



SYLLABUS
SCHOOL OF DISTANCE EDUCATION
ANDHRA UNIVERSITY, VISAKHAPATNAM.
B.E./B.TECH. - CHEMICAL ENGINEERING
IIIrd Year

DMCHE-301: HEAT TRANSFER

Introduction: Modes of heat transfer. Basic laws of heat transfer. Analogy between heat flow and electrical flow.

Conduction: The Fourier heat conduction equation. Steady state one dimensional heat conduction through plane wall, cylindrical wall, spherical wall, and composite structures. Heat transfer from extended surfaces. Three dimensional heat conduction equation. Numerical problems on unsteady state heat conduction through a semi-infinite slab; through an infinite slab, infinite cylinder, sphere. Critical insulation thickness.

Convection: The convective heat transfer coefficient. Introduction to Thermal boundary layer. Dimensionless numbers in heat transfer and their significance. Dimensional analysis.

Forced Convection: Heat transfer by forced convection inside tubes and ducts in laminar transition and turbulent flow. Analogy between momentum and heat transfer-Reynold's, Colburn, and Prandtl analogies. Heat transfer to liquid metals. Forced convection over exterior surfaces. heat transfer to tubes in crossflow. Empirical relations in agitated vessels, packed beds.

Natural Convection: Natural convection from vertical & horizontal surfaces. Grashoff Number.

Heat Transfer with Phase Change: Heat transfer from condensing vapors. Filmwise and dropwise condensation.

Derivation and practical use of Nusselt equations. Condensation of superheated vapours, effect of non-condensable gases on rate of condensation.

Heat Transfer by Boiling liquids : Boiling of saturated liquid. Maximum heat flux and critical temperature drop - minimum flux and film boiling.

Heat transfer by radiation : Thermal radiation, Black body radiation, Kirchhoff's law, emissivity, gray body. Laws of black body radiation. Geometric (or, shape) factor. Radiation in enclosures with black surfaces and gray surfaces. Large parallel plates. Concentric cylinders and spheres. Combined heat transfer by conduction, convection and Radiation.

Heat Exchangers: Types of heat exchangers. Log-mean temperature difference. Energy balances. Overall heat transfer coefficients. Heat exchanger effectiveness. Fouling factors. Design and description of heat transfer equipment. Heat Exchangers, Condensers, boilers, and kettles. Extended surface equipment.

Evaporation: Types of evaporators, capacity and economy of evaporators, Boiling point elevation and Duhring's rule. Material and energy balances in single effect evaporator. Multiple effect evaporators. Methods of feeding - capacity and economy of multiple effect Evaporators.

Text Book: 1. Unit Operations of Chemical Engineering 6th Ed, by W.L. McCabe, J.C. Smith & P. Harriot.

Reference:

1. Heat Transmission by William H. McAdams.
2. Fluid Dynamics and Heat Transfer by James G. Knudsen & Donald L. Kaatz
3. Process Heat Transfer, by D.Q. Kern

DMCHE-302 : MASS TRANSFER - I

Introduction:

Mass transfer Operations, molecular diffusion in fluids, binary solutions, Fick's law, equation of continuity, steady state equimolar counter current diffusion, Stefan's diffusion, estimation of diffusivity of gases and liquids, application of molecular diffusion, mass transfer coefficients in turbulent flow, theories of mass transfer, analogy between momentum, heat and mass transfer in laminar and turbulent flow, correlations for mass transfer coefficients in simple situations, diffusion in solids.

Interphase mass transfer : concept of equilibrium, diffusion between phases, material balances in steady state co-current and counter-current stage processes.

Equipment for gas-liquid Operations: sparged vessels, mechanically agitated vessels for single phase liquids and gas - liquid mixtures. Tray towers, Sieve tray design for absorption and distillation, design of batch distillation columns, Venturi scrubbers, spray towers and spray chambers, design of packed towers for absorption and distillation, Tray tower versus packed towers.

Distillation: Principles of VLE for binary systems, phase diagrams, relative volatility, Ideal solutions, azeotropes, enthalpy concentration diagrams, flash vaporisation, partial condensation, differential distillation, steam distillation, continuous distillation, McCabe-Thiele method, Ponchon-Savarit method, Tray efficiencies, introduction to multicomponent distillation, azeotropic and extractive distillation.

Absorption: solubilities of gases in liquids, two component system multicomponent systems, ideal and non-ideal solutions, choice of solvent for absorption, single component absorption, material balance counter

current multistage operations, dilute gas mixtures, non-isothermal operation, tray efficiency, continuous contact equipment, HETP, HTU, NTU concepts for single component absorption, graphical construction for transfer units, non-isothermal operation absorption with chemical reaction.

Text Book: 1. Mass Transfer Operations., Robert E. Treybal, Third edition, McG-H Book Co.,

Reference Book:

1. "Unit Operations-in-Chemical-Engineering", McCabe, W.L, Smith, J.C. & Harriot, P, 5th Edn, MGH Co.
2. "Chemical Engineering Hand Book" J.H. Perry.

DMCHE-303: CHEMICAL ENGINEERING THERMODYNAMICS

First law thermodynamics: Application of the first law of closed systems, flow systems and Chemical systems. Second law of the thermodynamics-entropy and its calculations, available and unavailable energy. The functions, H.G. and A (Enthalpy, Gibbs function and work function), Chemical potential, criteria of thermodynamic equilibrium in terms of extensive and intensive properties. Maxwell equations, Molar and partial molar properties. Thermodynamics of gases, PVT models, fugacity of single and mixture of gases. Actual behaviour of gases-enthalpy and entropy correction plots-Joule Thompson coefficient. Phase behaviour of pure component, construction and use of thermodynamic charts, phase rule. Phase equilibria in single component systems. Clausius-Clapeyron equation, temperature coefficient of the latent heat, integration of the Clausius-Clapeyron equation. General properties of solution and the Gibbs's Duhem equation. Ideal solution - Raoult's law - Henry's law.

Imperfect vapour phase: Non-ideal solutions. Conventions for the activity coefficients. The effect of temperature and pressure on activity coefficients. The calculation of activity coefficients. The equations of van Laar, Margules and Wilson -

the test of the thermodynamic consistency of vapour liquid equilibria. Chemical or Reaction equilibria. Equilibria involving gases, standard free energy change, equilibrium constant, effect of temperature on equilibrium constant, evaluation of standard free energy changes equilibrium constant, effect of temperature on equilibrium constant, evaluation of standard free energy changes-the third law of thermodynamics. Reaction Equilibria involving gases together with immiscible liquids and solids, conditions of equilibria for several independent reactions. Reaction equilibrium in solution. Electrolytes.

Text Book: 1. Introduction to Chemical Engineering Thermodynamics. by J.M.Smith , H.C.Van Ness and M.M.Abbott., 6th Edition, McGraw-Hill International Editions 2000.

Reference Books :

1. Chemical Engineering Thermodynamics., B.F.Dodge., McGH Book Co.,
2. Schaum Outline of Theory and Problems of Thermodynamics., Michael M.Abbott and Hendrick C.VanNess McGraw-Hill International Book Co., Singapore 1981

DMCHE-304:GENERAL CHEMICAL TECHNOLOGY

Sources of Water: Its treatment for different purposes. Environmental protection. Municipal waste waters. Industrial solid wastes. Air pollution. Manufacture of pulp and paper, different types of cement, manufacture of portland cement and its uses.

Different types of coal: Grading and classification. Distillation of coal and the product treatment (For low and High temperature carbonisations). Coal tar distillation and products

Brief treatment of the Sulfur and Sulfuric acid, Hydrochloric acid, Phosphorous and Phosphoric acid. Manufacture of Ammonia and nitric acid.

Manufacture and uses of Sodium carbonate, Sodium Hydroxide, Electrolytic alkali and chlorine.

Synthetic fibres. Manufacture of Viscose rayon and cupra ammonium rayon. Manufacture of cellulose acetate its uses and applications. Manufacture of synthetic rubber

Manufacture of nitrogen, oxygen and Hydrogen, Handling and Storage

Manufacture of Cane Sugar. Manufacture of Starch, uses and applications. Dextrin manufacture. Fermentation technology principles. Manufacture of Industrial alcohol.

Extraction of oil and fats. Classification of oils. Glycerine, fatty acid and soap manufacture. Synthetic detergents and their classification, mentioning important members in each group with their uses. Brief description of their manufacturing processes.

Textbook: Chemical Industries by Norman N.Shreve, 5th Edition

Reference:

1. Fuel Science by Harker & Allen.
2. Outlines of Chemical Technology by Charles E.Dryden.

DMCHE-305 :COMPUTER APPLICATIONS

Roots of algebraic and transcendental equations - iteration methods - Regula - Falsi method - Newton Raphson method. Roots of simultaneous sets of transcendental and algebraic equations.

System of linear equations and their solution by different techniques. Numerical differential and integration-Regression analysis-Least squares and orthogonal polynomial approximation.- Numerical solution of ordinary differential equations-Numerical solution of partial differential equations (simple case studies).Note: application of the above techniques to problems of interest in Chem.Engineering.

Text Book: 1. Digital computation for chemical engineers Leon Lapidus, McGH Book Co.

Reference Books:

1. Applied Numerical Methods, Camehan et al McGraw Hill Book Co.
2. Applied Numerical Methods with personal computers by constantinides, MGH Co, NY 1990.

DMCHE-306: PROCESS ENGINEERING ECONOMICS

Value of money equivalence: Value of money, equations for economic studies, equivalence, types of interest, discrete, continuous. Annuities; Relation between ordinary annuity and the periodic payments. Continuous cash flow and interest compounding, present worth of an annuity, perpetuities and capitalised costs. Bonds and debentures; value of a bond & yield rate.

Depreciation: Types and various methods of calculating depreciations, depreciation accounting. Cost accounting: Basic relationship in accounting, balance sheet and income statement. Various ratios to study the balance sheet & income statements. Cost estimation: Cash flow for industrial operations, factors affecting investments & production costs-estimation of capital investment, cost indices, cost factors in capital investment, methods of estimating capital investment. Estimation of total product cost: Manufacturing costs and general expenses.

Profitability, alternate investments and replacements. Mathematical methods for profitability evaluation. Economic production charts for plants operating below 100%, above 100% and under dumping conditions. General procedure for determining optimum conditions. Break even chart for production schedule and its significance for optimum analysis.

Economic balance in fluid flow, heat transfer and mass transfer operations: Optimum economic pipe diameter in fluid

dynamics, optimum flow rate of cooling water in condenser in heat transfer and optimum reflux ratio in distillation operation.

Economic balance in cyclic operations and semi continuous cyclic operations. Economic balance in yield and recovery, economic balance in chemical reactors, batch and flow reactors.

Text Books: 1. Plant Design and Economics for Chemical Engineers (Fourth Edition) by

Max S Peters and Klaus D. Timmerhans (Chapters 5 to 11) McGraw Hill Book Company.

1. Process Engineering Economics by Herbert E Schweyer McGraw Hill Book Company.

DMCHE-307: PRINCIPLES OF ENVIRONMENTAL ENGINEERING

Types of emission from Chemical Industries and their effects on environment, Environmental legislation, Noise pollution, occupational health hazards.

Materiological factors in pollution dispersion (ALP and ELP), Plume behaviour and characteristics, chimney design considerations: Plume rise, effective stack height.

Methods of analysis of air pollutants, particulate matter, SO_x , NO_x , CO_x analysis.

Removal of particulate matters: principles and design of settling chambers, solid traps, cyclone separators, fabric and fibre filters, scrubbers and electrostatic precipitators. **General methods** of control and removal of sulphur dioxide, oxides of nitrogen, organic vapors from gaseous effluents with design aspects. **Sources of waste waters**, Effluent guidelines and standards, characterisation of effluent streams, Oxygen demanding wastes, Oxygen sag curves, BOD curve. Analysis of water pollutants.

Methods of primary treatment: Screening, sedimentation, floatation and Neutralization, Biological treatment: Bacteria and bacterial growth curve, aerobic processes suspended growth processes, activated sludge process, extended aeration, contact stabilization, aerated lagoons and stabilization ponds, attached growth processes, with design aspects. Trickling filters, rotary drum filters, fluidized bed contactors, Anaerobic processes.

Methods of tertiary treatment.: carbon adsorption, ion exchange, reverse osmosis, ultra filtration, chlorination, Ozonation & sonozone process, sludge treatment and disposal.

Solid waste management: Solid waste collection, Transportation, solid waste processing and recovery. **Hazards in waste management,** risk assessment and safety measures, types of hazardous wastes, health effects, safety measures, risk assessment response measures, Case studies for pollutants removal and safety measures in Fertilizer Industry, Petroleum Refinery & Petrochemical, Paper, Pharmaceutical-Industries. **Industrial-Safety :** Why-safety, Accidents, causes & remedial measures, safety-aspects of site selection, Plant Layout & Unit plot planning.

Hazards of commercial chemical operations and reactions, Safety aspects of process design, Instrumentation for safe operations, Safety aspects in design and Inspection of pressure vessels, Effect of toxic agents, Toxicity vs. Hazards, Respiratory hazards, Safe experimentation and testing of reactions & materials for safety. Flammable materials, Fire extinguishing agents and their application, Eye-safety-in-chemical-processing, Personnel-protective-equipment, Permit systems, Hazard-evaluation-Techniques, Modern-safety-management-systems, Safety effectiveness.

Text book:

1. Environmental pollution control., By C.S.Rao., Wiley Eastern Ltd.,
2. Safety and Accident prevention in Chemical Operations by Fawcett and Wood

Reference Books :

1. S.P.Mahajan.,”Pollution control in process Industries. “TMGHill Pub Co.,
2. Arcadio P. Sincero & Geogoria Sincero., “Environmental Engineering”
3. Loss prevention in Chemical Industries by Frank P.Lees

DMCHE-308 : HEAT TRANSFER LABORATORY

1. Determination of total thermal resistance and thermal conductivity of composite wall.
2. Determination of the thermal conductivity of a metal rod.
3. Determination of the natural convective heat transfer coefficient for a vertical tube.
4. Determination of critical heat flux point for pool boiling of water.
5. Determination of forced convective heat transfer coefficient for air flowing through a pipe.
6. Determination of over-all heat transfer coefficient in double pipe heat exchanger.
7. Study of the temperature distribution along the length of a pin fin under natural and forced convection conditions.
8. Estimation of unsteady state film heat transfer coefficient between the medium in which the body is cooled.
9. Determination of Stefan-Boltzmann constant.
10. Determination of emissivity of a given plate at various temperatures.
11. Determination of radiation constant of a given surface.

DMCHE-309 : MASS TRANSFER LABORATORY

List of Experiments:

1. Steam Distillation
2. Differential Distillation
3. Height Equivalent to a Theoretical Plate
4. Vapour-Liquid Equilibria
5. Determination of Liquid Diffusion Coefficient
6. Determination of Vapour Diffusion Coefficient
7. Surface Evaporation
8. Height of a Transfer Unit.
9. Ternary Liquid Equilibria (Binodal Curve)
10. Liquid-Liquid Equilibria.
11. Limiting flowrates in Spray Tower.
12. Hydrodynamics of Perforated Plate Tower.
13. Volumetric Mass Transfer Coefficients in Perforated Plate Tower.
14. Dynamics of Liquid Drops (Single Drop Extraction Tower)
15. Studies of Axial Mixing Characteristics in a Packed Bed.
16. Gas-Liquid mass transfer in packed Tower.
17. Drying Characteristics of a given material.

DMCHE-310:GENERAL CHEMICAL TECHNOLOGY LABORATORY

List of Experiments:

A. Analysis of Water:

1. Total solids, dissolved solids, pH
2. Chlorides and sulphates.
3. Temporary, permanent and total hardness.

B. Analysis of oils:

4. Acid value
5. Iodine value
6. Saponification value

C. Miscellaneous analysis:

7. Analysis of coal: Proximate analysis.
8. Analysis of Lime : Estimation of acid insolubles, available lime and calcium carbonate
9. Analysis of Bleaching powder : Estimation of chlorine content.
10. Analysis of Starch / Glucose : Estimation of total reducing sugars.
11. Analysis of Saw dust : Estimation of total cellulose, and - cellulose.

E. Miscellaneous preparations:

12. Preparation of soap.
13. Preparation of copper and chrome yellow pigments.
14. Preparation of phenol formaldehyde resin.