RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

Chemical Engineering, V-Semester

CM-501 Mass Transfer-I

Course Objective

The purpose of this subject is to introduce the undergraduate students with the most important separation equipments in the process industry, and provide proper understanding of unit operations. This course explains the diffusion phenomena, fundamentals of mass transfer and techniques involved in mass transfer operations of distillation and absorption.

Unit I Diffusion phenomenon: Molecular and eddy diffusion in gases, liquids and solids, interface mass transfer, Mass transfer theories: film theory Penetration theory and surface renewal theory

Unit II Fundamentals of Mass Transfer: Individual and film coefficients, overall mass transfer coefficient and their inter relationships; Analogies in transfer processes, determination of mass transfer co-efficient; two phase flow in packed beds, co-current and counter current processes flooding loading, column internals: types of trays/ plates and packing, point and plate efficiency.

Unit III Distillation: Vapour liquid Equilibrium, Boiling point diagram, Relative volatility, flash and differential distillation for two component mixture, steam distillation, azeotropic distillation, extractive distillation.

Unit IV Continuous and Differential contact Distillation: Rectification, reflux ratio, calculation of numbers of plates by NTU, optimum reflux ratio, open steam, multiple feed and multiple product calculations, Enthalpy concentration diagram, Panchon-Savarit method for calculation of number of theoretical plates. Approximate equation; Fensky and Underwood equation for minimum numbers of plate calculation. Batch distillation.

Unit V Absorption: Absorption and Stripping of dilute mixtures: Fundamentals of absorption, equilibrium curves, Operating lines from material balances, co-current, Counter current and cross current contacting fluids, Design of absorption towers, Calculations of NTU and HTU, concept of HETP.

References:

1. Mc-Cabe W.L, Smith J.M.; Unit Operation in Chemical Engineering; Tat Mc-GrawHill.
2. Coulson J. M. Richardson; Chemical Engineering – Vol 2; Butterworth Heinmann, Oxford, Delhi
3. Treybal R.E; Mass Transfer Operation; Mc. Graw Hill.

4. Sherwood, T.K. Pigford R.L. and Wilke, C.R.; Mass Transfer; Mc. Graw Hill.

List of Experiment (Pl. expand it):

1. To determine to diffusion coefficient of liquid vapour in air by Stefan's tube.
2. To determine diffusion coefficient, or diffusivity, of given liquid in air.
3. To determine Mass Transfer Co-Efficient in gas liquid system by evaporation
4. To study the rates and phenomena of diffusion into gases flowing through the pipe.
5. To study different types of plates and packing.
6. To prepare the vapor-liquid equilibrium and Boiling point diagram for a binary liquid mixture.
7. Determination of relative volatility of a given system of acetic acid and water.
8. To verify Rayleigh equation for differential distillation of binary system.
9. To carry out the steam distillation.
10. Studies on packed tower distillation unit.
11. Studies on the sieve plate distillation unit.
12. Studies on bubble cap distillation column.
13. To study the absorption of a gas in a packed column and calculation of NTU and HTU.

Note: Each student should perform at least eight experiments out of the above list.

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New Scheme Based On AICTE Flexible Curricula

Chemical Engineering, V-Semester

CM-502 Heat Transfer

Course Objective

To understand the fundamentals of heat transfer mechanisms in fluids and solids and their applications in various heat transfer equipment in process industries.

Unit I Conduction: Modes of heat transfer one dimensional and two dimensional, heat rate equations, Theory of insulation, critical radius calculations, types of insulation material, conduction through slab, cylinder and sphere.

Unit II Convective heat transfer: Heat transfer in boundary layer and in films, natural and\ forced convection, co/counter/cross current contacting for heat transfer, individual and overall heat transfer coefficient, fouling factor.

Unit III Radioactive heat transfer: Black body radiation, concept of shape factor, methods of determination of shape factor, radiation exchange in enclosure with black surfaces

Unit IV Heat transfer under phase change conditions: Boiling and condensation of pure components, heat flux temperature diagram for boiling and condensation under vertical and horizontal surfaces, nucleate & pool boiling, effect of surface condition on condensation, correlation for heat transfer under condensation. Evaporation- Type of evaporators and their applications single and multiple effect evaporators, design and operation of forward– backward and mixed feed operations, effect of boiling point elevation and hydrostatic head vapour recompression.

Unit V Heat Exchange equipment: Introduction to general design of double pipe ,shell and tube exchangers, condensers, extended surface equipments, heat exchanger equation – coil to fluid, jacket to fluid.

References:

1. Donald Q. Kern; Process Heat Transfer; Tata McGraw Hill.
2. Alan J. Chapman; Heat Transfer; Collier McMillan.
3. Rao Y.V.C; Heat Transfer; PHI

List of Experiment (Pl. expand it):

1. To determine the thermal conductivity of metal rod.
2. To determine the equivalent thermal conductivity of composite wall.
3. To determine heat transfer coefficient in force convection.
4. To determine heat transfer coefficient in Natural convection.
5. To determine heat transfer coefficient with the help of Stefan Boltzmann Apparatus.
6. To calculate emissivity of the test plate by emissivity measurement apparatus.
7. To determine heat transfer coefficient in double pipe heat exchanger.
8. To study the heat transfer characteristics of a shell and tube heat exchanger (heating/cooling) of water.
9. To determine heat transfer coefficient in parallel and counter flow heat exchanger.
10. To measure the rate of evaporation using an open pan evaporator.
11. To measure the rate of condensation of pure water vapour and to determine the heat transfer coefficient.
12. Demonstrate the film-wise drop-wise condensation and determination of the heat transfer coefficient.
13. To study the single effect evaporator and find out the heat transfer coefficient.

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New Scheme Based On AICTE Flexible Curricula

Chemical Engineering, V-Semester

Departmental Elective CM- 503 (A) Computation Methods in Chemical Engineering

Course Objective

The objective of subject to understand the applications of computational techniques for chemical engineering calculations numerical techniques in chemical engineering calculations.

Unit I Treatment of engineering data: Graphical representation. Empirical equations, Interpolation, Newton's formula, Lagrange's Interpolation formula, extrapolation, Integration, Graphical Integration, Graphical Construction of Integral curves, Numerical Integration.

Unit II Interpretation of Engineering Data: Significant figure, Classification of Measurements, Propagation of Errors, Variation and Distribution of Random Errors, Properties of Variance, Confidence limits for small samples.

Unit III Ordinary Differential Equations: Formulation, Application of Law of Conservation of Mass– Mixing in flow process. Classification of ordinary Differential Equations and its applications to common Chemical Engineering problem

Unit IV Numerical Solutions of Ordinary Different Equations: Linear Second– order Equations with variable coefficients, Numerical solution by Runge Kutta Method. Its application to higher–order equations

Unit V Formulation of partial Different Equations: Finite difference, linear finite difference equations, non-linear difference equations, Optimization, types of methods, its application relating to chemical processes.

References:

1. Mickley HS, Sherwood and Reed; Applied Mathematics in Chemical Engineering; TMH pub.
2. Jenson & Jeffrey's; Mathematical Methods In Chemical Engineering; Mc Graw Hill
3. Luyben WL; Process modeling, simulation and control for chemical engineer; Mc Graw Hill

List of Experiment (Pl. expands it):

1. Data representation and treatment by Graphical methods, Pressure- Volume-Temperature and concentration relationships for gases and their mixtures.
2. Integrated methods of data processing. Integral functions and their graphical representation.
3. Estimation of properties from empirical correlations (Nokay)
4. Estimation of critical properties from group contribution method.

5. Redlich-Kwong equation of state and other Virial equations to estimate thermodynamic properties like compressibility factor, molar volume and P-V-T relationships.
6. To study the effect of liquid viscosity and dissolved gases on pump efficiency, reciprocating pump performance.
7. Measurement errors their propagation and minimization of random errors. Selection of confidence limits.
8. Mass balance problems using continuity equation applied to a dynamic system. Formation of differential equations (component balance) and their solution & examples – CSTR and flow through pipes.
9. Numerical Solutions of batch reactor problems. Euler Algorithm
10. Runge-Kutta algorithm and its application in chemical Engineering. Implicit and explicit calculations. Problems related to effect design, optimum liquid concentration.
11. Transient flow of fluid unsteady temperature and varying concentration problems and use of partial differential equation to solve them.

Note: Each student should perform at least eight experiments from the above list.

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

Chemical Engineering, V-Semester

Departmental Elective CM- 503 (B) Pulp & paper Technology

Course Objective

This course introduces the manufacture of paper from fibrous raw materials to the processing of finished products with emphasis on papers produced from wood, non-wood and secondary fibres. It will focus on the entire pulp and paper manufacturing process address the environmental issues that arise from the different processes involved.

Unit- I

Introduction: Present status of pulp and paper industries; Fibrous raw materials; Fiber chemistry. Raw Material Preparation: Debarking, chipping, chip screening, storage. Pulping: Chemical, semi chemical, mechanical, chemi-mechanical and non-conventional. Secondary fiber pulping. Advances and recent trends in pulping.

Unit- II

Bleaching: Objectives of bleaching bleach ability measurement, bioleaching. Chemical Recovery: Composition and properties of black liquor, oxidation and desalination, concentration of black liquor & its incineration caustic zing and clarification, sludge washing and burning.

Unit- III

Pulp Manufacture: Stock preparation, beating and refining, functional and control additives for papermaking, wet-end chemistry, polymer chemistry, retention sizing.

Unit- IV

Paper Manufacture: Approach flow system, wire part, sheet forming process, sheet transfer mechanism, press part, theory of pressing, dryer part, paper drying process, calendaring, cylinder mould machine, finishing, fiber recovery systems, recent developments in paper making. Coating and lamination.

Unit- V

Paper Properties: Physical (optical, strength and resistance), chemical and electrical properties, paper defects. Paper Grades: Types, composition, manufacturing techniques, properties and uses.

References:

1. Britt, K. W. (Ed.), "Handbook of Pulp and Paper Technology," 2nd ed., CBS Publishers & Distributors, Delhi, 1984.
2. Casey, J. P., "Pulp and Paper Chemistry and Chemical Technology," Vol. 1, 3rd ed., Wiley Interscience.
   Rydholm, S. A., "Pulping Processes," Wiley Inter science.

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

Chemical Engineering, V-Semester

Departmental Elective CM- 503 (C) Pharmaceutical Technology

Unit I Unit Operation in Pharmaceutical Industries: working principle of evaporation, distillation, drying, mixing, size reduction, crystallization, filtration, size separation, conveying, humidification, air conditioning and refrigeration equipments

Unit II Introduction to pharmaceutical laws and regulation
Formulation, development of sterile dosage forms. Production facilities, environmental control and personnel in the production of sterile dosage form, compounding, processing, filtration, sealing, sterilization, packing and labeling of sterile dosage forms. Quality control tests like sterility, pyrogen, clarify, safety and leakage testing.

Unit III Tablets and Capsules
Types of tablets. Manufacturing of tablets by wet granulation, dry granulation and direct compression. Tablet processing problems and defects, tablet standardization: hardness, friability, weights variation, disintegration, dissolution and content uniformity tests.
Capsules: Hard gelatin capsule, capsule size, formulation and preparation of filled hard gelatin capsules, soft gelatin capsule, soft gel - manufacturing procedures; quality control of capsules.

Unit IV Cosmetics and Toiletries:
Introduction, factors to be considered in the formulation of facial cosmetics, dentifrices, deodorant, antiperspirants, shampoos, hairdressing and hair removers.

Unit V Pharmaceutical packing:
packing components, types of packing containers and closures, materials used for and their pharmaceutical specification, method of evaluation, stability aspects of packaging materials.

References:
1. Leon lachman, Lieberman; Theory & practice of industrial pharmacy; Verghese P, Mumbai
2. Ganderto; Unit process in pharmacy.
3. HersheyD; Chemical engineering in medicine and biology - Plenum press, new york.
4. Chemical engineering in medicine - chern. Engg. Progrer syrnp series no. C 66, vol 62.

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New Scheme Based On AICTE Flexible Curricula

Chemical Engineering, V-Semester

Open Elective CM- 504 (A) Organic Process Technology

Course Objective

To Study of organic process industries involving process technology, raw material availability, production pattern, Engg. Problems involving material of construction, Environment pollution, waste utilization and disposal, energy consumption and conservation Equation.

Unit I Soaps and detergents:

Pulp and paper, pulping process, chemical recovery, stock preparation and paper making,

Unit II

Agro based alcohol industries, production of cane sugar, molasses, formation of alcohol, alcohol derivatives like acetic acid, acetic anhydride, vinyl acetate and ethylene glycol.

Unit III

Intermediates for petrochemical from petroleum based stocks, phenol, methanol, ethylene, propylene, aromatic benzene, toluene, xylene, acrylo-nitrite, styrene and butadiene.

Unit IV

Dyes and Dye intermediates, insecticides and pesticides, nitration and nitrating agents.

Unit V

Man-made fibers; rayon, polyester, polyamides, acrylics, cellulose and acetate

References:

1. Gupta VB & Kathari VK; Manufacturing Fibre Technology; Chapman Hall, Newyork Edition.
2. Kathari V.K.; Progress In Textile, Sciences Technology, Vol I & II; IAFL Publications, S-351 Greater Kailash part I New Delhi – 48 I Ed.
3. Austin, G.T; Shreeves Chemical Progress Industries; Mc. Graw Hill New York
4. Dryden C.E; Outlines Of Chemical Technology; Affiliated. East West press, New Delhi, 1997

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Chemical Engineering, V-Semester

Open Elective CM- 504 (B) Fuel Cell Technology

Course Objective:
Provide thorough understanding of performance characteristics of fuel cell power plant and its components. Outline the performance and design characteristics and operating issues for various fuel cells. Discuss the design philosophy and challenges to make this power plant economically feasible. Thus at the successful end of the course, the students will have sufficient knowledge for working in a fuel cell industry or R&D organization.

Unit I Fundamentals:
Electrochemical cells, electrolytic cell, galvanic cell, construction and working, Faraday's law of electrolysis, problems on displacements, classification of electrodes , Nernst's theory, single electrode potential, EMF of cell, EMF series, common types of cells.

Unit II Introduction:
Potential convention, current conventions, equilibrium constants, mass transfer limited current, Cottrell equation, factors affecting reaction rate and current, mechanism involving electrode reactions, reversibility kinetics, Butler-Volmer Equations, Tafel plots , Tafel equation, equations governing modes of mass transfer –Nernst-Planck Equation, Ficks law of diffusion, concept of Helmholtz plane.

Unit III Hydrogen fuel cell:
Introduction to hydrocarbon based fuel cells, general issues, fossil fuels and other fuels used, H2production from renewable sources and storage, working of H2 fuel cell, safety issues, steam reforming, internal reforming, cost estimation.

Unit IV Proton Exchange Membrane Fuel Cell:
Introduction, working of PEMFC, electro chemistry modeling, exchange current density, local surface over potential (activation loss), current & mass conversion, gas phase species diffusivity, membrane phase electronic conductivity, osmotic drag coefficient, back diffusion flux, fuel crossover.

Unit V Solid Oxide Fuel Cells:
Introduction, working of SOFC, modeling SOFC(Nernst voltage, current distribution, & over potential of electrolytes, electric potential field) modeling current transport & potential field, activation over potential, cell potential, treatment of electrolyte interface, Ohmic over potential, Activation over potential, Modeling electrochemical potential.

Unit VI Fuel Cell Systems:

System processes –fuel processing, rejected heat utilization, system optimization – pressurization, temperature utilization, heat recovery, fuel cell networking, life cycle analysis of fuel cells, hybrid systems –introduction to microbial and enzymatic fuel cell.

References:

1. Bokris John O' m, Srinivasan S., "Fuel cells-their electrochemistry", McGraw Hill 1969.
2. Appleby A.J. Fralkes F. R., "Fuel cell handbook", Van Nostrand Reinhold 1989.
3. Kordesch Karl, Simader G., "Fuel cells and their applications", VCH publications 1996. 41
4. U S Department of energy, "Fuel cell: a handbook",
5. Leo J.M.J., Blomen, Mugerwa M. N., "Fuel cell systems", Plenum Press

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Chemical Engineering, V-Semester

Open Elective CM- 504 (C) Energy Management

Unit I

Introduction to Energy Management:

Definition need and types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marketing, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel & energy substitution, Energy audit Instruments.

Unit II

Energy and Environment Monitoring:

Defining monitoring & targeting, elements of monitoring & targeting, data and information – analysis, techniques-energy consumption, production, cumulative sum of differences CUSUM).

Global environmental concerns: United Nations Framework Convention on climate Change (UNFCC), sustainable development, Kyoto protocol, Conference of Parties (COP), Clean Development Mechanism(CDM) ,Prototype Carbon fund (PCF)

Unit III

Energy Efficiency:

Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings. Energy efficiency in Electrical Utilities: Electrical System, Electric motors, HVAC and Refrigeration System, Fans and blowers, Pumps and Pumping System, Cooling Tower, Lighting System.

Unit IV

Waste Heat Recovery and Insulation:

Classification, advantages and applications, commercially viable waste heat recovery devices, saving potential Insulation-types and application, economic thickness of Insulation, heat savings & application criteria, Refractory –types, selection and application of refractories, heat loss.

Unit V

Heat Exchangers Networks and pinch Technology:

Energy targeting, area targeting, number of units targeting, shell targeting, cost targeting Pinch design methods, Grid diagram, composite curve, problem table, algorithm, grand composite curve.

Suggested Readings :

1. Goodall P.M. " The Efficient Use of Steam; Editor: Westbury House.
2. Mannan S; Lee's Loss prevention in the processes industries", Vol. VolI 2nd Ed, Butterworth Heinemann.
3. Kafarov V.V., " Wasteless chemical processes", Mir
4. Shenoy U.V.; Heat Exchange Network Synthesis", Gulf publishing Company.
5. Kemp I.C.; Pinch Analysis and Process Integration: A user Guide on Process Integration for the Efficient Use of Energy, 2nd Ed. Butterworth Heinemann.
6. Henderson S.M. ; Perry R.L. and young J.H. ; " Principles of Process Engineering; 4th Ed. Asae.
7. D. Reay , " Industrial Energy Conservation"

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Chemical Engineering, V-Semester

CM-505 Chemical Process Plant Simulation Lab-I

Simulation Study of Various Chemical Process with the help of following Softwares :

MATLAB , AFT Fathom, ChemCAD, Pro Simulator .

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Chemical Engineering, V-Semester

CM-506 Organic Process Technology Lab

1. To determine the iodine value of the given sample of oil.
2. To prepare Phenyl aZoβ –napthol from aniline.
3. To determine chloride in a given H_2o sample by argentrometric method.
4. To prepare oxalic acid from cane sugar.
5. Determine the strength of the given formalin solution.
6. Preparation of urea formaldehyde resin.
7. To determine the concentration of sugar by using polarimeter.