## ANNA UNIVERSITY : CHENNAI 600 025
### UNIVERSITY DEPARTMENTS

**R - 2008**

**B.TECH. CHEMICAL ENGINEERING**

**III – VIII SEMESTERS CURRICULUM & SYLLABI**

### SEMESTER III

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* Including credit for Industrial Training

* training should be undergone by the student during the summer vacation of sixth semester

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**TOTAL** 18 2 10 26*

* Including credit for Industrial Training

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AIM

To facilitate the understanding of the principles and to cultivate the art of formulating physical problems in the language of mathematics.

OBJECTIVES

- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model physical processes.
- To develop Z-transform techniques which will perform the same task for discrete time systems as Laplace Transform, a valuable aid in analysis of continuous time systems.

UNIT I  FOURIER SERIES  9+3
Dirichlet’s conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series – Complex form of Fourier series – Parseval’s identity – Harmonic Analysis.

UNIT II  FOURIER TRANSFORM  9+3

UNIT III  PARTIAL DIFFERENTIAL EQUATIONS  9+3
Formation – Solutions of first order equations – Standard types and Equations reducible to standard types – Singular solutions – Lagrange’s Linear equation – Integral surface passing through a given curve – Solution of linear equations of higher order with constant coefficients.

UNIT IV  APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS  9+3
Method of separation of Variables – Solutions of one dimensional wave equation and one-dimensional heat equation – Steady state solution of two-dimensional heat equation – Fourier series solutions in Cartesian coordinates.

UNIT V  Z–TRANSFORM AND DIFFERENCE EQUATIONS  9+3

L: 45, T: 15, TOTAL : 60 PERIODS

TEXT BOOK

REFERENCES
AIM
To learn fundamental and applied aspects of organic chemistry towards different applications.

OBJECTIVE
• To acquire knowledge about chemical bonding, hybridization, bond fission, different types of chemical reactions and their mechanism, isomerism in organic molecules, synthesis of organic compounds and various applications of organic products.

UNIT I  STRUCTURAL CONCEPT OF ORGANIC MOLECULES  5

UNIT II  REACTION AND THEIR MECHANISM  10

UNIT III  ISOMERISM  6

UNIT IV  HYDROCARBONS AND THEIR CLASSIFICATION  10

UNIT V  SYNTHETIC ORGANIC CHEMISTRY  14

APPLIED ORGANIC CHEMISTRY

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
AIM
To know the principle and importance of various analytical instruments used for the characterization of various materials

OBJECTIVES
- To have thorough understanding of theory, instrumentation and applications of analytical equipments used in industries for testing quality of raw materials, intermediates and finished products
- To know the importance of analytical instrumentation during the purification, compounding and formulating the finished product

UNIT I INTRODUCTION TO SPECTROSCOPICAL METHODS OF ANALYSIS 12
ELECTROMAGNETIC RADIATION: Various ranges, Dual properties, Various energy levels, Interaction of photons with matter, absorbance & transmittance and their relationship, Permitted energy levels for the electrons of an atom and simple molecules, Classification of instrumental methods based on physical properties
QUANTITATIVE SPECTROSCOPY: Beer -Lambert's law, Limitations, Deviations (Real, Chemical, Instrumental), Estimation of inorganic ions such as Fe, Ni and estimation of Nitrite using Beer -Lambert's Law

UNIT II UV AND VISIBLE SPECTROCOPY 12
Various electronic transitions in organic and inorganic compounds effected by UV, and Visible radiations, Various energy level diagrams of saturated, unsaturated and carbonyl compounds, excitation by UV and Visible radiations, Choice of solvents, cut off wavelengths for solvents, Lamda max and epsilon max rules, Woodward -Fieser rules for the calculation of absorption maxima (Lamda max) for dienes and carbonyl compounds, Effects of auxochromes and effects of conjugation on the absorption maxima, Different shifts of absorption peaks( Batho chromic, hypsochromic, hypochromic), Multicomponent analysis (no overlap, single way overlap and two way overlap), Instrumentation for UV and VISIBLE spectrophotometers (source, optical parts and detectors), Photometric titration (Experimental set -up and various types of titrations and their corresponding curves), Applications of UV and VISIBLE spectroscopies

UNIT III IR , RAMAN AND ATOMIC SPECTROSCOPY 10
Theory of IR spectroscopy, Various stretching and vibration modes for diatomic and triatomic molecules (both linear and nonlinear), various ranges of IR (Near, Mid, Finger print and Far) and their usefulness, Instrumentation (Only the sources and detectors used in different regions), sample preparation techniques, Applications.Raman spectroscopy: Theory, Differences between IR and Raman. Atomic absorption spectrophotometry: Principle, Instrumentation (Types of burners, Types of fuels, Hollow cathode lamp, Chopper only) and Applications, Various interferences observed in AAS (Chemical, radiation and excitation) Flame photometry: Principle, Instrumentation, quantitative analysis (Standard addition method and internal standard method) and applications
Differences between AAS and FES.

UNIT IV THERMAL METHODS 5
Thermogravimetry: Theory and Instrumentation, factors affecting the shapes of thermograms (Sample Characteristics and instrumental characteristics), thermograms of some important compounds (CuSO4, 5H2O, CaC2O4, 2H2O, MgC2O4, Ag2CrO4, Hg2CrO4, AgNO3 etc), applications. Differential thermal analysis: Principle, Instrumentation and applications, differences between DSC and DTA. Applications of DSC (Inorganic and Polymer samples)
UNIT V CHROMATOGRAPHIC METHODS
Classification of chromatographic methods, Column, Thin layer, Paper, Gas, High Performance Liquid Chromatographical methods (Principle, mode of separation and Technique). Separation of organic compounds by column and Thin layer, mixture of Cu, Co and Ni by Paper, separation of amino acids by paper, estimation of organic compounds by GC and HPLC

TOTAL : 45 PERIODS

REFERENCES
5. Day R.A Underwood A.L Qualitative Inorganic analysis ( A. I. Vogel).
7. Sharma, B.K., Instrumental Methods of Analysis, Goel publishing House,1995

CH9203 MECHANICS OF SOLIDS

AIM
To given them knowledge on structural, Mechanical properties of Beams, columns.

OBJECTIVE
- The students will be able to design the support column, beams, pipelines, storage tanks and reaction columns and tanks after undergoing this course. This is precursor for the study on process equipment design and drawing.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS

UNIT II TRANSVERSE LOADING ON BEAMS

UNIT III DEFLECTIONS OF BEAMS
Double integration method – Macaulay’s method – Area – moment theorems for computation of slopes and deflections in beams – conjugate beam method

UNIT IV STRESSES IN BEAMS
UNIT V  
TORSION  
Torsion of circular shafts – derivation of torsion equation \( T/J = C/R = G0/L \) – stress and deformation in circular and hollow shafts – stresses and deformation in circular and hollow shafts – stepped shafts – shafts fixed at both ends – stresses in helical springs – deflection of springs – spring constant 

COLUMNS  
Axially loaded short columns – columns of unsymmetrical sections – Euler’s theory of long columns – critical loads for prismatic columns with different end conditions – effect of eccentricity.

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCE

CH9204  
BASIC MECHANICAL ENGINEERING  
L T P C  
3 0 0 3

AIM  
To impart knowledge on thermodynamics and thermal engineering power generating units such as engines and theory of machines

OBJECTIVE
- Students should learn thermodynamics and thermal engineering to understand the principles behind the operation of thermal equipments like IC engines and turbines etc., Students should be able to appreciate the theory behind operation of machinery and be able to design simple mechanisms

UNIT I  
LAWS OF THERMODYNAMICS  
Basic concepts and hints; Zeroth law; First Law of Thermodynamics - Statement and application; Steady flow energy equation-problems; Second law of Thermodynamics – Kelvin - Plank statement and Clausius statement problems; Limitations; Heat Engine, Refrigerator and Heat Pump, Available energy, Equivalence entropy; Reversibility: Entropy charts; Third law of Thermodynamics - Statement.

UNIT II  
HEATING AND EXPANSION OF GASES  
Expressions for work done, Internal energy and heat transfer for Constant Pressure, Constant Volume, Isothermal, Adiabatic and Polytropic processes-Derivations and problems; Free expansion and Throttling process.

UNIT III  
AIR STANDARD CYCLES  
Carnot cycle; Stirlings cycle; Joule cycle; Otto cycle; Diesel cycle; Dual combustion Cycle-Derivations and problems.
UNIT IV  I.C. ENGINES, STEAM AND ITS PROPERTIES AND STEAM TURBINES
Engine nomenclature and classification; SI Engine; CI Engine; Four Stroke cycle, Two stroke cycle; Performance of I.C. Engine; Brake thermal efficiency; Indicated Thermal Efficiency, Specific fuel consumption. Steam - Properties of steam; Dryness fraction; latent heat; Total heat of wet steam; Dry steam; Superheated steam. Use of steam tables; volume of wet steam, volume of superheated steam; External work of evaporation; Internal energy; Entropy of vapour, Expansion of vapour, Rankine cycle. Steam turbines – Impulse and Reaction types - Principles of operation.

UNIT V  SIMPLE MECHANISM, FLY WHEEL, DRIVES AND BALANCING
Definition of Kinematic Links, Pairs and Kinematic Chains; Working principle of Slider Crank mechanism and inversions; Double slider crank mechanism and inversions. Flywheel-Turning moment Diagram; Fluctuation of Energy. Belt and rope drives; Velocity ratio; slip; Creep; Ratio of tensions; Length of belt; Power Transmitted; gear trains-types. Balancing of rotating masses in same plane; Balancing of masses rotating in different planes.

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
5. Kothandaraman and Dhomkundwar,": A course in Thermal Engineering (SI Units)", Dhanpat Rai and Sons, Delhi (2001)

CH9205  PROCESS CALCULATIONS

L T P C  3 0 0 3

AIM
The aim of this course is to give fundamental knowledge on material and energy balances and steady state simulation.

OBJECTIVE
-  To teach concept of degree of freedom and its application to solution of mass and energy balance equations for single and network of units and introduce to process simulators.

UNIT I  6
Units, dimensions and conversion; Process variables and properties; Degree of freedom.

UNIT II  11
Concept of material balance Material balance calculations not involving and involving single and multiple reactions including combustion Material balance calculations involving phase change.
UNIT III  
Heat capacity; Calculation of enthalpy changes without phase change; Energy balance calculations without and with reactions including combustion.

UNIT IV  
Simultaneous material and energy balance calculations for Humidification, vaporization, condensation, mixing, crystallization.

UNIT V  
Material balance and energy balance calculations for network of units without and with recycle. Demonstration of ASPEN Process Simulator

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCE

CH9206 FLUID MECHANICS L T P C  
3 0 0 3  

AIM  
To understand the principles and applications fluid mechanics.

OBJECTIVE
- To impart to the student knowledge on fluid properties, fluid statics, dynamic characteristics for through pipes and porous medium, flow measurement and fluid machineries

UNIT I  
Methods of analysis and description - fluid as a continuum – Velocity and stress field - Newtonian and non-Newtonian fluids – Classification of fluid motion

UNIT II  
Fluid statics – basic equation - equilibrium of fluid element – pressure variation in a static fluid - application to manometry – Differential analysis of fluid motion – continuity, Euler’s and Bernoulli equation

UNIT III  
The principle of dimensional homogeneity – dimensional analysis, the Pi-theorem - non-dimensional action of the basic equations - similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies

UNIT IV  
Reynolds number regimes, internal flow - flow through pipes – pressure drop under laminar and turbulent flow conditions – major and minor losses; Line sizing; External flows - boundary layer concepts, boundary layer thickness under laminar and turbulent flow conditions- Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds.
UNIT V
Flow measurement - Constant and variable head meters; Velocity measurement techniques; Types, characteristics and sizing of valves; Classification, performance characteristics and sizing of pumps, compressors and fans

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES

CY9212 ORGANIC CHEMISTRY LAB L T P C 0 0 4 2
(Common to Chemical and Petroleum Refining & Petrochemicals )

OBJECTIVE
To learn basic principles involved in analysis and synthesis of different organic derivatives.

LIST OF EXPERIMENTS
1. Analysis of nature of organic compounds – To identify aliphatic/aromatic, saturated/unsaturated compounds.
2. Identification and characterization of various functional groups by their characteristic reactions: a) alcohol, b) aldehyde, c) ketone, d) carboxylic acid, e) phenol, f) ester, g) primary, secondary and tertiary amines h) amide i) nitro compounds.
5. Analysis of proteins.
6. Methodology of filtration and recrystallization.
7. Introduction to organic synthetic procedures:
   i. Acetylation – Preparation of acetanilide from aniline.
   ii. Hydrolysis – Preparation of salycilic acid from methyl salycilate.
   iii. Substitution – Conversion of acetone to iodoform.
   iv. Nitration – Preparation of m-dinitrobenzene from nitrobenzene.
   v. Oxidation – Preparation of benzoic acid from benaldehyde/ benzyl alcohol

TOTAL : 60 PERIODS

REFERENCE MANUAL
EE9214  ELECTRICAL ENGINEERING LABORATORY  L T P C

AIM
To provide the practical knowledge and control methods of electrical machines

OBJECTIVE
- To impart practical knowledge on
- Characteristic of different machines
- Method of speed control of machines
- Measurement of various electrical parameters

LIST OF EXPERIMENTS
1. Study of DC & AC Starters
2. Study of Transducers
3. Wheatstone Bridge and Schering Bridge
4. ADC and DAC Converters
5. Speed Control of DC Shunt Motor
6. Load Test on DC Shunt Motor
7. OCC & Load Characteristics of DC Shunt Generator
8. Load Test on Single-Phase Transformer
9. Load Test on Three-Phase Induction Motor
10. Load Test on Single-Phase Induction Motor.

TOTAL : 60 PERIODS

MA9262  NUMERICAL METHODS  L T P C

AIM
This course gives a complete procedure for solving numerically different kinds of problems occurring in engineering and technology.

OBJECTIVE
- The students would be acquainted with the basic concepts of numerical methods and their applications.

UNIT I  SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS  9 +3

UNIT II  INTERPOLATION AND APPROXIMATION  9 + 3
Interpolation with unequal intervals – Lagrange interpolation – Newton’s divided difference interpolation – Cubic Splines – Interpolation with equal intervals – Newton’s forward and backward difference formulae.

UNIT III  NUMERICAL DIFFERENTATION AND INTEGRATION  9 + 3
UNIT IV  INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS  9 + 3

UNIT V  BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS  9 + 3
Finite difference methods for solving two-point linear boundary value problems. Finite difference techniques for the solution of two dimensional Laplace’s and Poisson’s equations on rectangular domain – One dimensional heat-flow equation by explicit and implicit (Crank Nicholson) methods - One dimensional wave equation by explicit method.

L: 45, T: 15, TOTAL : 60 PERIODS

TEXT BOOKS

REFERENCES

CY9261  PHYSICAL CHEMISTRY  L T P C  3 0 0 3
(Common to Chemical, Textile, Leather and Petroleum Refining & Petrochemicals )

AIM
To know the basic concepts of physical chemistry and its applications.

OBJECTIVE
• To acquire knowledge in the field of electrochemistry, solubility behaviour, chemical reaction kinetics, photochemical reactions and colloidal chemistry towards different applications.

UNIT I  ELECTROCHEMISTRY  9

UNIT II  IONIC EQUILIBRIA  9
UNIT III CHEMICAL KINETICS

UNIT IV PHOTOCHEMISTRY

UNIT V COLLOIDS

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES

CH9253 CHEMICAL ENGINEERING THERMODYNAMICS- I

AIM
To introduce fundamental thermodynamic principles and their application

OBJECTIVES
- Students will learn PVT behaviour of fluids, laws of thermodynamics, thermodynamic property relations and their application to fluid flow, power generation and refrigeration processes.

UNIT I
Scope of thermodynamics; Definition of system, control volume, state and path function, equilibrium, reversibility, energy, work and heat. zeroth law; temperature scales

UNIT II
PVT behaviour of fluids; Mathematical representation of PVT behaviour; Generalized compressibility factor correlation; Generalized equations of state
UNIT III  
Joule’s experiment, internal energy, first law, energy balance for closed systems, mass and energy balance for open systems. Statements of the second law of thermodynamics, heat engine and refrigerator, Carnot cycle and Carnot theorems, thermodynamic temperature scale, entropy and its calculation, second law of thermodynamics for a control volume, Third law of thermodynamics, entropy from a microscopic point of view.

UNIT IV  
Thermodynamic potentials – internal energy, enthalpy, Helmholtz free energy, Gibbs free energy; thermodynamic property relations – Maxwell relations – partial derivatives and Jacobian method; residual properties; thermodynamic property tables and diagrams.

UNIT V  
Duct flow of compressible fluids, Compression and expansion processes, steam power plant, internal combustion engines, jet and rocket engines, refrigeration – vapour compression and absorption refrigeration cycles; liquefaction processes.

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES

CH9254  MECHANICAL OPERATIONS  L T P C
3 0 0 3

AIM
To impart knowledge on solid handling and solid liquid separation

OBJECTIVE
- The students will learn characterization of solids, size reduction, techniques of solid – fluid separation and mixing

UNIT I
General characteristics of solids, different techniques of size analysis, shape factor, surface area determination, estimation of particle size. Screening methods and equipment, screen efficiency, ideal and actual screens.

UNIT II
Laws of size reduction, energy relationships in size reduction, methods of size reduction, classification of equipments, crushers, grinders, disintegrators for coarse, intermediate and fine grinding, power requirement, work index; size enlargement - principle of granulation, briquetting, pelletisation, and flocculation.
UNIT III
Gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - continuous centrifuges, super centrifuges, design of basket centrifuges; industrial dust removing equipment, cyclones and hydro cyclones, electrostatic and magnetic separators, heavy media separations, floatation, jigging

UNIT IV
Theory of filtration, Batch and continuous filters, Flow through filter cake and filter media, compressible and incompressible filter cakes, filtration equipments - selection, operation and design of filters and optimum cycle of operation, filter aids.

UNIT V
Mixing and agitation - Mixing of liquids (with or without solids), mixing of powders, selection of suitable mixers, power requirement for mixing. Storage and Conveying of solids - Bunkers, silos, bins and hoppers, transportation of solids in bulk, conveyer selection, different types of conveyers and their performance characteristics.

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCE

CH9255 HEAT TRANSFER L T P C
3 0 0 3

AIM
To understand the principles and applications heat transfer

OBJECTIVE
- To learn heat transfer by conduction, convection and radiation and heat transfer equipments like evaporator and heat exchanger

UNIT I

UNIT II
Concepts of heat transfer by convection - Natural and forced convection, analogies between transfer of momentum and heat - Reynold's analogy, Prandtl and Coulburn analogy. Dimensional analysis in heat transfer, Correlations for the calculation of heat transfer coefficients, heat transfer coefficient for flow through a pipe, flow through a non circular conduit, flow past flat plate, flow through packed beds. Heat transfer by natural convection.
UNIT III
Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, effect of non-condensable gasses on rate of condensation. Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling.

UNIT IV
Theory of evaporation - single effect and multiple effect evaporation - Design calculation for single and multiple effect evaporation. Radiation heat transfer - Emissive power, Black body radiation, Emissivity, Stefan - Boltzman law, Plank’s law, radiation between surfaces.

UNIT V
Parallel and counter flow heat exchangers - Log mean temperature difference - Single pass and multipass heat exchangers; plate heat exchangers; use of correction factor charts; heat exchangers effectiveness; number of transfer unit - Chart for different configurations - Fouling factors

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES

CH9259 MATERIAL SCIENCE AND TECHNOLOGY L T P C
3 0 0 3

AIM
To impart knowledge in material properties and manufacturing methods

OBJECTIVE
  • Students will be able to understand various material and its properties and manufacturing methods

UNIT I INTRODUCTION

UNIT II MECHANICAL BEHAVIOUR
UNIT III PHASE DIAGRAMS AND PHASE TRANSFORMATIONS 8

UNIT IV FERROUS, NON-FERROUS METALS AND COMPOSITES 10
Pig iron, Cast iron, Mild Steel-properties, Applications and Manufacturing methods; Stainless steels, Special Alloy steels-properties and uses; Heat treatment of plain-carbon steels. Manufacturing methods of Lead, Tin and Magnesium. Properties and applications in process industries. FRP-Fiber Reinforced Plastics (FRP), Different types of manufacturing methods; Asphalt and Asphalt mixtures; Wood.

UNIT V NANOMATERIALS 9

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES

CY9262 TECHNICAL ANALYSIS LAB L T P C
(Common to Chemical and Petroleum Refining & Petrochemicals) 0 0 4 2

OBJECTIVE
- To learn basic principles involved in estimation and characterization of industrially important materials.

I. Soap Analysis
   a. Estimation of total fatty acid
   b. Estimation of percentage alkali content

II. Oil Analysis
   a. Estimation of free acid
   b. Determination of Saponification value
   c. Determination of iodine value

III. Cement Analysis
   a. Estimation of Silica content
   b. Estimation of mixed oxide content
   c. Estimation of calcium oxide content
   d. Estimation of calcium oxide by rapid method
IV. Coal Analysis
   a. Estimation of Sulphur present in coal
   b. Ultimate analysis of coal
   c. Proximate analysis of coal
V. Analysis of Bleaching Powder
   a. Estimation of available chlorine
VI. Analysis of Glycerol
   a. Estimation of purity of glycerol
VII. Analysis of fuels
   a. Flash point  b. Fire point  c. Cloud point  d. Pour point  e. Aniline point.

TOTAL : 60 PERIODS

REFERENCE MANUAL

CH9257 MECHANICAL ENGINEERING LAB  L T P C
                                           0 0 4 2

AIM
To impart practical knowledge in operating IC engines and conduct experiments. To understand test procedures in testing material for engineering applications

OBJECTIVES
• Students will be able to understand Power-generating units such as engines and operate IC engines and conduct tests. They will be able to appreciate the theory behind the functioning of engines. Material properties, their behavior under different kinds of loading and testing can be visualized.

LIST OF EXPERIMENTS *
1. Port timing diagram
2. Valve timing diagram
3. Study of 2,4 stroke I C Engines
4. Load test on 4-stroke petrol engine
5. Performance test on 4-stroke single cylinder diesel engine
6. Performance test on 4-stroke twin cylinder diesel engine
7. Heat balance test on diesel engines
8. Tension test
9. Compression test
10. Deflection test
11. Hardness test (Rockwell and Brinell)
12. Spring test
13. Torsion test
14. Impact test

TOTAL : 60 PERIODS

* Minimum 10 experiments shall be offered
AIM
To understand the concepts of fluid mechanics through experiments

OBJECTIVE
- To learn experimentally to calibrate flowmeters, find pressure loss for fluid flows and determine pump characteristics.

LIST OF EXPERIMENTS
1. Viscosity measurement of non-Newtonian fluids
2. Calibration of constant and variable head meters
3. Calibration of weirs and notches
4. Open drum orifice and draining time
5. Flow through straight pipe
6. Flow through annular pipe
7. Flow through helical coil and spiral coil
8. Losses in pipe fittings and valves
9. Characteristic curves of pumps
10. Pressure drop studies in packed column
11. Hydrodynamics of fluidized bed
12. Drag coefficient of solid particle

EQUIPMENT REQUIRED
1. Viscometer
2. Venturi meter
3. Orifice meter
4. Rotameter
5. Weir
6. Open drum with orifice
7. Pipes and fittings
8. Helical and spiral coils
9. Centrifugal pump
10. Packed column
11. Fluidized bed

TOTAL: 60 PERIODS

AIM
To present the stages involved in the large scale manufacture of different chemicals.

OBJECTIVES
- To gain knowledge on unit processes and unit operations involved in the manufacture of different chemicals in different industries like chloro-alkali, petroleum, pharmaceutical, fertilizer etc.

UNIT I
Introduction to chemical processing; symbolic representation of different unit operations and unit processes to build a flowsheet

UNIT II
Chlor-Alkali- Industries, Cement, Glass and ceramics, Pulp and paper.
UNIT III  
Oil, Soap and Detergent, Petroleum Refining, Petrochemicals, Polymers

UNIT IV  
Pharmaceuticals, Chemical Explosives, Paints and Pigments.

UNIT V  
Dyes and intermediates, Fertilizers, Sugar, Food Products

TOTAL : 45 PERIODS

TEXT BOOKS

CH9302  
CHEMICAL ENGINEERING THERMODYNAMICS II

AIM  
To present thermodynamic principles from a chemical engineering viewpoint.

OBJECTIVE
- The Students will be well versed with the behavior of fluids under PVT conditions and also apply them for practical purpose. Main advantage will be to deal with power production and refrigeration processes. The study further provides a comprehensive exposition to theory and application of solution thermodynamics.

UNIT I  
PROPERTIES OF SOLUTIONS
Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation, excess properties of mixtures.

UNIT II  
PHASE EQUILIBRIA
Criteria for equilibrium between phases in multi component non-reacting systems in terms of chemical potential and fugacity, application of phase rule, vapour-liquid equilibrium, phase diagrams for homogeneous systems and for systems with a miscibility gap, effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium, ternary liquid-liquid equilibrium.

UNIT III  
CORRELATION AND PREDICTION OF PHASE EQUILIBRIA
Activity coefficient-composition models, thermodynamic consistency of phase equilibria, application of the correlation and prediction of phase equilibria in systems of engineering interest particularly to distillation and liquid extraction processes.

UNIT IV  
CHEMICAL REACTION EQUILIBRIA
Definition of standard state, standard free energy change and reaction equilibrium constant, evaluation of reaction equilibrium constant, prediction of free energy data, equilibria in chemical reactors, calculation of equilibrium compositions for homogeneous chemical reactors, thermodynamic analysis of simultaneous reactions.

UNIT V  
REFRIGERATION

L : 45, T : 15 , TOTAL: 60 PERIODS
TEXT BOOKS

REFERENCES

CH9304 MASS TRANSFER I L T P C
3 0 0 3

AIM
To impart knowledge on fundamentals of mass transfer phenomena and rate based mass transfer operations.

OBJECTIVE
● Students will learn to determine mass transfer rates under laminar and turbulent conditions and apply these concepts in the design of humidification columns, dryers and crystallisers.

UNIT I
9
Introduction to mass transfer operations; Molecular diffusion in gases, liquids and solids; diffusivity measurement and prediction; multi-component diffusion.

UNIT II
10
Eddy diffusion, concept of mass transfer coefficients, theories of mass transfer, different transport analogies, application of correlations for mass transfer coefficients, inter phase mass transfer, relationship between individual and overall mass transfer coefficients.

UNIT III
9
Humidification – Equilibrium, humidity chart, adiabatic and wet bulb temperatures; humidification operations; theory and design of cooling towers, dehumidifiers and humidifiers using enthalpy transfer unit concept.

UNIT IV
9
Drying– Equilibrium; classification of dryers; batch drying – Mechanism and time of cross through circulation drying, continuous dryers – material and energy balance; determination of length of rotary dryer using rate concept.

UNIT V
8
Crystallization - Equilibrium, classification of crystallizers, mass and energy balance; kinetics of crystallization – nucleation and growth; design of batch crystallizers; population balance model and design of continuous crystallizers.

TOTAL : 45 PERIODS

TEXT BOOKS
REFERENCES

CH9305 CHEMICAL REACTION ENGINEERING I

AIM
To impart knowledge to design different types of chemical reactors

OBJECTIVES
- Students gain knowledge on different types of chemical reactors, the design of chemical reactors under isothermal and non-isothermal conditions

UNIT I 10
Rate equation, elementary, non-elementary reactions, theories of reaction rate and temperature dependency; Design equation for constant and variable volume batch reactors, analysis of experimental kinetics data, integral and differential analysis.

UNIT II 10
Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, combination of reactors, size comparison of reactors.

UNIT III 7
Design of reactors for multiple reactions - consecutive, parallel and mixed reactions - factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield.

UNIT IV 10
Non-isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for different reactors, design for constant rate input and constant heat transfer coefficient, operation of batch and continuous reactors, optimum temperature progression.

UNIT V 8
The residence time distribution as a factor of performance; residence time functions and relationship between them in reactor; basic models for non-ideal flow; conversion in non-ideal reactors

L : 45, T : 15, TOTAL : 60 PERIODS

TEXT BOOKS

REFERENCE
AIM
The aim of this course is to create awareness in every engineering graduate about the importance of environment, the effect of technology on the environment and ecological balance and make them sensitive to the environment problems in every professional endeavour that they participates.

OBJECTIVE
• At the end of this course the student is expected to understand what constitutes the environment, what are precious resources in the environment, how to conserve these resources, what is the role of a human being in maintaining a clean environment and useful environment for the future generations and how to maintain ecological balance and preserve bio-diversity. The role of government and non-government organization in environment managements.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY
Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.
Field study of common plants, insects, birds
Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION
Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – soil waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides.
Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES
Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.
Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.
UNIT IV    SOCIAL ISSUES AND THE ENVIRONMENT

UNIT V   HUMAN POPULATION AND THE ENVIRONMENT

TOTAL: 45 PERIODS

TEXT BOOKS

REFERENCES

GE 9371    COMMUNICATION SKILLS AND SOFT SKILLS LAB

AIM
To enhance the overall capability of students and to equip them with the necessary Communication Skills and Soft Skills that would help them excel in their profession.

OBJECTIVES
- To equip students of engineering and technology with effective speaking and listening skills in English.
- To help them develop their soft skills and interpersonal skills, which will make the transition from college to workplace smoother and help them excel in their job.
- To enhance the performance of students at Placement Interviews, Group Discussions and other recruitment exercises.

1. PC based session
   A. Career Lab  (15 periods) Viewing and discussing audio-visual materials

1. Resume / Report Preparation / Letter Writing: (3)
   Letter writing – Job application with Resume - Project report - Email etiquette.
2. **Presentation skills:** (3)
   Elements of effective presentation – Structure of presentation - Presentation tools – Body language.

3. **Soft Skills:** (3)
   Time management – Stress management – Assertiveness – Negotiation strategies, Psychometrics - Analytical and logical reasoning.

4. **Group Discussion:** (3)
   Group discussion as part of selection process, Structure of group discussion – Strategies in group discussion – Mock group discussions.

5. **Interview Skills:** (3)
   Kinds of interviews – Interview techniques – Corporate culture – Mock interviews.

**TOTAL : 45 PERIODS**

**II. Class Room Session**

1. **Resume / Report Preparation / Letter writing:** Students prepare their own resume and report. (9)
2. **Presentation Skills:** Students make presentations on given topics. (12)
3. **Group Discussion:** Students participate in group discussions. (12)
4. **Interview Skills:** Students participate in Mock Interviews (12)

**Note:** Classroom sessions are practice sessions.

**REFERENCES**


**Lab Requirement:**

1. Teacher console and systems for students.
2. English Language Lab Software
3. Tape recorders

**CH9307  MECHANICAL OPERATIONS LABORATORY**

**AIM**

To impart knowledge on mechanical operations by practice

**OBJECTIVES**

- Students develop a sound working knowledge on different types of crushing equipments and separation characteristics of different mechanical operation separators.

**LIST OF EXPERIMENTS**

1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press
4. Characteristics of batch Sedimentation
5. Reduction ratio in Jaw Crusher
6. Reduction ratio in Ball mill
7. Separation characteristics of Cyclone separator
8. Reduction ratio of Roll Crusher
9. Separation characteristics of Elutriator
10. Reduction ratio of Drop weight crusher
11. Size separation using Sub-Sieving

**EQUIPMENT REQUIRED**
1. Sieve shaker
2. Leaf filter
3. Plate and Frame Filter Press
4. Sedimentation Jar
5. Jaw Crusher
6. Ball Mill
7. Cyclone Separator
8. Roll Crusher
9. Elutriator
10. Drop Weight Crusher
11. Sieves.

**CH9308**
**HEAT TRANSFER LABORATORY**

**AIM**
To impart knowledge on heat transfer operation by practice

**OBJECTIVE**
- Students develop a sound working knowledge on different types of heat transfer equipments.

**LIST OF EXPERIMENTS**
1. Performance studies on Cooling Tower
2. Batch drying kinetics using Tray Dryer
3. Heat transfer in Open Pan Evaporator
4. Boiling Heat Transfer
5. Heat Transfer through Packed Bed
6. Heat Transfer in a Double Pipe Heat Exchanger
7. Heat Transfer in a Bare and Finned Tube Heat Exchanger
8. Heat Transfer in a Condenser
9. Heat Transfer in Helical Coils
10. Heat Transfer in Agitated Vessels

**EQUIPMENT REQUIRED**
1. Cooling Tower
2. Tray Dryer
3. Open Pan Evaporator
4. Boiler
5. Packed Bed
6. Double Pipe Heat Exchanger
7. Bare and Finned Tube Heat Exchanger
8. Condenser
9. Helical Coil
10. Agitated Vessel.

**TOTAL : 60 PERIODS**
AIM
This course aims at providing the required skill to apply the statistical and Linear Programming tools for engineering problems.

OBJECTIVES
- The students will have a fundamental knowledge of the concepts of statistical inference
- Have the knowledge of applying Linear programming tools in management problems.

UNIT I TESTING OF HYPOTHESIS 9 + 3

UNIT II DESIGN OF EXPERIMENTS 9 + 3
Completely randomized design – Randomized block design – Latin square design - $2^2$ - factorial design.

UNIT III STATISTICAL QUALITY CONTROL 9 + 3
Control charts for measurements ($\bar{X}$ and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling

UNIT IV LINEAR PROGRAMMING 9 + 3
Formulation – Graphical solution – Simplex method – Big-M method - Transportation and Assignment models

UNIT V ADVANCED LINEAR PROGRAMMING 9 + 3
Duality – Dual simplex method – Integer programming – Cutting-plane method.

L: 45, T: 15, TOTAL: 60 PERIODS

TEXT BOOKS

REFERENCES
AIM
To impart knowledge on mass transfer operations

OBJECTIVES
- Students will learn fundamentals of absorber and stripper, distillation column, extraction and leaching equipments and adsorber.

UNIT I ABSORPTION 12
Gas Absorption and Stripping – Equilibrium; material balance; limiting gas-liquid ratio; tray tower absorber - calculation of number of theoretical stages, tray efficiency, tower diameter; packed tower absorber – rate based approach; determination of height of packing using HTU and NTU calculations.

UNIT II DISTILLATION 12
Vapour liquid equilibria - Raoult’s law, vapor-liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by Mc.Cabe - Thiele method and Ponchan - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio. Introduction to multi-component distillation, azeotropic and extractive distillation

UNIT III LIQUID-LIQUID EXTRACTION 12
Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for batch and continuous extractors- differential contact equipment-spray, packed and mechanically agitated contactors and their design calculations-packed bed extraction with reflux. Pulsed extractors, centrifugal extractors-Supercritical extraction

UNIT IV LEACHING 12
Solid-liquid equilibria- leaching equipment for batch and continuous operations- calculation of number of stages - Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (shank’s system), equipments for leaching operation, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.

UNIT V ADSORPTION AND ION EXCHANGE & MEMBRANE SEPARATION PROCESS 12
Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves. Principle of Ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.

L : 45 , T : 15 , TOTAL : 60 PERIODS

TEXT BOOKS

REFERENCES
AIM
To introduce non-ideal behavior of reactors and heterogeneous reactors

OBJECTIVES
- The objective is to study the non-ideal behavior of homogeneous reactors, gas-solid catalytic and non-catalytic reactors and gas-liquid reactors.

UNIT I  CATALYSTS  7
Nature of catalysts, surface area and pore-volume distribution, catalyst preparation.

UNIT II  HETEROGENEOUS REACTORS  10
Rate equations for heterogeneous reactions, adsorption isotherms, rates of adsorption and desorption, surface reaction analysis of rate equation and rate controlling steps.

UNIT III  GAS-SOLID CATALYTIC REACTORS  10
Diffusion within catalyst particle, effective thermal conductivity, mass and heat transfer within catalyst pellets, effectiveness factor, Thiele Modulus, fixed bed reactors.

UNIT IV  GAS-SOLID NON-CATALYTIC REACTORS  9
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.

UNIT V  GAS-LIQUID REACTORS  9
Absorption combined with chemical reactions; mass transfer coefficients and kinetic constants; application of film, penetration and surface renewal theories; Hatta number and enhancement factor for first order reaction, tower reactor design.

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCE

AIM
To familiarize the students with concepts of process dynamics and control leading to control system design.

OBJECTIVE
- To introduce dynamic response of open and closed loop systems, control loop components and stability of control systems along with instrumentation.
UNIT I INSTRUMENTATION
Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.

UNIT II OPEN LOOP SYSTEMS
Laplace transformation, 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; transportation lag.

UNIT III CLOSED LOOP SYSTEMS
Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability.

UNIT IV FREQUENCY RESPONSE
Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings

UNIT V ADVANCED CONTROL SYSTEMS
Introduction to advanced control systems, cascade control, feed forward control, Smith predictor controller, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES

CH9354 PLANT SAFETY AND RISK ANALYSIS
L T P C
3 0 0 3

AIM
To introduce awareness on the importance of plant safety and risk analysis

OBJECTIVES
- Students learn about implementation of safety procedures, risk analysis and assessment, hazard identification

UNIT I
Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling

UNIT II
Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety
UNIT III
Over all risk analysis--emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies. Quantitative risk assessment - rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

UNIT IV
Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough-Mexico-Madras-Vizag-Bopal analysis

UNIT V
Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop study-case studies-pumping system-reactor-mass transfer system.

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES

CH9355 CHEMICAL REACTION ENGINEERING LAB* L T P C 0 0 3 2

AIM
To impart knowledge on reaction engineering by practice

OBJECTIVES
- Students develop a sound working knowledge on different types of reactors.

LIST OF EXPERIMENTS
1. Kinetic studies in a batch reactor
2. Kinetic studies in a plug flow reactor
3. Kinetic studies in a PFR followed by a CSTR
4. RTD studies in a PFR
5. RTD studies in a packed bed
6. RTD studies in CSTRs in series
7. Studies on micellar catalysis
8. Study of temperature dependence of rate constant using CSTR.
9. Kinetic studies in sono-chemical reactor
10. Batch reactive distillation
11. Kinetics of photochemical reaction
12. Demonstration of heterogeneous catalytic reaction
13. Demonstration of gas-liquid reaction

EQUIPMENT REQUIRED
1. Batch reactor
2. Plug flow reactor
3. CSTR
4. Sono-chemical reactor
5. Photochemical reactor

*Minimum 10 experiments shall be offered.

TOTAL : 45 PERIODS

CH 9356 COMPUTATIONAL CHEMICAL ENGINEERING LABORATORY L T P C 0 0 4 2

AIM
To give practice to students to solve chemical engineering problems through programming and using computational tools.

OBJECTIVES
- Students will solve chemical engineering problems from core courses using C and MATLAB programming and also using computational tools like Excel and Aspen.

Programming in C
C programs will be written to solve problems from core courses of chemical engineering.

Microsoft Excel Software
The computational, plotting and programming abilities in Excel will be used to solve different chemical engineering problems.

Programming in MATLAB
Chemical engineering problems will be solved using the powerful computational and graphical capability of MATLAB.

ASPEN Software
Individual process equipments and flowsheets will be simulated using Aspen Plus and property analysis and estimation will be done using Aspen Properties.

Evaluation
This lab course will have two or three online assessment tests and an online end semester examination in the Process Simulation Laboratory and assignments in all the above four units.

TOTAL : 60 PERIODS

REFERENCE
Students are expected to present two seminars along with report on any recent topic in chemical engineering.

AIM
To give an overview of mass, momentum and energy transport, present the fundamental equations and illustrate how to use them to solve problems.

OBJECTIVES
- To describe mass, momentum and energy transport at molecular, microscopic and macroscopic level, to determine velocity, temperature and concentration profiles.

UNIT I  MOMENTUM TRANSPORT 8
Viscosity, temperature effect on viscosity of gases and liquids, Newton’s law, mechanism of momentum transport, shell balance method, pressure and velocity distributions in falling film, circular tube, annulus, slit.

UNIT II  EQUATIONS OF CHANGE AND TURBULENT FLOW 7
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.

UNIT III  ENERGY TRANSPORT 8
Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier’s law, mechanism of energy transport, shell energy balance, temperature distribution in solids and laminar flow, with electrical, nuclear, viscous, chemical heat source, heat conduction through composite walls, cylinders, spheres, fins, slits.

UNIT IV  EQUATIONS OF CHANGE FOR NONISOTHERMAL SYSTEM AND TEMPERATURE DISTRIBUTION IN TURBULENT FLOWS 9
Energy equations, special forms, 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 V  MASS TRANSPORT, EQUATIONS OF CHANGE FOR MULTICOMPONENT SYSTEMS AND CONCENTRATION DISTRIBUTION IN TURBULENT FLOWS 13
Diffusivity, temperature and pressure effect, Fick’s law, mechanism of mass transport, theory of diffusion in gases and liquids, shell mass balances, concentration distribution in solids and in laminar flow: stagnant gas film, heterogeneous and homogeneous chemical reaction systems, falling film, porous catalyst. The equation of continuity, summary of equations of change and fluxes, use of equations of change, dimensional analysis, time smoothed equations of change, empirical expressions for turbulent mass flux.

L : 45 , T : 15 , TOTAL : 60 PERIODS

TEXT BOOKS

REFERENCES
AIM
To give practice to students to design in detail different process equipments.

OBJECTIVES
- Students learn to do in detail process and mechanical design and engineering drawing of different chemical engineering equipments

UNIT I
Heat Exchangers, Condensers, Evaporators

UNIT II
Cooling Tower, Dryers

UNIT III
Absorption column, Distillation Column, Extraction Column, Adsorption column

UNIT IV
Packed bed Reactors, Pressure Vessel, Storage Vessel

UNIT V
Design of Plant Layout, Pipe Lines and Pipe Layouts, Schematics and Presentation, Materials of Construction and Selection of process equipments

REFERENCES
UNIT V
Introduction to optimization approaches to optimal design, role of simulations in process design, Design under uncertainty and failure tolerance, Engineering around variations, Introduction to process integration

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES

CH9404 PROCESS ECONOMICS L T P C
3 0 0 3

UNIT I INTRODUCTION

UNIT II CONSUMER AND PRODUCER BEHAVIOUR

UNIT III PRODUCT AND FACTOR MARKET

UNIT IV PERFORMANCE OF AN ECONOMY – MACRO ECONOMICS

UNIT V AGGREGATE SUPPLY AND THE ROLE OF MONEY

TOTAL : 45 PERIODS
TEXT BOOKS

CH9405 MASS TRANSFER LAB

AIM
To impart knowledge on mass transfer by practice

OBJECTIVE
- Students develop a sound working knowledge on different types of mass transfer equipments.

LIST OF EXPERIMENTS
1. Separation of binary mixture using simple distillation
2. Separation of binary mixture using Steam distillation
3. Separation of binary mixture using Packed column distillation
4. Measurement of diffusivity
5. Liquid-liquid extraction
6. Drying characteristics of Vacuum Dryer
7. Drying characteristics of Tray dryer
8. Drying characteristics of Rotary dryer
9. Water purification using ion exchange columns
10. Mass transfer characteristics of Rotating disc contactor
11. Estimation of mass/heat transfer coefficient for cooling tower
12. Demonstration of Gas – Liquid absorption

EQUIPMENTS REQUIRED
1. Simple distillation setup
2. Steam distillation setup
3. Packed column
4. Liquid-liquid extractor
5. Vacuum Dryer
6. Tray dryer
7. Rotary dryer
8. Ion exchange column
9. Rotating disc contactor
10. Cooling tower
11. Absorption column

Minimum 10 experiments shall be offered.

TOTAL : 60 PERIODS
LIST OF EXPERIMENTS
1. Response of first order system
2. Response of second order system
3. Response of Non-Interacting level System
4. Response of Interacting level System
5. Open loop study on a level system
6. Open loop study on a flow system
7. Open loop study on a thermal system
8. Closed loop study on a level system
9. Closed loop study on a flow system
10. Closed loop study on a thermal system
11. Tuning of a level system
12. Tuning of a flow system
13. Tuning of a thermal system
14. Flow co-efficient of control valves
15. Characteristics of different types of control valves

*Minimum 10 experiments shall be offered.

TOTAL : 60 PERIODS

CH9407 COMPREHENSION

The objective of the comprehension test is to assess the overall level of proficiency and the scholastic attainment of the student in the various subjects studied during the degree programme.

TOTAL : 30 PERIODS

CH9408 INDUSTRIAL TRAINING

1. The main objective of this industrial training is to expose them to real time operations and relate the concepts learnt in theory with practical operations.
2. The students are expected to undergo training in an industry for four weeks.
3. After successful completion of the training, the students submit a detailed technical report.

CH9451 PROJECT WORK

AIM
To initiate the ability of doing a complete plant design.

OBJECTIVE
- The objective of the project is to make use of the knowledge gained by the student at various stages of the degree course.
- Each student is required to submit a report on the project assigned to him by the department. The report should be based on the information available in the literature or data obtained in the laboratory/industry.
- Students, in addition to the home problem will be permitted to undertake industrial/consultancy project work, outside the department, in industries/Research labs for which proportional weightage will be given in the final assessment.
UNIT I  INTRODUCTION  5
Introduction to optimization; applications of optimization in chemical engineering; classification of optimization problems.

UNIT II  SINGLE VARIABLE OPTIMIZATION  9
Necessary and sufficient conditions for optimum; region elimination methods; interpolation methods; direct root methods.

UNIT III  MULTIVARIABLE OPTIMIZATION WITHOUT AND WITH CONSTRAINTS  9
Necessary and sufficient conditions for optimum; direct search methods; indirect search methods.

UNIT IV  OTHER OPTIMIZATION METHODS  9
Introduction to geometric, dynamic and integer programming and genetic algorithms.

UNIT V  APPLICATIONS OF OPTIMIZATION  13
Formulation of objective functions; fitting models to data; applications in fluid mechanics, heat transfer, mass transfer, reaction engineering, equipment design, resource allocation and inventory control.

TOTAL : 45 PERIODS

TEXT BOOKS
UNIT IV INORGANIC SEPARATIONS 9
Controlling factors, Applications, Types of Equipment employed for Electrophoresis, Dielectrophoresis, Ion Exchange Chromatography and Eletrodialysis, EDR, Bipolar Membranes.

UNIT V OTHER TECHNIQUES 9
Separation involving Lyophilisation, Pervaporation and Permeation Techniques for solids, liquids and gases, zone melting, Adductive Crystallization, other Separation Processes, Supercritical fluid Extraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques.

TOTAL: 45 PERIODS

REFERENCES
TEXT BOOKS

REFERENCES

CH9024 PROCESS MODELING AND SIMULATION

UNIT I INTRODUCTION
Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations.

UNIT II STEADY STATE LUMPED SYSTEMS
Degree of freedom analysis, single and network of process units, systems yielding linear and non-linear algebraic equations, flow sheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

UNIT III UNSTEADY STATE LUMPED SYSTEMS
Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

UNIT IV STEADY STATE DISTRIBUTED SYSTEM
Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.

UNIT V UNSTEADY STATE DISTRIBUTED SYSTEM & OTHER MODELLING APPROACHES

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
### CH9025  PROCESS PLANT UTILITIES  L T P C  3 0 0 3

#### UNIT I  IMPORTANT OF UTILITIES
9  
Hard and Soft water, Requisites of Industrial Water and its uses. Methods of water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening and Reverse Osmosis. Effects of impure Boiler Feed Water.

#### UNIT II  STEAM AND STEAM GENERATION
9  
Properties of Steam, problems based on Steam, Types of Steam Generator such as Solid Fuel Fired Boiler, Waste Gas Fired Boiler and Fluidized Bed Boiler. Scaling and Trouble Shooting. Steam Traps and Accessories.

#### UNIT III  REFRIGERATION
9  
Refrigeration Cycles, Methods of Refrigeration used in Industry and Different Types of Refrigerants such as Monochlorodifluoro Methane, Chlorofluoro Carbons and Brins. Refrigerating Effects and Liquefaction Processes.

#### UNIT IV  COMPRESSED AIR
9  

#### UNIT V  FUEL AND WASTE DISPOSAL
9  

#### TOTAL : 45 PERIODS

### REFERENCES

### CH9026  SUPPLY CHAIN MANAGEMENT  L T P C  3 0 0 3

#### UNIT I  INTRODUCTION
6  
Definition of Logistics and SCM: Evolution, Scope, Importance& Decision Phases – Drivers of SC Performance and Obstacles.

#### UNIT II  LOGISTICS MANAGEMENT
10  

#### UNIT III  SUPPLY CHAIN NETWORK DESIGN
10  

42
UNIT IV SOURCING, AND PRICING IN SUPPLY CHAIN  9
Supplier selection and Contracts - Design collaboration - Procurement process. Revenue management in supply chain

UNIT V COORDINATION AND TECHNOLOGY IN SUPPLY CHAIN  10
Supply chain coordination - Bullwhip effect – Effect of lack of co-ordination and obstacles – IT and SCM - supply chain IT frame work. eBusiness & SCM. Metrics for SC performance – Case Analysis

TOTAL : 45 PERIODS

REFERENCES
2. Logistics, David J.Bloomberg, Stephen Lemay and Joe B.Hanna, PHI 2002
4. Modeling the supply chain, Jeremy F.Shapiro, Thomson Duxbury, 2002

CH9027  ENERGY TECHNOLOGY  L T P C
UNIT I  ENERGY  8
Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources

UNIT II  CONVENTIONAL ENERGY  8
Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

UNIT III  NON-CONVENTIONAL ENERGY  10
Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

UNIT IV  BIOMASS ENERGY  10
Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.

UNIT V  ENERGY CONSERVATION  9
Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.

TOTAL : 45 PERIODS
TEXTBOOKS

REFERENCES

CH9028 ELECTROCHEMICAL ENGINEERING L T P C
3 0 0 3

UNIT I 9

UNIT II 9
Mass transfer in electrochemical systems: diffusion controlled electrochemical reaction –the importance of convention and the concept of limiting current. over potential, primary-secondary current distribution –rotating disc electrode.

UNIT III 10

UNIT IV 8

UNIT V 9
Electrodes used in different electrochemical industries: Metals-Graphite –Lead dioxide –Titanium substrate insoluble electrodes –Iron oxide –semi conducting type etc. Metal finishing- cell design. types of electrochemical reactors, batch cell, fluidized bed electrochemical reactor, filter press cell, Swiss roll cell, plug flow cell, design equation, figures of merits of different type of electrochemical reactors.

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
CH9029  PETROLEUM REFINING AND PETROCHEMICALS  L T P C  3 0 0 3

UNIT I  9

UNIT II  9
Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen.

UNIT III  9
Treatment Techniques: Removal of Sulphur Compounds in all Petroleum Fractions to improve performance, Solvent Treatment Processes, Dewaxing, Clay Treatment and Hydrofining.

UNIT IV  9
Cracking of Naphtha and Feed stock gas for the production of Ethylene, Propylene, Isobutylene and Butadiene. Production of Acetylene from Methane, Catalytic Reforming of Petroleum Feed Stocks and Extraction of Aromatics.

UNIT V  9
Production of Petrochemicals like Dimethyl Terephthalate (DMT), Ethylene Glycol, Synthetic Glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol and Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and Production of Carbon Black.

TOTAL : 45 PERIODS

TEXT BOOKS

CH9030  DRUGS AND PHARMACEUTICAL TECHNOLOGY  L T P C  3 0 0 3

UNIT I  INTRODUCTION  9
Development of drugs and pharmaceutical industry; organic therapeutic agents uses and economics

UNIT II  DRUG METABOLISM AND PHARMACO KINETICS & MICROBIOLOGICAL AND ANIMAL PRODUCTS  9
Drug metabolism; physico chemical principles; pharma kinetics-action of drugs on human bodies. Antibiotics- gram positive, gram negative and broad spectrum antibiotics; hormones

UNIT III  IMPORTANT UNIT PROCESSES AND THEIR APPLICATIONS  9
Chemical conversion processes; alkylation; carboxylation; condensation and cyclisation; dehydration, esterification, halogenation, oxidation, sulfonation; complex chemical conversions fermentation.
UNIT IV MANUFACTURING PRINCIPLES & PACKING AND QUALITY CONTROL 9
Compressed tablets; wet granulation; dry granulation or slugging; advancement in granulation; direct compression, tablet presses formulation; coating pills; capsules sustained action dosage forms; parenteral solutions, oral liquids; injections; ointments; standard of hygiene and manufacturing practice. Packing; packing techniques; quality control.

UNIT V PHARMACEUTICAL PRODUCTS & PHARMACEUTICAL ANALYSIS 9
Vitamins; cold remedies; laxatives; analgesics; nonsteroidal contraceptives; external antiseptics; antacids and others. Analytical methods and tests for various drugs and pharmaceuticals – spectroscopy, chromatography, fluorimetry, polarimetry, refractometry, pHmetry

TEXT BOOK

REFERENCES

CH9031 POLYMER TECHNOLOGY L T P C
3 0 0 3

UNIT I GENERAL ASPECTS OF POLYMERS 9
Classification, mechanisms and methods of polymerization, Properties-Molecular weight, Glass transition temperature, Crystallinity, thermal, Electrical and Mechanical properties

UNIT II APPLICATION ORIENTED POLYMERS 9
Resins – PVC, Silicon Oil and resins, fibrous Polymers – Nylon 66, Polycrylonitrile, adhesives-Epoxides, Phenol formaldehyde, Urea formaldehyde

UNIT III ELASTOMERS 9
Natural Rubber, Styrene – butadiene, Polysisopropene – Neoprene, Silicone rubber, Thermoplastic elastomers

UNIT IV PROCESSING OF POLYMERS 9
Processing additives, plasticizers, Antiaging additives, surface and optical properties, modifiers, fire retardants, additives for rubber and elastomers, various molding techniques

UNIT V PHYSICAL AND CHEMICAL TESTING OF PLASTICS 9
Mechanical properties, tensile strength and hardness, electrical properties, volume resistivity, dielectric strength, optical properties- glass, light transmission and refractive index, chemical analysis – elemental and functional analysis

TOTAL : 45 PERIODS

REFERENCES
UNIT I PROCESS INTENSIFICATION
Novel reactor configurations; combination of reaction and separation; use of different energy fields, lab on a chip.

UNIT II CHEMICAL PRODUCT DESIGN
Scope and importance; identification of needs and specifications; sources of ideas and screening ideas; selection of product idea; process development for product manufacture; specialty chemical manufacture; economic aspects.

UNIT III RENEWABLE ENERGY
Hydrogen production, Hydrogen economy, Fuel Cell Technology, biofuel cells and bio-hydrogen, solar energy

UNIT IV MATERIALS ENGINEERING
Polymers and composites, ceramics and glasses, colloidal dispersions and nanoparticles, thin films and electronic materials

UNIT V BIOENGINEERING
Biomechanics, biotransport and biomaterials, biomolecular and cellular engineering, drug discovery and development.

REFERENCES

GE9021 PROFESSIONAL ETHICS IN ENGINEERING

AIM
To sensitize the engineering students on blending both technical and ethical responsibilities.

OBJECTIVES
- Identify the core values that shape the ethical behavior of an engineer.
- Utilize opportunities to explore one’s own values in ethical issues.
- Become aware of ethical concerns and conflicts.
- Enhance familiarity with codes of conduct.
- Increase the ability to recognize and resolve ethical dilemmas.

UNIT I ENGINEERING ETHICS
UNIT II ENGINEERING AS SOCIAL EXPERIMENTATION
Engineering as Experimentation – Engineers as responsible Experimenters – Research Ethics - Codes of Ethics – Industrial Standards - A Balanced Outlook on Law – The Challenger Case Study

UNIT III ENGINEER’S RESPONSIBILITY FOR SAFETY

UNIT IV RESPONSIBILITIES AND RIGHTS

UNIT V GLOBAL ISSUES

TOTAL: 45 PERIODS

TEXT BOOKS

REFERENCES