B.Tech. III Semester

CH2301: Chemical Engineering Thermodynamics- I (3 1 0)

Unit I : Basic Concepts & Definitions : Thermodynamics, approaches of thermodynamics, System & its types, Property, Equilibrium, Processes, Reversible & Irreversible, Isobaric, Isometric, Isothermal and adiabatic processes, Work, Heat, Energy.

Unit II : First Law of Thermodynamics : Law, Calculation of Internal energy, Enthalpy, Heat capacities, work done for various processes, Application of first law to closed systems (Isobaric, Isometric, Isothermal and Adiabatic processes) and open systems, Throttling process, Joule – Thompson effect.

Unit III : Second Law of Thermodynamics : Heat engine and its efficiency, Heat pump, Refrigerator, COP, Second law of Thermodynamics, Kelvin–Planck statement & Clausius Statement, Carnot's cycle and Carnot theorems, Clausius inequality, Entropy and its calculation, Principle of entropy increase.

Third Law of Thermodynamics : Its limitation and applications.

Unit IV : Thermochemistry : Enthalpy, Heat of reaction at constant pressure and volume, Hess's Law of constant heat summation , Effect of temperature on heat of reaction at constant pressure (Kirchoff's equation), Heat of dilution, Heat of hydrogenation, Heat of formation, Heat of neutralization and Heat of combustion, Adiabatic flame temperature.

Unit V : Equation of State, VLE/LLE Equilibrium : Le Chatlier's Principle, Kinetic theory, Vapour Liquid Equilibria in Ideal solution, VLE involving high pressures and Multicomponent systems, Consistency test for VLE data, Liquid-Liquid Equilibrium Diagrams, Equation of state of real gas, Principles of corresponding states.

Books Recommended :

1. Chemical Engineering Thermodynamics by Y.V.C. Rao, Universities Press(India) Ltd. Hyderabad.
2. Engineering Thermodynamics by P. K. Nag, Tata McGraw Hill.
3. Principle of Physical Chemistry by Maron, Samuel H. Pruton Carl F., Oxford & IBH publishing Co. Pvt. Ltd. New Delhi.
4. Textbook of Physical Chemistry by Samuel Glasstone, Macmillan Co. Ltd. London.
5. Chemical Engineering Thermodynamics by B.F. Dodge.

CH2302: Chemical Engineering Calculations (3 1 0)

Unit I : Review : Concepts of Units & dimensions, Pressure, Temperature, Volume, Moles, Average molecular weight , Stochiometry & composition relationships.

Unit II : Gaseous Processes : Ideal gas law, Dalton's law, Amagat's law, Partial pressure and Pure component volume, Different methods of solving problems related to gaseous mixture and chemical reactions in gaseous phase.

Unit III : Vapor Pressure : Concepts of vapor pressure, Vapor pressure of immiscible liquids, Antoine equation, Cox chart, Vapor pressure of solutions and problems based on Raoult's law. **Humidity & Saturation :** Difference between saturation & humidity, Different methods of expressing saturation & humidity, Psychometry & its problems .

Unit IV : Material Balance : General equation and concept of law of conservation of mass, Problems on material balances with & without chemical reaction, Recycle, Bypass & Purge calculations, Specific type of industrial applications on above, Calculation of number of independent equations for solving material balance problems by matrix method.

Unit V : Energy Balance : Problems on Thermochemistry, General heat balance equation and concepts of law of conservation of energy, Combustion calculations, Reaction flame temperature calculations, Heat balances for reacting & non–reacting processes, Specific type of industrial applications on above.

Books Recommended :

1. Fundamentals of Chemical Engineering by S.N. Saha., Dhanpat Rai Pub. Co.(Pvt) Ltd. New Delhi.
2. Chemical Process Principles Part I by Hougen, Watson & Ragatz Vol. I, Asia Publishing house.
3. Basic Principle & Calculation in Chemical Engineering by D.M. Himmelblau, Prentice Hall.
4. Stoichiometry by B. I .Bhatt and S.M. Vora, Tata McGraw Hill Pub Co.

CH2303: Process Instrumentation and Analysis (3 1 0)

Unit I : Measurement Fundamentals: Need & scope of Process Instrumentation, classification of process variables, Measurement terms & characteristics- signal terms, range related terms, readability terms, accuracy related terms (Static & Dynamic), energy related, operational related terms, calibration, hysterisis, Operational modes of instrumentation as Null Instrument, Deflection instrument, Analog & Digital Sensors.

Unit II: Temperature Measurement: Temperature scales, Units, standards & calibration. Thermocouple, Thermo resistive systems, Filled System thermometers, Radiation & optical pyrometer, Fiber-optic thermometers, Bimetallic thermometers, Liquid in glass thermometers, Temperature sensitive material indicators, Pyroelectric thermometers. Application & selection

Unit III: Pressure Measurement: Pressure scales & units, Mechanical pressure elements, liquid column elements, elastic element, design of Bourdon Spring elements. Direct & indirect vacuum measurements, Pressure probes, Positives displacement type meters, electronic pressure sensors. Application & Selection.

Unit IV: Flow & Liquid Level Measurement:
Flow Measurement : Head flowmeters: Orificemeter, venturimeter, pitot tube, flow calculations. Variable area flowmeters: Rotameter, orifice meters, Positive displacement,

Liquid Level Measurement: Classification, Displacer, Float, Pressure gauges, Balance method. Direct and differential method, Measurement in open vessels and Closed pressure vessels.

Unit V: Chemical Variables Measurement: Spectrophotometric Method: Infrared, Mass, Atomic absorption, Measurement of Viscosity, Humidity, pH
Instrument for gas analysis : Gas Chromatography and Mass Spectroscopy

References:

1. Instrument Engineers Handbook (Instrumentation) by B.G. Liptak
2. Process Instrument & Control Handbook by D. M. Considine, Mc-Graw Hill Company.
3. Industrial Instrumentation by D. P. Ekmann
5. Instrumentation by Kerk F.M., Rimbo W,R. and Trarapore D.B.

CH2304: Mathematics III (3 1 0)

UNIT-I : Functions of a Complex Variable: Complex variable, function of complex variable, limit, continuity, and differentiability, of a function of a complex variable. Analytic functions, Cauchy- Riemann equations, Orthogonal curves, harmonic functions, conformal mapping, bilinear transformation (Mobius transformation) Cauchy integral theorem, Caucy integral formula, Cauchy's inequality Taylor theorem, Laurent's theorem.

UNIT-II : Fourier Series and Fourier Transform : Periodic function, Fourier series, Dirichlet's conditions for a Fourier series. Advantages of Fourier series and determination of Fourier coefficients, Fourier series of function of periods 2, change of interval, Even Odd functions, Half range sine and cosine series, practical harmonic analysis, Fourier transformation, Fourier sine and cosine transform, properties of Fourier transform.

UNIT-III : Laplace Transformation: Laplace transformation, properties of Laplace transformation, first shift theorem, Laplace transform of the derivative of f(t), multiplication and division by t. Unit step function: Laplace transformation of unit function, second shifting theorem, Laplace transform of function and periodic function. Inverse Laplace transformation Multiplication by s, division by s, first shifting property, second shifting property, inverse Laplace transform of derivatives, solution of differential equations by Laplace transform

UNIT-IV : Correlation & Regression : Scatter diagram, Linear Correlation, Measures of Correlation, Karl Pearson's Coefficient of correlation , Limits for correlation coefficients, Coefficient of correlation for bivariate frequency distribution, Rank correlation, Linear Regression, Equations to the line of Regression. Regression coefficient. Angle between two lines of Regression.

UNIT –V : Theoretical Distributions: Discrete and Continuous probability distribution's. Mathematical expectation, Mean and Variance, Moments, Moments generating function, probability distribution ,Binomial,Poisson and Normal distribution ,Test of siginificance sassed on chi-square , T,F,and Z distribution degree of freedom , conditions for applying X^2 (chi-square) test , student's test.

Books Recommended :

1. B.S. Grewal B.S. "Higher Engg. Mathematics"
2. Kreyszig E " Advanced Engineering mathematics"
3. Prasad C " Advanced Engineering mathematics"
4. Pati T " Functions of complex variables"
5. Dass H.K. " Advanced Engineering mathematics"
6. Ray M. " Mathematics statistics"

CH2305: Basic Electronics Engineering (3 1 0)

UNIT-I : Junction Diode And its Application : Properties of P-N junction, Open Circuited P-N junction, Current component of PN diode, V-I Characteristics, Temperature dependence of V-I characteristics, Diode resistance, Space charge capacitance C_T, Diffusion capacitance C_D, Junction diode switching times, Diode as a rectifier- Half wave & Full wave rectifier, Clipper, Clamper.

UNIT-II : Special Purpose Diode : Breakdown diode, Zener diode, Avalanche, Tunnel diode photo voltaic effect, Photo diode, Pin diode, LED, LCD, Varactor diode – working & its characteristics, Application.

UNIT-III : Transistor and Fet : Junction transistor, Transistor current components, Transistor as an amplifier, Transistor construction, Transistor Circuit configuration (Common Base, Common Emitter, Common Collector) and characteristics, CE current gain, Analytical expression for transistor characteristics, Early effect, Ebers-Moll model, JFET construction, Operation, V-I characteristics, Transfer characteristics, Metal Oxide Semiconductor Field Effect Transistor (MOSFET) : Introduction, Construction, Operation and Characteristics, Depletion MOSFET, Enhancement MOSFET.

UNIT-IV : Cro & Multi Layer Devices : CRT configuration, Focusing, Deflection system & its sensitivity, Lissajous figure pattern.
Thyristor Family : Construction, working & characteristics of SCR, SCS, UJT, Diac, Triac

UNIT-V : Operational Amplifiers : Differential amplifier, CMRR, OPAMP symbol and terminal characteristics, Block Schematic of OPAMP, Ideal OPAMP characteristics, Practical OPAMP characteristics, Inverting Amplifier, Non- Inverting Amplifier, Voltage Follower, adder, substractor, comparator, integrator, differentiator, Log & Antilog amplifier.

Books Recommended :

1. Integrated Electronics : Analog & Digital Circuit Systems – Jacob Millman & Halkias, TMH
2. Electronics Devices and Circuit Theory – Boylestad & Nashelsky, 8th Ed., PHI
3. Electronics Devices and Circuit – Allen Mottershead, PHI
4. Integrated Circuits by K.R. Botkar, Khanna Publications
5. A course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai & Sons, 2010, A. K. Sawhney.

B.Tech. IV Semester

CH2401: Fluid Mechanics (3 1 0)

Unit I : Fluid Static & Applications : Hydrostatic equilibrium, Hydrostatic equilibrium in centrifugal field and its applications in chemical engineering like manometers decanters.
Fluid flow process : Velocity gradient and shear, Types of fluids, Concept of viscosity, Kinematic viscosity, Nature of flow- Laminar, Turbulent, Reynolds number, Boundary layer formation and separation.

Unit II : Basic equations for fluid flow : Mass balance & momentum balance equations, Bernoulli's equation without and with corrections for solid boundaries, Kinetic energy, Friction factor, Pump work.

Unit III : Incompressible fluids : Flow through pipes, Flow characteristic- Shear stress, Friction factor, Laminar flow for Newtonian fluids, Hagen Poiseuille equation, Laminar flow for Non–Newtonian liquids, Turbulent flow through pipes and close channels and its characteristic equations, Friction factor and its dependence on roughness, Reynolds number, Friction factor for flow through channels of non-circular cross section – concept of equivalent diameter, Frictional losses due to sudden change in velocity or direction of flow; Expansion, Contraction, Effect of fittings, Flow of liquids in thin layers.

Unit IV : Transportation of fluids : Pipe fitting like bends, Elbows, Flanges, Tee and different types of valves, Seals for moving parts, Pumps, NPSH, Power requirement, Types of pumps – Centrifugal & Positive displacement, Troubleshooting in operation – Priming & Cavitations, Characteristic curves – Head / Capacity power / Capacity and Efficiency / Capacity head flow and Head work relationship.
Metering of Fluids : Variable Head meters- Venturimeter & Orifice meter, Variable Area meter – Rotameter, Insertion meters – Pitot tube.

Unit V : Agitation And Mixing Of Liquids : Various agitators, Impellers, Propellers, Turbines, Paddles, Flow characteristics for Newtonian liquids, Standard Turbine design, Circulation velocities and power Calculations in agitation process including power correlations, Effects of baffles, Blending and Mixing

Books Recommended :

1. Unit Operations of Chemical Engineering by McCabe Smith And Harriot, Fifth Edition, McGraw Hill Inc.
2. Chemical Engineering by J.M. Coulson and Richardson Vol.2
3. Unit Operation in Chemical Engineering by Chattopadhyay, Khanna publishers.

CH2402: Mechanical Operations (3 1 0)

Unit I : Solid Properties, Handing, Mixing, Storage & Transportation : Characterization of solid particles, Particle shape, Size, Size analysis, Number of particles in mixture, Screen analysis, Standard screens, Size measurement for fine particles, Storage of solids, Conveying of solids – Mechanical and Pneumatic (brief descriptions)
Mixing of Solids : Types of important mixers like kneaders, Dispersers, Masticators, Roll mills, Muller mixer, Pug mixers, Blenders, Screw mixer etc., Mixing index.

Unit II : Size Reduction : Principle, Major equipment, Crushers, Grinders, Ultra fine grinders, Cutting machines, Energy & Power calculations for size reduction, Closed circuit and open circuit grinding.

Unit III : Settling : Elutriation, Classification and sedimentations, Flow of solids through fluids, Stoke's law, Free and Hindered settling, Types of thickeners (Batch & Continuous), Settling chambers, Cyclones & multicyclones and their design, Dust and dump collectors, Electrostatic precipitators, Filter bags, Venturi scrubbers.

Unit IV : Mechanical Separations : Industrial screens; their capacity and effectiveness
Filtration : Theory, Batch and Continuous filtration equipment and their functioning, Filter aids, Clarifiers – Principle only, Centrifugal separation for liquids decanters.

Unit V : Fluidization : Flow of fluids through beds of particles, Kozeny Carman equation, Burke – Plummer Equation, Ergun equation, Aggregate and particulate fluidization, Fluidization velocity, Porosity, Expansion of fluidized bed, Industrial applications.

Books Recommended :

1. Unit operations of chemical Engineering by McCabe Smith and Harriot, Fifth edition, McGraw Hill Inc.
2. Chemical Engineering by J. M. Coulson and Richardson Vol. 2 .
3. Unit Operations for Chemical Engineering by G. G .Brown & Associates.
4. Unit Operations in Chemical Eng. By P. Chattopadhyay, Khanna publishers.

CH2403: Organic Chemical Technology (3 1 0)

Unit I : Oils & Fats : Status and scope, Major Oils seeds production in India, Expression, Solvent extraction, Energy & Solvent requirements, Mineral seeds and other oil bearing materials, Hydrogenation of oils, Corrosion problems and materials of construction of equipments.

Unit II : Soaps & Detergents : Raw materials, Manufacturing of detergents, Active detergent matter, Biodegradability, Fat splitting, Purification of fatty acids, Soap Manufacturing, Total fatty matters (TFM), Glycerin manufacturing, Materials of construction.

Unit III : Cane Sugar : Cane production & varieties, Manufacturing equipments & technology, Cane sugar refining, Bagasses utilization, Energy requirements and conservation, Environmental considerations, Khandsari technology, Molasses based industries, Materials of construction.

Unit IV : Polymers : Status and scope, Applications, Classification of polymers, Degree and modes of polymerization, Molecular weight and it distribution, Selected industrial polymerization including plastics, Synthetic Rubber and Polymeric foams, synthetic fibers.
Penicillin : Manufacturing process, Scope and applications.

Unit V : Regenerated Cellulose : Growth of industry, Raw materials, Pretreatment, Pulping, Manufacturing of paper, Recovery of chemicals, Environmental considerations, viscose rayon.
Varnishes and Paints : Scope and applications, Types of coatings, General manufacturing procedure, Environmental considerations.

Book Recommended :

1. Chemical Process Industries – R.N. Shreve & J.A. Brink
2. Chemtech I , II, III , IV – IIT Madras
3. Outlines of Chemical Technology by Dryden , Co. M.G. Rao and M. Sitting.
4. Handbook of Oil & Colour, Chemists Association OCCA.

CH2404: Chemical Engineering Thermodynamics – II (3 1 0)

Unit I : Thermodynamic Potentials : Free Energy functions and their significances in phase and chemical equilibria, Gibbs-Helmholtz equation, Gibbs free energy minimum principle, Maxwell relations, Various Tds equations, C_p and C_v relations.

Unit II : Clapeyron equation : Joule Thomson Coefficient, Clausisus – Clapeyron equations and some important correlations for estimation vapour pressures, Estimation of thermodynamic properties by using graphs and tables.

Unit III : Multicomponent Mixtures : Partial molar properties, Partial molar Gibbs free energy, Chemical potential and its dependence on temperature and pressure, Fugacity and its calculation, Dependence of fugacity on temperature & pressure, Gibbs phase rule and its significance.

Unit IV : Properties of Solutions : Ideal solutions (Lewis Randall Rule) Phase equilibrium in ideal solutions, Phase equilibrium problems, Excess properties, Gibbs – Duhem relation, Activity & activity coefficient, Dependence of activity coefficient on temperature and composition, Excess Gibbs free energy models : Margules, Van–laar, Wilson and NRTL equations, UNIQUAC and UNIFAC methods, Herny's Law.

Unit V : Chemical Equilibrium : Equilibrium constants in terms of measurable properties, Variation of equilibrium constants with temperature and pressure, Adiabatic reactions, Equilibrium in homogeneous & heterogeneous reactions.

Books Recommended :

1. Chemical Engineering Thermodynamics by Y.V.C. Rao, Universities Press (India) Ltd. Hyderabad.
2. Engineering Thermodynamics by P. K. Nag, Tata McGraw Hill
3. Introduction to Chemical Engineering Thermodynamics by J.M. Smith and H.C. Van Ness, McGraw Hill International Ltd.
4. Chemical Eng. Thermodynamics by S. Sandler.
5. Properties of Gasses and Liquids by Reid Prausnitz and Rolling, McGraw Hill.

CH-2405: Strength of Materials (4 1 4)

Unit I : Stress and Strain : Direct stress, Strain, Elasticity and Elastic limit, Hooke's law, Stress- Strain diagram for ductile and brittle material, Elongation of uniform and tapered bars, Temperature stresses in composite systems, Elastic Moduli & their inter-relations, Introduction to various mechanical properties. Principal Stresses and Strains, Stresses due to direct loading, complimentary shear stresses, Normal and shear stresses due to two perpendicular normal stresses, Ellipse of stresses, Mohr's stress circle.

Unit II : Bending Moment and Shear Forces : Bending moment, Shear force & Thrust diagram for cantilever, Simply supported beam, Single & double overhanging beams for different types of loadings & their combination. Co-relation between rate of loading, Shearing forces and Bending Moments, Computation of loading diagram & Bending Moment diagram from shear force diagram. Importance of SFD & BMD. Point of Inflection/contra flexure/ Virtual hinge.

Unit III : Bending & Shear Stresses : Introduction to Theory of bending, Equation of pure bending, Bending and Shearing stresses, Shearing stresses variation / distribution in various sections of loaded beam. Beams of uniform strength, Practical application of bending equation.

Unit IV : Column and Struts : Crushing and buckling load, Euler's theory of long columns, assumptions & limitations, Euler's crippling load formula for various end conditions of long columns.
Empirical Formula : Rankine's straight line formula and Johnson's parabolic formula.
Slope and Deflections : Method of integration & Mecauly's method for determination of Slope and Deflections of cantilever and simply supported beams. Propped Cantilever beam.

Unit V : Thin and Thick Cylinders: *Thin Cylinders* : Circumferential and Longitudinal stresses, Riveted cylindrical boilers, Thin spherical shells, stresses in conical tank.
Thick Cylinders and Spheres : Derivation of lame's equation, Hoop stresses and radial pressure distribution.
Rivetted and Welded Connection : Types of riveted and welded connections, failure of joints, Riveted valve, Efficiency of joints, Advantages and disadvantages.

Book Recommended :

1. Strength of Material by S. Ramamrutham
2. Strength of Materials by Warnock
3. Strength of Materials Vol. I by S.B. Junnarkar
4. Strength of Materials by R. K. Rajput

5. Strength of Materials by Dr. Sadhu Singh
6. Strength of Materials by F.L. Singer
7. Strength of Materials by R.S. Vaishwaner
8. Strength of Materials by S. Timoshenko
9. Strength of Materials by Frocht
10. Solid Mechanics by Kazmi
11. Strength of Materials by B.S. Basavarajaiah
12. Strength of Materials by R.S. Khurmi

B.Tech. V Semester

CH3501: Heat Transfer (3 1 0)

Unit I : Heat transfer by conduction in solid, Fourier's Law, Compound resistance in series, Heat flow through a cylinder, Unsteady state heat conduction, Principles of heat flow in fluids, Counter current and parallel flows, Energy balances, Rate of heat transfer, Overall heat transfer coefficient, Individual heat transfer coefficient, Fouling factors.

Unit II : Heat transfer to fluids without phase changes, Heat transfer by forced convection in Laminar and Turbulent flow, Natural convection, Heat transfer to fluids with phase change, Heat transfer from condensing vapours, Heat transfer to boiling liquids, Dimensional analysis.

Unit III : Radiation heat transfer, Kirchoff's law, Radiation between surfaces, Combined heat transfer by conduction, convection and radiation.

Unit IV : Heat exchange equipment, Heat exchangers and general design of Parallel, Counter current, Shell & tube heat exchangers, Extended surface equipment.

Unit V : Evaporation – Types of evaporators and fields of their applications, Single and Multiple effect evaporators, their design and operation, Vapor recompression.

Books Recommended

1. Process Heat Transfer By D.Q.Kern.
2. Heat Transmission by Mc. Adams
3. Unit Operations of Chemical Engineering – McCabe Warren, L Smith, Julian C And Harriot Peter. Fifth edition McGraw Hill Inc.
4. Chemical Engineering – Coulson J. M., Richardson Vol.-I

CH3502: Mass Transfer - I (3 1 0)

Unit I: Phase Equilibria Vapor-liquid equilibrium curves and boiling point diagram, Volatility, Solubility of gases, Enthalpy –Concentration diagrams.

Equilibrium Stage Operations Principles, Determination of number of ideal stages for two component systems by graphical and absorption factor methods, Application of enthalpy concentration diagram, Multi component systems.

Unit II: Distillation Flash distillation, Design and operation characteristics of plate columns, Analysis of fractionating column by Mc-Cabe Thiele's method and enthalpy concentration diagram method, Effect of reflux ratio, Design of sieve plate columns, Plate efficiencies, Azeotropic distillation, Steam distillation.

Unit III: Principle of Diffusion Theory of diffusion, Equimolal and molecular diffusion in gases and liquids, Diffusion velocities, Mass transfer coefficient for mass transfer through known areas.

Unit IV: Gas Absorption Design of packed towers, Principles of absorption, Rate of absorption, Two film theory, Overall coefficients, HTU method, Interrelation between heat transfer, momentum transfer and mass transfer.

Unit V : Adsorption: Types of adsorption, Commercial adsorbent and their application, Characteristics and properties of adsorbents, Adsorption equilibria; Specific surface area of an adsorbent, Selection of adsorbent, Single stage and multistage operation, rate of adsorption and breakthrouth curve, Elution; Ion-exchange.

Books Recommended

1. Mass Transfer by Robert E Trebyl, McGraw Hill Inc.
2. Unit Operations of Chemical Engineering by McCabe Warren, Smith Julian C and Harriot Peter. Fifth edition McGraw Hill Inc.
3. Introduction to Chemical Engineering by Badger & Bancherro, TATA McGraw Hill Inc.

CH3503: Process Equipment Design (Mechanical)–I (3 1 0)

Design of non-pressure storage vessel, Unfired pressure vessels (Storage & Process) with internal and external pressures.

End Closures, Flat plates, Flanged, Dished, Hemispherical, Ellipsoidal and conical ends.

High Pressure vessels, Support of vessels

Books Recommended

1. Introduction to Chemical Equipment Design (Mechanical Aspects) by B.C. Bhattacharya – Chemical Engineering Education Development Center.
2. Process Equipment Design By Brownell & Young
3. Process Equipment Design by M.V.Joshi

CH3504: Inorganic Chemical Technology (3 1 0)

Unit I : Source of Impurities : Polluted, Contaminated and Palatable waters, Water pollutants and their effects.
Treatment : Sedimentation, Coagulation, Filtration, Softening, Aeration, Ion exchange, Reverse osmosis, Disinfection, Industrial waste water and Sewage treatment, Primary, Secondary and Tertiary treatment, Aerobic and Anaerobic treatment .
Desalination : Evaporation, Reverse osmosis etc.

Unit II : Gaseous Fuels : Classification, Manufacture and use of LPG, Wood gas, Coal gas, Producer gas, Water gas, Synthesis gas, Carbureted water gas.
Industrial Gas : Manufacture and use of hydrogen, Carbon dioxide, Acetylene, Oxygen, Nitrogen and Inert gases.

Unit III : Fertilizers : Status of Industry, Grading and classification of fertilizers, Raw materials, Hydrogen production, Fixation of nitrogen, Synthesis, Ammonia based fertilizers, Manufacture of phosphatic fertilizers and phosphoric acid, Potash fertilizers, NPK values, Corrosion problems and Materials of construction.

Unit IV : Soda Ash : Manufacturing, Special materials of construction, Solvey and Modified Solvey process, Environmental consideration, Corrosion problems and Materials of construction.
Chlor Alkali Industry : Electrochemistry of brine electrolysis, Current efficiency, Energy efficiency, Diaphragm cells, Mercury cells, Mercury pollution and control, Caustic soda, Chlorine, Hydrochloric acid, Corrosion problems and Materials of construction .

Unit V : Cement, Glass, Sulfuric Acid: Manufacturing, Environmental consideration, Corrosion problems, Engineering Problems and Materials of construction.

Books Recommended :

1. Chemical Process Industries – R.N. Shreve & J. A. Brink
2. Chem Tech I, II, III, IV- IIT, Madras
3. Outlines of Chemical Technology by Dryden Co. M. G. Rao and M. Sitting .

CH3505: Numerical Analysis and Computer Application (3 1 0)

Unit—I : Approximations and Errors in Computation : Errors and their analysis**,** Types of errors, General Error – formula , Errors in Numerical Computation, Errors in a series approximation of Functions.

Curve fitting : Method of Least squares, Fitting of a Straight Line, Fitting of an Exponential Cures, Polynomial Fit: Non linear Regression (Second Degree Parabola), Multiple Linear Regression, Curve fitting by Sum of Exponentials, Spline fitting: Cubic Spline fitting , Least Square Approximation , Method of moments.

Unit –II : Numerical Solution of Algebraic and Transcendental Equations : Graphical method, Bisection Method, Regulators Method, Secant Method, Regulafalsi Method, Muller's Method Newton Raphson Method, Iteration Method, AITKEN'S Method , Newton Rate of Convergence .

Roots of Polynomials : Horners Method , Multiple Roots, Complex Roots, Lin-Bairstow's Giraeffe's root Squaring Method, Ramajujan's Method, Chebyshev Method, Comparison of Iterative Methods.

Solution of a System of Simultaneous Linear Algebraic Equations Direct Method : Gauss Elimination Method, Gauss Jordan Method, Triangularisation Method, Crout's Method, Cholesky Method, Ill Conditioned System of Equation and Refinement of Solution .

Iterative Methods : .Jacobi Iterative Method, Gauss Seidel Iterative Method, Successive Over Relaxation (SOR) Method .

Unit III : The Calculus of Finite Differences : Finite Differences, Difference Formula, Operators and Relation between Operators. Differences of a Polynomial Factorial Polynomial, Effect of an Error on a Difference Table. Inverse Operator, Application to Summation of Series

Interpolation with Equal Intervals : Newton's Forward and Backward Interpolation Formula.

Central Difference Interpolation Formula : Gauss's Forward and Backward Interpolation Formula, Sterling's Formula, Bessel's Formula, Laplace– Everetts Formula, Choice of Interpolation Formula .

Interpolation with Unequal Intervals : Lagrange's Interpolation, Newton's Difference Formula, Hermit's Interpolation, Inverse Interpolation, Lagrange's Method, Iterative Method .

Unit IV : Numerical Differentiation and Integration : Numerical Differentiation, Newton's forward and Backward difference interpolation formula . Sterling's & Bessel central difference interpolation formula , Maxima and Minima of a Tabulated function , Errors in Numerical differentiation the cubic spine method .

Numerical Integration : Newton-cote's quadratic formula Trapezoidal rule , Simpson's $1/3^{rd}$ and $3/8^{th}$ rule , Boole's rule, Weddle rule, Error's in quadrature formula. Euler Maclaurin's formula Gaussion Quadratare formula, Numerical evaluation of singular integrals, Romberg integration , Gauss- Lagendre two and three point formula Numerical double integration .

Unit V : Difference Equations : Definition, Order and degree of a difference equation, Linear difference equations, Difference equations reducible to Linear form. Simultaneous difference equations with constant coefficients. Applications

Numerical solution of Ordinary Differential Equation : Taylor series method, Picard's Method, Euler's method, Improved Euler's Method, Modified Euler method, Runge's method, Runge Kutta method , Predict corrector method, Milne's method, Adam – Bashforth method.

Numerical Solution of Partial Differential Equations : Classification of P.D.E. of the second order Elliptic equations, Solution of Laplace equation, Solution of poisson's Equation, Solution of elliptic equations by Relaxation method parabolic equations, Solution of one two dimensional heat equation, Hyperbolic Equations, Solution of wave equations .

Recommended Books:-

1. JAIN & IYNGAR Numerical Methods for Scientific and Engineering Computations.
2. RAO G.S. Numerical Anlysis.
3. Grewal B S Numerical Methods In Engineering and Science.
4. Das K K Advance Engineering Methods.
5. Rajaraman V Computer Oriented Numerical Methods

NACA LABS:
Programming in C & C++ Of various Numerical Methods.

B.Tech.VI Semester

CH3601: Mass Transfer – II (3 1 0)

Unit I: Humidification Operations : Definitions, Humidity chart and its use in measurement of humidity and calculations of humidification operations, Adiabatic humidification.

Unit II : Leaching : Equipment, Principles of leaching, Calculation of number of ideal stages, Stage efficiency

Unit III : Liquid- Liquid Extraction : Equipment, Principles of extraction, Panchon – Savorit method, Counter current extraction using reflux application of McCabe method, Extraction in packed and spray column.

Unit IV: Crystallization : Principles, yield of crystals, Super solubility curve, Crystal growth, Equipment and application of principles to design.

Unit V : Drying : Equipment, Principles, Mechanism and theory of drying, Calculation of drying time.

Book Recommended

1. Mass Transfer by Robert E. Trebyl, McGraw Hill Inc.
2. Unit Operations of Chemical Engineering- Mc Cabe Warren, L. Smith Julian C and Harriot, Peter Fifth edition McGraw Hill Inc.
3. Introduction to Chemical Engineering by Badger & Bancherro TATA McGraw Hill Inc.

CH3602 : Process Equipment Design- II (3 1 0)

Design of Heat Transfer Equipments : Double Pipe heat exchanger, Shell and Tube heat exchanger, Vertical & Horizontal Condensers and Evaporators.

The Paper will be of four hours duration and the candidates will be allowed to use the following reference book in the examination hall .

1. Hand book of Chemical Engineering J.H.Perry
2. Tubular Heat Exchange Manufacture Association Manual
3. ISI Codes.

Candidates have to bring their own copies of the above books and they will be not supplied by the university or the examination centers.

Books Recommended

1. Process Heat Transfer by D.Q.Kern
2. Heat Transmission by McAdams
3. Unit Operations of Chemical Engineering by McCabe Warren, L Smith Julian C and Harriot Peter Fifth edition McGraw Hill Inc.
4. Chemical Engineering by Coulson J.M., Richardson Vol- I

CH3603 : Process Dynamics and Control (3 1 0)

Unit I : Importance of process control in chemical plants and systems, various types of Control systems Viz open loop and closed loop control, Feedback and Feed forward control, Servo and regulator control. Importance of dynamic behavior of processes in process control. Physical and block diagram representation of control system, use of Laplace Transformation in analysis of control systems.

Unit II : Simple System Analysis : Laplace transformation and transfer function, Block diagrams, Linearization, First and higher order systems, Interacting and Non-interacting systems, Distributed and lumped parameters systems, Dead time.

Unit III : Linear Open Loop Systems : Response of First order, Second order and higher order systems. Linearization of Non-Linear systems, Transportation lag.
Linear Closed Loop Systems : Study of various control system and their components Viz. Controllers, Final Control Elements. Measuring Instruments, Closed Loop Transfer Functions. Transient response of simple control system, Stability criterion and analysis.

Unit IV : Root Locus, Stability Criterion and Transient Response : Transient response analysis form Root Locus, Application of Root Locus to control system. Routh Stability criterion,

Unit V : Frequency Response Analysis : Design of control system by frequency response. Closed loop response by frequency response, Frequency Response Technique: Phase margin and Gain margin, Bode stability criterion; Nyquist stability criterion

Books Recommended

1. Coughnaowr, D.R., "Process Systems Analysis and Control", McGraw-Hill,Inc.
2. Stephanopolous, G., "Chemical Process Control", Prentice-Hall.
3. Seborg, D.E., Edgar, T., and Mellichamp, D.A., "Process Dynamics and Control", John Wiley and Sons, Inc
4. Bequette, B.W.,"Process Control: Modeling, Design, and Simulation", Prentice-Hall, Inc.
5. Process Control by Hariott P., TMH edn.

CH3604 : Chemical Reaction Engineering (3 1 0)

Unit I : Kinetics of Homogeneous Reactions : Kinetics and thermodynamics of Chemical reactions, Kinetics of homogenous reactions rate theories, Analysis of rate equations.

Unit II : Interpretation of Batch Reactor Data : Irreversible reactions, Total pressure method of kinetic studies, Analysis of complex rate equations, Complex reactions, Chain reactions, Variable volume reactions, Rate constants and equilibrium.

Unit III : Ideal Reactor For Single Reaction : Ideal batch reactors, Steady state Mixed Flow Reactor, Steady state Plug Flow Reactor, Size comparison of single reactor, Multiple-reactor system,

Unit IV : Design For Multiple Reaction : Introduction to multiple reaction, Qualitative treatment of product distribution and of reactor size for parallel reaction, Reversible first order reaction in series, Favorable contacting patterns for irreversible reaction in series (First order followed by first order)

Unit V: Catalysis : Heterogeneous catalysts, General characteristics, Adsorption on solid surface, Physical properties of catalysts, Preparation of catalyst, Steps in catalytic reaction, Synthesizing a rate law.

Books Recommended

1. Chemical Engineering kinetics by J.M. Smith
2. Chemical Reaction Engineering by O Levenspieal
3. Elements of Chemical reaction Engineering by H.S. Foggler
4. Reaction Kinetics for Chemical Engineering by S.H. Walas.

CH3605 : Engineering Materials (3 1 0)

Unit I : Crystalline and Non –Crystalline Material : Crystalline State: Atomic bonding: Bravias lattices; Miller indices; Structure of some Common inorganic Compounds, Structural Imperfections: Point Defects in Crystals.
Mechanical Properties : Mechanical properties like Elastic and Plastic deformations, Hardness, Toughness, Fatigue, Creep etc. and their Variation with Temperature

Unit II : Failure of Materials Under service conditions, Phase diagram and their relations to properties of metals and alloys, Response of materials to chemical environment.

Unit III : Corrosion : Mechanism of corrosion- Dry and wet corrosion, Factors influencing corrosion, Atmospheric corrosion, Methods of Corrosion Control, Cathodic and anodic control, Inhibition and other precautionary measures.

Unit IV : Non-Ferrous Metals : Copper, Brasses, Bronze, Aluminium, their Mechanical Properties, Workability and applications, Corrosion resistance. Non-metallic materials of Construction

Unit V : Ceramics : Various types Specially Glasses and Refractories, Properties and applications.
Polymers : Comparison of properties of various polymers and their relationship with chain structure, Some application in Chemical Industries

Books Recommended

1. CHEMTECH- Materials of Construction by O.P. Kharbanda
2. Corrosion and its Prevention III by K.S.Rajagopalan
3. The Structure and Properties of Materials Vol. I to III by H.W.Hyden, G. William and J. Qulf.
4. Introduction to Material Science for Engineers by James F. Shackel Ford.
5. Chemical Engineering HandBook by Robert H. Perry.
6. Element of Material Science and Engineering by L.H.Van Vlack
7. Corrosion Engineering by M.G.Fontanne and N.D. Grehnee.
8. Chemistry of Engineering Materials by C.K.Agrawal.
9. Raghavan, V., “Materials Science and Engineering”, Prentice Hall of India, New Delhi
10. VanVlack, L.H., “Materials Science for Engineers”, Addison-Wesley Publishing Co.

B.E. VII Semester

CH4701:Project Engineering, Economics & Management (3 1 0)

Unit I : Project Engineering : Introduction to Project engineering, difference between Project & Process engineering, Role of a project leader, General design considerations, Plant layout and Site selection, Flow diagram- qualitative & quantitative, Concept of scale up, Concepts of techno-economic feasibility report.

Unit II : Project Finance & Accounts: Elementary knowledge of book of accounts – Journal, Ledger, Balance sheet, P/L a/c, Cost and asset accounting methods, Cost estimation, Cash flow investment, Production Cost, Capital investment, Cost indices, Production and overhead cost, Interest and taxes.

Unit III : Profitability & Alternative Investments: Depreciation and different methods of calculating it, Scrap value, Salvage value, Book value, Market value, Methods of calculating profitability, Alternative investments, Replacement of assets.
Break Even Analysis: Break Even Analysis, Break Even Chart & Its importance

Unit IV: Project Scheduling: Its importance and requirement steps, Network techniques, CPM, PERT, Gantt Chart.

Unit V: HR Personnel & Administration : Importance & role of this management function, Recruitment Process, Training & development, Job Evaluation – Job Analysis, Performance appraisal, Wages & Salary administration, Wage Policy, Wage Survey, Negotiation, Rewards, Motivation, Job enlargement & Job enrichment, Brief treatment on public relations, Brief introduction to Indian Factories Act.

Books Recommended

1. Plant Design & Economics for chemical Engineers by M.S. Peters & K. D. Timmerhaus.
2. Engineering Economics by Tarachand

CH4702 : Fuel Combustion Energy Technology (3 1 0)

Unit I : Solid Fuel : Classification of fuel, Origin, Composition, Characteristics and analysis of coal washing & storage of coal, Physical & chemical processing of coal, Various classification systems of coal briquetting, Carbonization, Gasification of coal.

Liquid Fuel : Origin, Composition and classification, Properties, Chemical processing – Cracking, Reforming, Polymerization, Alkylation and Isomerization.

Gaseous Fuel : Classification of gaseous fuel, Natural gas, LPG, Refinery gas, Producer gas, Water gas.

Unit II: Fuel Combustion Calculation : Fundamentals of various combustion calculations with numerical examples.

Unit III: Combustion Process : General Principles of combustion, Flame, Draught, Limits of Inflammability, Types of combustion Process- Surface, Submerged, Pulsating, Slow combustion.

Unit IV : Energy Conservation : Energy consumption pattern in various sectors, Various ways of energy conservation in various process industries including petroleum.

Unit V: Non – Conventional Energy Technologies : General principles with applications and technology of Biomass Energy, Solar Energy, Geothermal Energy, Wind Energy, Nuclear Energy, Hydal, Tidal and Ocean Energy.

Books Recommended

1. Fuel combustion Energy Technology by S.N. Saha , Dhanpat Rai Publication Co. Pvt. Ltd. New Delhi.

CH4703 : Process Equipment Design- III (3 1 0)

Design of Mass Transfer Equipments : Absorption Tower, Distillation Tower, Tunnel and Rotary dryers.

The Paper will be of three hours duration and the candidates will be allowed to use the following reference book in the examination hall.

1. Hand Book of Chemical Engineering J. H. Pery
2. Coulson & Richardson Vol – VI
3. Mass Transfer by R. Treybal
4. ISI Codes

Candidates have to bring their own copies of ISI Code book and they will be not be supplied by the university or the examination centers.

CH4704 : Transport Phenomena (3 1 0)

Unit I : Introduction to Transport Phenomena : Similarity between momentum, heat and mass transfer, the continuum hypothesis, Basic laws of Fluid motion, Newton's second law of motion, Principle of balance between Momentum, Heat and Mass Transfer, Principles of conservation of Momentum, Mass and Energy.

Unit II : Momentum Transport Phenomena : Momentum Transport in Laminar Flow: Newton's law of viscosity, Science of rheology, Prediction of viscosity and its dependence on Temperature, Pressure and Composition, Boundary conditions, Shell balance approach for stress distribution and velocity profiles. Introduction to time derivatives and vector analysis. Equation of continuity and Equation of motion and their application in fluid flow problems.

Unit III : Unsteady state Momentum Transport, Flow near a wall suddenly set in motion. Momentum Transport Phenomena in Turbulent Flow. Definitions of friction factors, friction factor for flow in tubes, for flow around spheres, for packed bed column.

Unit IV : Energy Transport Phenomena : Energy Transport in Laminar Flow: Fourier's Law of Heat Conduction. Prediction of thermal conductivities and its dependence on temperature, Pressure and composition, Boundary conditions, Shell balance approach. Types of heat sources, Principle of Extended surfaces, Types of cooling fans, Free and Forced convection. Unsteady State Heat Transport, Unsteady state heat conduction in solids, Heating of semi-infinite slab, heating of finite slab.

Unit V : Mass Transport Phenomena : Definitions of concentration, Velocities and Mass fluxes, Fick's law of diffusion, Prediction of diffusivity and its dependence on temperature, Pressure and composition. Boundary conditions, Shell balance approach for Mass Transfer problems. Problems of diffusion with homogeneous and heterogeneous chemical reaction. Diffusion and chemical reaction in porous catalyst - the effectiveness factor. The equation of continuity for multicomponent mixtures.

Books Recommended

1. R.B. Bird, W.E. Stewart and E. W.Lighfoot, “Transport Phenomena”, John Wiley & Sons.
2. Brodkey, R. S. and Hershey, H. C., “Transport Phenomena”, McGraw-Hill
3. Welty, J.R., Wicks, C.W., Wilson, R.E. and Rorrer, G., “Fundamentals of Momentum Heat and Mass Transfer”, John Wiley & Sons.

CH4705 : Petroleum Refinery Engineering (3 1 0)

Unit I : Formation of petroleum crude, Origin & occurrence composition, Classification & Physical properties of petroleum, Crude, Conversion of organic matter into petroleum crude, Different sources of petroleum oil.

Unit II : Physical properties and test methods of melting point, Viscosity, Density of petroleum products, Mass Spectroscopy, Heat of combustion, Flash & Fire point, Smoke Point, Aniline Point, Carbon residue, Pour Point, Freezing Point, Viscosity Index, Diesel Index, Octane & Cetane number.

Unit III : Chemical treatment of petroleum products, Caustic Soda treatment, Treatment with H_2SO_4 & H_2, Mercaptan removal & oxidation process, Dewaxing, Sulphur in petroleum crude oil & Petroleum products, Refining Lubricating Oils.

Unit IV : Refining of Petroleum crude, Type of Refineries, Planning for operation of oil refinery, Distillation & Equilibrium, Degree of separation, Type of trays of distillation column & its efficiencies, Types of distillation in a petroleum industries, Application of petroleum products from an oil refinery.

Unit V : Cracking & Reforming, Type of Cracking, Thermal cracking reaction, Dubbs process & Tube still process of thermal cracking, Visbreaking, Delayed coking & Fluidized coking, Catalytic cracking, Fixed & Moving bed catalytic cracking, Thermal reforming, catalytic & its reaction, catalytic reforming process.

Books Recommended :

1. Petroleum Refinery Engineering by W.L. Nelson
2. Petroleum Refining by Gary and Handwarke, Marcel Dekker
3. Petroleum Refining & Petrochemicals by N.K. Sinha, Umesh Publications New Delhi.

CH4706 : Polymer Technology - I (3 1 0)

Unit I : Introduction to Polymer Science : Classification of Polymer and functionality, Polymerization, Polymer Structure, Molecular Weight Distribution, Number Average, Weight Average, z-Average Molecular Weight, Chemical Structure and Thermal Transition types, Mechanism of Polymerization.

Unit II : Polymer Synthesis : Step Growth Polymerization and its Kinetics, Molecular Weight of Step Growth Polymerization, Chain Growth Polymerization and its kinetics, Co-polymerization and its kinetics, Polymerization Techniques, Reaction of Synthetic Polymer, Chemical Structure Determination.

Unit III : Conformation, Solution and Molecular Weight : Thermodynamics of Polymer Solution, The Flory Huggins Theory, Polymer Conformation and Chain Dimensions, Process of Polymer Dissolution, Nature of Polymer Molecules in Solution, Measurement of Molecular Weight, Osmometry, Light Scattering, GPC, Viscosity of dilute Polymer Solution.

Unit IV : Soild State Properties : Amorphous State, Glass Transition Temperature, Glassy Solid and Glass Transition, The Crystalline State, Crytalline Melting Temperature, Degree of Crystallinity & its effect on Properties of Polymer, Mechanical Properties and methods of its testing.

Unit V : Polymer Degradation & the Environmental Effect : Polymer Degradation and Stability, Types of Degradation, Thermal Degradation, Mechanical Degradation, Photo degradation, Degradation by high energy radiation, Hydraulic Degradation, the management of plastic in environment, Biodegradation.

Books Recommended :

1. Polymer Science and Technology by Fried
2. Outlines of Polymer Technology by Sinha PHI

B.Tech. VIII Semester

CH4801 : Process Utilities and Safety (3 1 0)

Unit I : Role of Process utilities in process industries.
Heat Transfer Media : Characteristics properties, Classification, Selection and their industrial application.

Unit II : Steam System : Application in chemical process plants, Design of efficient steam heating systems, Condensate utilization and Flash steam
Steam Traps : Types and characteristics.

Unit III : Water: Water its characteristic and conditioning for process industries e.g. Boiler feed, Cooling etc., Recycling aspects of water.
Air : Characteristics of Air and Air receivers

Unit IV : Introduction to process safety, Accidents and loss statistics, Nature of the accidents / hazardous process.
Toxicology : Toxic material and biological response, Dose responses relationship and models, Threshold dose and its definition, Material safety data sheets and Industrial hygiene evaluation.
Safety Devices : Personal safety devices and general hygiene management, Ventilation..

Unit V : Fire and Explosion : Definition, Flammability characteristics and explosion, Design to prevent fires and explosions by Inverting, Purring, Ventilation, sprinkler systems, Static electricity controls.
Relief and Relief sizing in vapor/gas, Liquid and Runway Reaction services.

Books Recommended :

1. Handbook of Heat Transfer Media by P. L. Aaeringer Renold.
2. High Temperature Heat Carrier by A. V. Chechetckin, Pergammon Press.
3. Efficient use of Steam by P. M. Goodal, Guilford
4. Chemical Process Safety : Fundamentals with applications by A. Crowl Daniel and F. L. Joseph, Prentice Hall.

CH4802: Optimization Techniques in Chemical Engineering (3 1 0)

Unit I : Introduction to Systems analysis and modeling with reference to chemical engineering problems.
Differential method for solving one and two variable problems with and without constraints, Case Studies, Application of Langrangian Multiplier method.

Unit II : Linear Programming

- Modeling,
- Graphical Method,
- Single Phase Simplex Method
- Two phase Simplex Method,
- Duality,
- Sensitivity Analysis.

Unit III : Geometric Programming :

- As applied to chemical engineering problems with degree of difficulty equal to zero and one
- With and without constraints.

Unit IV : Search Methods

- Sequential search methods
- Golden section method
- Dichotomous Search method.

Unit V : Introduction to Dynamic Programming as applied to discrete Multistage problems Like Cascade of CSTR, Train of heat exchanger etc.

Computer Programming techniques applied to optimization.

Book Recommended:

1. Optimization Theory and Practice by Beveridge and Schecheter
2. Optimization Techniques for chemical Engineers by Asghar Hussain
3. Optimization by S.S. Rao
4. Linear Programming by Hadley

CH4803 : Environmental Pollution Control Engineering (3 1 0)

Unit I : Air, Water and Noise pollution, General effect on Man, Animal, Vegetation, Property and Environment, Meteorological aspects of air pollutant dispersion—Temperature lapse rates and stability, Plume behavior, Dispersion of air pollutants.

Unit II : Air Pollution : Composition of clean air and nature of air pollutants, their classification and sources, their effects on man and his environment, Air quality criteria and standards, Atmospheric sampling and analysis sources, Emission and inventories, Computation of quantities and interpretation of data, Air pollution control equipment and their selection for gaseous and particulate pollutants, Devices and techniques for air pollution control for mobile sources, Particulate Emission Control-Gravitational settling chambers, Cyclone Separator, Fabric Filter, ESP, Wet scrubber. Need for legislation, Emission standards for various Industries, Economics of Air Pollution Control.

Unit III : Water Pollution : Major Sources of wastes from Industries, Control methods and equipment, Preliminary, Primary, Secondary and Tertiary treatment, Recovery of material from Process Effluents. Waste water sampling and analysis-methods, determination of organic matter, inorganic substances, Water quality criteria and standards for various purposes. Economics of water Pollution.

Unit IV: Pollution Due to Industrial Water : Nature of waste material from various chemical and allied Industries, Method use for their disposal by destruction or conversion into useful materials and reuse, Nuclear waste materials, Treatment and disposal of waste water, Liquid wastes, Solid waste, Materials and Nuclear waste materials, its management.

Unit V: Environmental Pollution Management : Case studies of sectoral examples for Chemical Industries.

Books Recommended :

1. Environmental Pollution Control Engineering by C. S. Rao, New Age International Ltd.
2. Environmental Engineering by N N Basak, Tata McGraw-Hill Pub. Co. Ltd.
3. Essentials of Environmental Studies by K. Joseph and R. Nagendran, Pearson Education (Singapore) Pvt. Ltd.

CH4804 : Process Modeling and Simulation (3 1 0)

Unit I : Introduction and fundamental of Process Modeling & Simulation, Classification of Mathematical Modeling, Model Building, Fundamental Law used in Modeling, Typical Mathematical forms of models.

Unit II : Chemical System Modeling, Component balance, Energy Conservation, Equation of Motion, Transport Equation of State, Equilibrium- Chemical Equilibrium, Phase Equation, Chemical Kinetics, Application of Chemical System Modeling.

Unit III : Process Models in Chemical Engineering, Models in Heat Transfer Operations, Modeling of Steady State Heat Conduction through a hollow cylindrical, Modeling of Double Pipe Heat Exchanger, Modeling of Stirred Tank Reaction, Models in Mass Transfer Operation, Single Stage Solvent Extraction, Two Stage Solvent Extraction. Distillation Column, Absorption : Linear Equation System.

Unit IV : Models in Reaction Engineering, Isothermal CSTR, Model of CSTR with cooling jacket, Batch reactor, Double Column Reactor, Chemical Reaction with Diffusion in a Tubular Reactor, Models in Fluid Flow Operation, Continuity Equation and Flow through Packed Bed Column.

Unit V : Simulation of Chemical Engineering System, Process Simulation & its scope, Formulation of Problems and step for Steady State Simulation, Simulation Strategies, Process Simulator & its Structure, Case Study using Chemical Engineering Software, Overview of Simulation Software as HYSIS, FLUENT.

Books Recommended :

1. Process Plant Simulation by B.V. Babu, Oxford University Press, New Delhi
2. Process Modeling and Simulation by R.W. Gaikwad and Dr. Dhirendra, Central Techno Publications, Nagpur.

CH4805 : Petrochemical Technology (3 1 0)

Unit I : Survey of Petrochemical Industries, Petrochemical Industries in India, Plastic and Synthetic Fiber Industries, Product of Petroleum Industries, Feed Stocks for Petrochemical Production, Purification and Separation of Feed Rocks, Separation of Aromatics.

Unit II : Chemical from Methane, Oxidation of Methanes, Chemical of Ethane, Ethylene, Acetylene, Production and Utilization of Synthesis Gases. Ethylene Production Cracking, Acetylene Production and Chemicals from Acetylene, Naphtha Cracking.

Unit III : Chemicals from C_3, C_4 and higher Carbon Compound. Dehydrogenation of Hydrocarbon and Higher Paraffin, Chemicals from different Hydrocarbons, Polymers and its properties, Polymers of Olefins, Polyethylene, Polypropylene.

Unit IV : Petroleum Aromatics, Benzene derivatives, Products from Toluene, Synthetic Fibers and its Production, Synthetic Rubber, Plastic and Rubber, Synthetic Detergents.

Unit V : Petroleum Coke and Carbon black, Channel Process, Furnace Process, Design of Steam Reformer, Naphtha Cracker, Catalytic Reformer, Pollution & Toxicity of Petroleum Products.

Books Recommended :

1. Modern Petroleum Technology by G.D. Hobson and W Pow.
2. A Textbook on Petrochemical Technology by Bhaskara Rao.

CH4806 : Polymer Technology - II (3 1 0)

Unit I : Additives, Blends & Composites : Additives, Plasticizers, Fillers & Reinforcements, Stabilizers, Flame Retardants, Biocides, Processing Additives, Colorants, Polymer Blends, Interpenetrating Network, Introduction to Polymer Composites, Composite Fabrication.

Unit II : Polymer Reaction : Hydrolysis, Acidolysis, Aminolysis, Hydrogenation, Addition and Sustitution Reaction, Reaction of Various Specific Groups, Cross linking Reaction, Reaction Leading of Graft & Block Copolymers, Miscellaneous Reactions.

Unit III : Experimental Methods : Polymers Synthesis, Isolation and Purification of Polymers, Polymer Fractionation, Molecular Weight Determination, Molecular Weight Distribution Curve, determination of Glass transition Temperature.

Unit IV : Engineering and Specialty Polymers : Engineering Thermoplastics, Polyolefins, Vinyl Polymers, Polyamides, Polycarbonates, Polysulphone, Fluoropolymers, Inorganic Polymers, Thermoplastic Polyesters, Natural and Synthetic Rubber, Cellulose and its Derivatives.

Unit V : Polymer Processing & its Manufacturing : Basic Processing Operations, Extrusion, Modeling, Calendering, Coating, Injection Moulding, Compression Moulding, Transfer Moulding, Blow Moulding, Die Casting, Rotation Casting, Film Casting.

Books Recommended :

1. Polymer Science and Technology by Fried
2. Outlines of Polymer Technology by Sinha PHI
