RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

Credit Based Grading System

Chemical Engineering, V-Semester

CM-5001 Advanced Chemical Engineering Thermodynamics

Course Objective

To understand the theory and applications of, thermodynamic properties, equations of state, various chemical engineering processes involving energy flow, phase and reaction equilibrium**.**

UNIT-1

Thermodynamic properties of homogeneous mixtures; property relationship for systems of variable compositions, partial molar properties, fugacity & fugacity-coefficient in ideal-solution, concept of fugacity departure

UNIT-2

Change of mixing activity, heat effects in mixing, and activity effect in gaseous mixture

UNIT-3

Refrigeration, ideal reversed Carnot cycle, vapour compression refrigeration, component of vapour compression plant (compressor, condenser, expansion device, evaporator) properties of refrigerant

UNIT-4

Chemical potential & its physical significance, effect of pressure & temperature on heat of reaction, concept of free energy, Vant-Hoffs equation, Claussions-Clapeyron equation, Gibbs-Duhem relationship of free energy with equilibrium constant, equilibrium & its applications.

UNIT-5

Elements of statistical thermodynamics, counting the number of microstates for a given macro-state, the most probable macrostate, Boltzman distribution, evaluation of Lagrangian constants alpha , statistical interpretation of work & heat.

References:

1. Smith J.M and Van Ness, Introduction to Chemical Engg. Thermodynamics – 6th edition.
2. Daubert, Chemical Engg. Thermodynamic; TMH.
3. Rathakrishnan E, Fundamentals of Engg Thermodynamics; PHI.
4. Dodge B.F., Chemical Engineering –Thermodynamics –McGraw Hill.
5. Balzhiser Samuels and Eliassen, Chemical Engg Thermodynaics Prentic Hall.
6. Sandler S.I, Chemical Engg-Thermodynamics-John Wiley and son.
7. Rastogi and Mishra, Chemical Engg. Thermodynaics.

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

Credit Based Grading System

Chemical Engineering, V-Semester

CM-5002 Computational 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

Credit Based Grading System

Chemical Engineering, V-Semester

CM-5003 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.

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

Credit Based Grading System

Chemical Engineering, V-Semester

CM-5004 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.

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

Credit Based Grading System

Chemical Engineering, V-Semester

Elective-I CM-5005 (1) 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

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

Credit Based Grading System

Chemical Engineering, V-Semester

Elective-I CM-5005 (2) Fertilizer 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 Introduction:

Plant nutrients, different types of fertilizers and their production in India. Different feed stocks. Synthesis gas production by steam-naphtha reforming and gas purification. Ammonia synthesis.

Unit- II Nitrogenous Fertilizers:

Urea manufacturing processes. Manufacture of sulphuric acid and ammonium sulphate. Nitric acid and ammonium nitrate manufacture.

Unit – III Phosphate Fertilizers:

Availability and grinding of rock phosphate, manufacturing processes for single and triple super-phosphate and phosphoric acid.

Unit- IV

Mixed Fertilizers:

Availability and manufacture of muriate of potash. Mono and di-ammonium phosphate, urea ammonium phosphates, NPK complex fertilizers, granulation techniques.

Unit-V

Major Engineering Problems:

Fertilizers storage and handling. Corrosion problems in fertilizers industries, Fertilizer plant effluent treatment and disposal.

References:

1. Slack A.V. “Chemistry and Technology of Fertilizers”, Wiley interscience Publishers.
2. Waggaman W.H., “Phosphoric Acid, Phosphates and Phosphatic Fertilizers”, Hafner Pub.
3. Austin G.T., “Shreve’s Chemical Processes Industries”, 5th Ed. McGraw Hill.
4. Rao M.G. and Sittig M., “Dryden’s Outlines of Chemical Technology”, Affiliated East W Press, Delhi.

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

Credit Based Grading System

Chemical Engineering, V-Semester

Elective-I CM-5005 (3) 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

Credit Based Grading System

Chemical Engineering, V-Semester

Elective-I CM-5005 (4) Membrane Separation Techniques

Course Objective
To understand the basic principle of membrane separation techniques and design of equipment involved.

Unit-I
Introduction: Membrane separation process, Definition of Membrane, Membrane types, Advantages and limitations of membrane technology compared to other separation processes, Membrane materials and properties.

Unit-II
Preparation of synthetic membranes: Phase inversion membranes, Preparation techniques for immersion precipitation, Synthesis of asymmetric and composite membranes and Synthesis of inorganic membranes.

Unit-III
Transport in membranes: Introduction, Driving forces, Non equilibrium thermodynamics, Transport through porous membranes, transport through nonporous membranes, Transport through ion-exchange membranes.

Unit- IV
Membrane processes: Pressure driven membrane processes, Concentration as driving force, electrically driven membrane processes.

Unit-V
Polarization phenomena and fouling: Concentration polarization, Pressure drop, Membrane fouling, methods to reduce fouling. Modules: Introduction, membrane modules, Comparison of the module configurations

References:

1. Mulder M, Basic Principles of Membrane Technology, Kluwer Academic Publishers, London, 1996.
2. Baker R. W., Membrane Technology and Research, Inc.(MTR), Newark, California, USA, 2004.
3. NathK., Membrane Separation Processes, Prentice -Hall Publications, New Delhi, 2008.

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Credit Based Grading System

Chemical Engineering, V-Semester

CM-5006 Chemical Process Plant Simulation Lab – I

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

MATLAB , AFT Fathom, ChemCAD, Pro Simulator .