivation). Active material. Population inversion – concept and discussion about different techniques. Resonant cavity.

Unit 2

Properties of LASERS

Gain mechanism, threshold condition for PI (derivation), emission broadening - line width, derivation of Dw FWHM . natural emission line width as deduced by quantum mechanics - additional broadening process: collision broadening, broadening due to dephasing collision, amorphous crystal broadening, Doppler broadening in laser and broadening in gases due to isotope shifts. Saturation intensity of laser, condition to attain saturation intensity.

Properties – coherency, intensity, directionality, monochromaticity and focussibility. LASER transition – role of electrons in LASER transition, levels of LASER action: 2 level, 3 level and 4 level laser system.

Unit 3

Types of LASERS

Solid state LASER: (i) Ruby LASER – principle, construction, working and application. (ii) Neodymium (Nd) LASERS. gas LASER: (i) He-Ne LASER - principle, construction, working and application. (i) CO_2 LASER - principle, construction, working and application. Liquid chemical and dye LASERS. Semiconductor LASER: Principle, characteristics, semiconductor diode LASERS, homo-junction and hetero-junction LASERS, high power semi conductor diode LASERS.

Applications in Communication field:

LASER communications: Principle, construction, types, modes of propagation, degradation of signal, analogue communication system, digital transmission, fiber optic communication.

Applications of LASERS in other fields:

Holography: Principle, types, intensity distribution, applications. laser induced fusion. Harmonic generation. LASER spectroscopy. LASERS in industry: Drilling, cutting and welding. Lasers in medicine: Dermatology, cardiology, dentistry and ophthalmology.

REFERENCES:

1. *William T Silfvast, "Laser Fundamentals", Cambridge University Press, UK (2003).*
2. *BB Laud, "Lasers and Non linear Optics", New Age International (P) Ltd., New Delhi.*
3. *Andrews, "An Introduction to Laser Spectroscopy (2e)", Ane Books India (Distributors).*
4. *KR Nambiar, "Lasers: Principles, Types and Applications", New Age International (P) Ltd., New Delhi.*
5. *T Suhara, "Semiconductor Laser Fundamentals", Marcel Dekker (2004).*

PHY261 LASERS IN MATERIAL PROCESSING 3 0 0 3

Unit 1

Basic optical theory: Nature of electromagnetic radiation, interaction of radiation with matter, reflection, refraction, polarization, laser fundamentals, laser beam characteristics, beam quality (laser cavity modes),Q-switching, mode locking, continuous wave, types of lasers, energy and power.

Laser interaction with materials: Optical properties of materials, laser interaction with metals, insulators, semiconductors, polymers and biological materials.

Laser surface treatment: Introduction to laser surface hardening, laser surface melting, laser surface alloying, laser surface cladding, laser cleaning. Laser ablation: mechanisms (photothermal, photophysical and photochemical), mask projection techniques, laser micro and nano structuring.

Unit 2

Laser cutting and drilling: Mechanism for inert gas and oxygen-assisted cutting, factors controlling cut quality and kerf width. Laser assisted drilling.

Laser welding: Introduction to laser keyhole welding and contrast with conduction limited welding, applications,

Direct laser fabrication (DLF): Laser sintering & laser rapid manufacturing, comparison with rapid prototyping. Main potential and limitations of DLF for direct fabrication and for the production of novel engineering materials and structures.

Unit 3

Laser forming: Mechanisms involved, including thermal temperature gradient, buckling, upsetting. Applications in alignment and straightening and in rapid production processes.

Scope of application of laser materials processing: focused on industrial application of laser in materials processing including laser welded tailored blanks.

Laser safety: Introduction to safety procedures in the use of lasers, including wavelength effects and laser safety standards.

REFERENCES:

1. *Steen, WM, Laser Material Processing (3rd Edition), Springer Verlag, 2003, ISBN 1852336986.*
2. *Silvast, WT, Laser Fundamentals, Cambridge University Press, 1998, ISBN 0521556171.*
3. *J. F. Ready, D.F. Farson. LIA Handbook of Laser Materials Processing Laser Institute of America, 2001.*
4. *M. von Allmen. Laser-Beam Interactions with Materials, Springer, 1987*
5. *D. Bauerle. Laser Processing and Chemistry, Springer, 2000*
6. *W.W. Duley, UV lasers : effects and applications in materials science, Cambridge University, Press, Cambridge ; New York, 1996.*
7. *J. Dutta Majumdar, and I. Manna, Laser Material Processing, Sadhana, Vol. 28, Year: 2003, 495-562.*

PHY262 NON-LINEAR DYNAMICS 3 0 0 3

Unit 1

Introduction: examples of dynamical systems, driven damped pendulum, ball on oscillating floor, dripping faucet, chaotic electrical circuits.

One-dimensional maps: the logistic map, bifurcations in the logistic map, fixed points and their stability, other one-dimensional maps.

Non-chaotic multidimensional flows: the logistic differential equation, driven damped harmonic oscillator, Van der Pol equation, numerical solution of differential equations.

Dynamical systems theory: two-dimensional equilibrium and their stability, saddle points, are contraction and expansion, non-chaotic three-dimensional attractors, stability of two-dimensional maps, chaotic dissipative flows.

Unit 2

Lyapunov exponents: for one- and two-dimensional maps and flows, for three-dimensional flows, numerical calculation of largest Lyapunov exponent, Lyapunov exponent spectrum and general characteristics, Kaplan-Yorke dimension, numerical precautions.

Strange attractors: general properties, examples, search methods, probability of chaos and statistical properties of chaos, visualization methods, basins of attraction, structural stability.

Bifurcations: in one-dimensional maps and flows, Hopf bifurcations, homoclinic and heteroclinic bifurcations, crises.

Hamiltonian chaos: Hamilton's equations and properties of Hamiltonian systems, examples, three-dimensional conservative flows, symplectic maps.

Unit 3

Time-series properties: examples, conventional linear methods, a case study, time-delay embeddings.

Nonlinear prediction and noise-reduction: linear predictors, state-space prediction, noise reduction, Lyapunov exponents from experimental data, false nearest neighbors.

Fractals: Cantor sets, curves, trees, gaskets, sponges, landscapes.

Calculations of fractal dimension: similarity, capacity and correlation dimensions, entropy, BDS statistic, minimum mutual information, practical considerations.

Fractal measure and multifractals: convergence of the correlation dimension, multifractals, examples and numerical calculation of generalized dimensions.

Non-chaotic fractal sets: affine transformations, iterated functions systems, Mandelbrot and Julia sets.

Spatiotemporal chaos and complexity: examples, cellular automata, coupled map lattices, self-organized criticality**.**

TEXTBOOK:

Hilborn, R. C., Chaos and Nonlinear Dynamics, Second Edition, Oxford University Press, 2000

REFERENCES:

1. *Sprott, J. C., Chaos and Time Series Analysis, Oxford University Press, 2003*
2. *Strogatz, S. H., Nonlinear Dynamics and Chaos, Westview Press, 2001*
3. *Solari, H. G., Natiello, M. A., and Mindlin, G. B., Nonlinear Dynamics, Overseas Press (India) Private Limited, 2005*

PHY263 CONCEPTS OF NANOPHYSICS AND NANOTECHNOLOGY 3 0 0 3

Unit 1

Introduction

Introduction to nanotechnology, comparison of bulk and nanomaterials – change in band gap and large surface to volume ratio, classification of nanostructured materials. Synthesis of nanomaterials - classification of fabrication methods – top down and bottom up methods.

Concept of quantum confinement and phonon confinement

Basic concepts – excitons, effective mass, free electron theory and its features, band structure of solids. Bulk to nano transition – density of states, potential well - quantum confinement effect – weak and strong confinement regime. Electron confinement in infinitely deep square well, confinement in two and three dimension. Blue shift of band gap - effective mass approximation. Vibrational properties of solids - phonon confinement effect and presence of surface modes.

Unit 2

Tools for characterization:

Structural – X-ray diffraction, transmission electron microscope, scanning tunneling microscope, atomic force microscope. Optical - UV – visible absorption and photoluminescence techniques, Raman spectroscopy.

Nanoscale materials – properties and applications:

Carbon nanostructures – structure, electrical, vibration and mechanical properties. Applications of carbon nanotubes

Unit 3

Field emission and shielding – computers – fuel cells – chemical sensors – catalysis – mechanical reinforcement. Quantum dots and Magnetic nanomaterials – applications.

Nanoelectronics and nanodevices:

Impact of nanotechnology on conventional electronics. Nanoelectromechanical systems (NEMSs) – fabrication (lithography) and applications. Nanodevices - resonant tunneling diode, quantum cascade lasers, single electron transistors – operating principles and applications.

TEXTBOOKS:

1. *Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan ,Nanoscale Science and Technology, John Wiley and Sons Ltd 2004.*
2. *W. R. Fahrner (Ed.), Nanotechnology and Nanoelectronics, Springer 2006.*

PHY264 THIN FILM PHYSICS 3 0 0 3

Unit 1

Introduction and preparation of thin film: Difference between thin and thick

film. Appreciation of thin film technology in modern era. Deposition technology: Physical methods, chemical methods, other new techniques, vacuum technology: Vacuum pumps & pressure gauges.

Defects in thin film: General concepts, nature of defect, microscopic defect and dislocation. Boundary defects. Defect and energy states - donar acceptor levels, trap and recombination centers, excitons, phonons.

Unit 2

Thin film analysis: Structural studies: XRD and electron diffraction. Surface studies: electron microscopy studies on film (SEM, TEM, AFM.) Film composition***:*** X-ray photoelectron spectroscopy (XPS), Rutherford Back Scattering spectroscopy (RBS) and Secondary Ion Mass Spectroscopy (SIMS).

Properties of thin film: Optical behaviors***:*** transmission, reflection, refractive index, photoconductivity, and photoluminescence.

Unit 3

Electrical behaviors: sheet resistivity, electron mobility and concentration, Hall effect, conduction in MIS structure.

Mechanical behaviors: stress, adhesion, hardness, stiffness.

Applications of thin films in various fields: Antireflection coating, FET, TFT, resistor, thermistor, capacitor, solar cell, and MEMs fabrication of silicon wafer: Introduction. preparation of the silicon wafer media, silicon wafer processing steps.

TEXTBOOK:

K.L. Chopra, "Thin Film Phenomena", McGraw-Hill, New York, 1969

REFERENCES:

1. *L.T. Meissel and R.Glang, "Hand book of thin film technology", McGraw Hill, 1978.*
1. *A.Goswami, "Thin Film Fundamentals ", New Age International, Pvt Ltd, New Delhi, 1996.*
2. *O.S.Heavens "optical Properties of Thin Films" by, Dover Publications, newyork 1991.*
3. *Milton Ohring "Materials science of thin films deposition and structures", Academic press, 2006.*
4. *Donald L.Smith "Thin Film deposition principle and Practice", McGraw –Hill international Edition, 1995.*

PHY270 MEDICAL PHYSICS 3 0 0 3

Unit 1

Ultrasonics - production methods and properties - acoustic impedance - Doppler velocimetry - echo cardiography – resolution – speckle - ultrasound imaging - therapeutic use of ultrasound - use in diagnostics of cardiac problems.

X-rays – production – intensity - hard and soft X-rays - characteristic and continuous X-ray spectrum - attenuation of x-rays by hard and soft tissues – resolution – contrast X-ray imaging - fluoroscopy modes of operation - image quality - fluoroscopy suites - radiation dose – computed-aided tomography (CAT)

Unit 2

Nuclear medicine - principles of nuclear physics – natural radioactivity, decay series, type of radiation and their applications, artificially produced isotopes and its application, accelerator principles; Nuclear Isomerism, internal conversion - ideal energy for radiotherapy based on interactions. Radionuclide used in medicine - radioisotope production – dosimetry – safety - radiation hazards – PET.

Nuclear magnetic resonance physics - magnetic moment – magnetization – relaxation - nuclear magnetic resonance spectroscopy.

Unit 3

Nuclear magnetic resonance imaging (MRI) – principle - chemical shift - magnetic resonance signal induction and relaxation - pulse sequencing and spatial encoding. **Laser physics** – characteristics of laser radiation, mode locking - power of laser radiation - lasers as diagnostic tool - lasers in surgery - laser speckle, biological effects, laser safety management.

TEXTBOOK:

Hendee W R and Rittenour E E, "Medical Imaging Physics", John Wiley & Sons, Chicago, 2001.

REFERENCE BOOKS

1. *Glasser.O.Medical Physics Vol.1, 2, 3 Book Publisher Inc Chicago, 1980*
2. *Jerraold T Bush Berg etal, The essentials physics of medical imaging, Lippincott Williams and wilkins(2002)*

PHY271 ADVANCED CLASSICAL DYNAMICS 3 0 0 3

Unit 1

Introduction to Lagrangian dynamics

Survey of principles, mechanics of particles, mechanics of system of particles, constraints, D'Alembert's principle and Lagrange's equation, simple applications of the Lagrangian formulation, variational principles and Lagrange's equations, Hamilton's principles, derivation of Lagrange's equations from Hamilton's principle, conservation theorems and symmetry properties.

Unit 2

Central field problem

Two body central force problem, reduction to the equivalent one body problem, Kepler problem, inverse square law of force, motion in time in Kepler's problem, scattering in central force field, transformation of the scattering to laboratory system, Rutherford scattering, the three body problem.

Rotational kinematics and dynamics

Kinematics of rigid body motion, orthogonal transformation, Euler's theorem on the motion of a rigid body.

Unit 3

Angular momentum and kinetic energy of motion about a point, Euler equations of motion, force free motion of rigid body.

Practical rigid body problems

Heavy symmetrical spinning top, satellite dynamics, torque-free motion, stability of torque-free motion - dual-spin spacecraft, satellite maneuvering and attitude control - coning maneuver - Yo-yo despin mechanism - gyroscopic attitude control, gravity-gradient stabilization.

TEXTBOOKS:

1. *H. Goldstein, Classical Mechanics, Narosa Publishing House, New Delhi, 1980, (Second Edition)*
2. *H. Goldstein,Charles Poole, John Safko, Classical Mechanics, Pearson education, 2002 (Third Edition)*
3. *Howard D. Curtis, Orbital Mechanics for Engineering Students, Elsevier, pp.475 — 543*
4. *Anderson.John.D, Modern Compressible flow, Mc Graw Hill.*

REFERENCE BOOKS:

1. *D. A. Walls, Lagrangian mechanics, Schaum Series, McGrawHill, 1967.*
2. *J. B. Marion and S. T. Thornton, Classical dynamics of particles and systems, Ft. Worth, TX: Saunders, 1995.*

PHY272 QUANTUM PHYSICS AND APPLICATIONS 3 0 0 3

Unit 1

Review of Planck's relation, De-Broglie relation and uncertainty principle basic concepts - Schrodinger equation: probabilistic interpretation of wave function, one dimension problems – particle in a box, harmonic oscillator, potential barrier and tunneling. Hydrogen atom, electrons in a magnetic field - X-ray spectra - periodic table.

Unit 2

Bosons and Fermions - symmetric and antisymmetric wavefunctions - elements of statistical physics: density of states, fermi energy, Bose condensation - solid state physics: Free electron model of metals, elementary discussion of band theory and applications to semiconductor devices.

Einstein coefficients and light amplification - stimulated emission - optical pumping and laser action.

Unit 3

Operation of He-Ne laser and Ruby laser - laser in science and Industry - Raman effect and applications.

Nuclear physics: nuclear properties - binding energy and mass formula - nuclear decay with applications - theory of alpha decay - nuclear forces – fission - principle of nuclear reactor - elementary particles - leptons, hadrons, quarks, field bosons - the standard model of elementary particles.

TEXTBOOK:

A Beiser, Perspectives in Modern Physics,Mc Graw Hill

REFERENCES;

1. *Arthur Beiser, Concepts of Modern Physics, 6th Edition Tata McGraw Hill*
2 *S H Patil,Elements of Modern Physics, Tata Mc Graw Hill, 1989*
3 *K Krane, Modern Physics, John Weiley, 1998.*
4 *K Thyagarajan, A K Ghatak, Lasers-Theory and Applications, Macmillan, 1991*

PHY273 COMPUTATIONAL PHYSICS 3 0 0 3

Unit 1

Differentiation: Numerical methods, forward difference and central difference methods, Lagrange's interpolation method.

Integration: Newton - cotes expression for integral, trapezoidal rule, Simpsons's rule, Gauss quadrature method.

Unit 2

Solution of differential equations: Taylor series method, Euler method, Runge Kutta method, predictor-corrector method.

Roots of equations: Polynomial equations, graphical methods, bisectional method, Newton-Raphson method, false position method.

Unit 3

Solution of simultaneous equations: Elimination method for solving simultaneous linear equations, Gauss elimination method, pivotal condensation method, Gauss-seidal iteration method, Gauss Jordan method, matrix inversion method.

Eigen values and Eigen vectors of matrix: Determinant of a matrix, characteristic equation of a matrix, eigen values and eigen vectors of a matrix, power method**.**

TEXTBOOK:

Rubin H Landau & Manuel Jose Paez Mejia, "Computational Physics", John Wiley & Sons

REFERENCES:

1. *Suresh Chandra, "Computer Applications in Physics", Narosa Publishing House, New Delhi*
1. *M Hijroth Jensen, Department of Physics, University of Oslo, 2003 (Available in the Web)*

PHY274 ASTROPHYSICS 3 0 0 3

Unit 1

Historical introduction: Old Indian and western – astronomy - Aryabhatta, Tycho Brahe, Copernicus, Galileo - Olbers paradox - solar system – satellites, planets, comets, meteorites, asteroids.

Practical astronomy - telescopes and observations & techniques – constellations, celestial coordinates, ephemeris.

Celestial mechanics - Kepler's laws - and derivations from Newton's laws.

Sun: Structure and various layers, sunspots, flares, faculae, granules, limb darkening, solar wind and climate.

Unit 2

Stellar astronomy: H-R diagram, color-magnitude diagram - main sequence - stellar evolution – red giants, white dwarfs, neutron stars, black holes - accretion disc - Schwartzchild radius - stellar masses Saha–Boltzman equation - derivation and interpretation.

Variable stars: Cepheid, RR Lyrae and Mira type variables - Novae and Super novae. Binary and multiple star system - measurement of relative masses and velocities. Interstellar clouds-Nebulae.

Unit 3

Galactic astronomy: Distance measurement - red shifts and Hubble's law – age of the universe, galaxies – morphology - Hubble's classification - gravitational lens, active galactic nuclei (AGNs), pulsars, quasars.

Relativity: Special theory of relativity - super-luminal velocity - Minkowski space - introduction to general theory of relativity – space - time metric, geodesics, space-time curvature. Advance of perihelion of Mercury, gravitational lens.

Cosmology: Comic principles, big bang and big crunch – cosmic background radiation - Nucleo-synthesis - plank length and time, different cosmic models - inflationary, steady state. Variation of G. anthropic principle**.**

REFERENCES:

1. *"Textbook of Astronomy and Astrophysics with elements of Cosmology", V.B.Bhatia, Narosa publishing 2001.*
2. *William Marshall Smart, Robin Michael Green "On Spherical Astronomy ",(Editor) Carroll, Bradley W Cambridge University Press ,1977*
3. *Bradley W.Carroll and Dale A. Ostlie.- "Introduction to modern Astrophysics" Addison- wesley, 1996.*
4. *BradleyW.Carroll and Dale A. Ostlie, "An Introduction to Modern Astrophysics" Addison-Wesley Publishing Company, 1996'*
5. *'Stellar Astronomy' by K.D Abhayankar.*
6. *'Solar Physics' by K.D Abhayankar.*

SSK111 SOFT SKILLS I 0 0 3 1

Soft skills and its importance: Pleasure and pains of transition from an academic environment to work-environment. Need for change. Fears, stress and competition in the professional world. Importance of positive attitude, self motivation and continuous knowledge upgradation.

Self-confidence: Characteristics of the person perceived, characteristics of the situation, characteristics of the perceiver. Attitude, values, motivation, emotion management, steps to like yourself, positive mental attitude, assertiveness.

Presentations: Preparations, outlining, hints for efficient practice, last minute tasks, means of effective presentation, language, gestures, posture, facial expressions, professional attire.

Vocabulary building: A brief introduction into the methods and practices of learning vocabulary. Learning how to face questions on antonyms, synonyms, spelling error, analogy, etc. Faulty comparison, wrong form of words and confused words like understanding the nuances of spelling changes and wrong use of words. Listening skills: The importance of listening in communication and how to listen actively.

Prepositions, articles and puncuation: A experiential method of learning the uses of articles and prepositions in sentences is provided.

Problem solving level – I**:** Number system; LCM &HCF; Divisibility test; Surds and indices; Logarithms; Ratio, proportions and variations; Partnership;

Problem solving level – II: Time speed and distance; work time problems;

Data interpretation: Numerical data tables; Line graphs; Bar charts and Pie charts; Caselet forms; Mix diagrams; Geometrical diagrams and other forms of data representation.

Logical reasoning: Family tree; Deductions; Logical connectives; Binary logic; Linear arrangements; Circular and complex arrangement; Conditionalities and grouping; Sequencing and scheduling; Selections; Networks; Codes; Cubes; Venn diagram in logical reasoning; Quant based reasoning; Flaw detection; Puzzles; Cryptogrithms.

TEXTBOOKS:

1. *A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.*
2. *Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.*
3. *Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*
4. *The Hard Truth about Soft Skills, by Amazone Publication.*
5. *Quantitative Aptitude by R.S. Aggarwal ,S. Chand*
6. *Quantitative Aptitude – Abijith Guha ,TMH.*
7. *Quantitative Aptitude for Cat- Arun Sharma. TMH.*

REFERENCES:

1. *Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.*
2. *More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.*
3. *The BBC and British Council online resources*
4. *Owl Purdue University online teaching resources*

www.the grammarbook.com online teaching resources

www.englishpage.com online teaching resources and other useful websites.

SSK112 SOFT SKILLS II 0 0 3 1

Professional grooming and practices: Basics of corporate culture, key pillars of business etiquette. Basics of etiquette: Etiquette – socially acceptable ways of behaviour, personal hygiene, professional attire, cultural adaptability. Introductions and greetings: Rules of the handshake, earning respect, business manners. Telephone etiquette: activities during the conversation, conclude the call, to take a message. Body Language: Components, undesirable body language, desirable body language. Adapting to corporate life: Dealing with people.

Group discussions: Advantages of group discussions, structured GD – roles, negative roles to be avoided, personality traits to do well in a GD, initiation techniques, how to perform in a group discussion, summarization techniques.

Listening comprehension advanced: Exercise on improving listening skills, grammar basics: Topics like clauses, punctuation, capitalization, number agreement, pronouns, tenses etc.

Reading comprehension advanced: A course on how to approach middle level reading comprehension passages.
Problem solving level – III: Money related problems; Mixtures; Symbol based problems; Clocks and calendars; Simple, linear, quadratic and polynomial equations; special equations; Inequalities; Functions and graphs; Sequence and series; Set theory; Permutations and combinations; Probability; Statistics.

Data sufficiency: Concepts and problem solving.

Non-verbal reasoning and simple engineering aptitude: Mirror image; Water image; Paper folding; Paper cutting; Grouping of figures; Figure formation and analysis; Completion of incomplete pattern; Figure matrix; Miscellaneous.

Spacial aptitude: Cloth, leather, 2D and 3D objects, coin, match sticks, stubs, chalk, chess board, land and geodesic problems etc., related problems.

TEXTBOOKS:

1. *A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.*
2. *Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.*
3. *Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*
4. *The Hard Truth about Soft Skills, by Amazone Publication.*
5. *Quick Maths – Tyra.*
6. *Quicker Arithmetic – Ashish Aggarwal*
7. *Test of reasoning for competitative examinations by Thorpe.E. TMH*
8. *Non-verbal reasoning by R.S. Aggarwal ,S. Chand*

REFERENCES:

1. *Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova*
2. *More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.*
3. *The BBC and British Council online resources*
4. *Owl Purdue University online teaching resources*

www.the grammarbook.com online teaching resources

www.englishpage.com online teaching resources and other useful websites.

SSK113 SOFT SKILLS III 0 0 3 1

Team work: Value of team work in organisations, definition of a team, why team, elements of leadership, disadvantages of a team, stages of team formation. Group development activities: Orientation, internal problem solving, growth and productivity, evaluation and control. Effective team building: Basics of team building, teamwork parameters, roles, empowerment, communication, effective team working, team effectiveness criteria, common characteristics of effective teams, factors affecting team effectiveness, personal characteristics of members, team structure, team process, team outcomes.

Facing an interview: Foundation in core subject, industry orientation/knowledge about the company, professional personality, communication skills, activities before interview, upon entering interview room, during the interview and at the end. Mock interviews.

Advanced grammar: Topics like parallel construction, dangling modifiers, active and passive voices, etc.

Syllogisms, critical reasoning: A course on verbal reasoning. Listening comprehension advanced: An exercise on improving listening skills.

Reading comprehension advanced: A course on how to approach advanced level of reading, comprehension passages. Exercises on competitive exam questions.

Problem solving level – IV: Geometry; Trigonometry; Heights and distances; Co-ordinate geometry; Mensuration.

Specific training: Solving campus recruitment papers, national level and state level competitive examination papers; Speed mathematics; Tackling aptitude problems asked in interview; Techniques to remember (In mathematics). Lateral thinking problems. Quick checking of answers techniques; Techniques on elimination of options, estimating and predicting correct answer; Time management in aptitude tests; Test taking strategies.

TEXTBOOKS:

1. *A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.*
2. *Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.*
3. *Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*
4. *The Hard Truth about Soft Skills, by Amazone Publication.*
5. *Data Interpretation by R.S. Aggarwal ,S. Chand*
6. *Logical Reasoning and Data Interpretation – Niskit K Sinkha*
7. *Puzzles –Shakuntala Devi*
8. *Puzzles – George J. Summers.*

REFERENCES:

1. *Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.*
2. *More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.*
3. *The BBC and British Council online resources*
4. *Owl Purdue University online teaching resources*

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www.englishpage.com online teaching resources and other useful websites.