CMC-701 PROCESS EQUIPMENT DESIGN-I

Unit I Bolted Flanges: Types of Flanges, and selection, Gaskets, Design of non- standard flanges, specifications of standard flanges. Mechanics of materials: Stress- Strain relationships of elastic materials subjected to tensile, compressive and shear forces, Elastic and plastic deformation.

Unit II Shell and tube heat exchanger- General design considerations- LMTD correction factor, fluid allocation, fluid velocities, stream temperatures, pressure drop, shell side and tube side heat transfer coefficients, Design of double pipe heat exchanger. Plate heat exchanger: advantages, disadvantages, design procedure, temperature correction factor, heat transfer coefficients, pressure drop.

Unit III Evaporators: classification, criteria for selection, design of evaporator. Condensers: heat transfer fundamentals, condensation outside horizontal tubes, condensation inside and outside vertical tubes, condensation inside horizontal tubes, condensation of mixtures. Reboilers: types, selection, boiling heat transfer fundamentals,

Unit IV Design Mass Transfer Equipments such as Distillation Columns, Dryers and Absorption column.

Unit V Design of Tall Vessels: Stresses in the shell of a tall vertical vessel, and period of vibration, vessel supports- introduction and classification of supports, design of skirt supports considering stresses due to dead weight, wind load, seismic load, design of base plate, skirt bearing plate, anchor bolts, bolting chairs and skirt shell plates, Design of saddle supports, ring stiffeners.

References:

1. L.E. Brownell and E. Young, John Wiley, New York, 1963, "Process equipment design".
2. B.C. Bhattacharya C.B.S. Publications, "Introduction to Chemical Equipment Design" .
3. M.V. Joshi, Mcmillan India, "Process Equipment Design".
4. J.M. Coulson, J.F. Richardson and R.K., Chemical Engineering Vol. 6".
5. Ludwig E.E., Gulf Publishing Company, "Applied Process Design for Chemical and
1. Petrochemical Plants" vol 1 and 2.
6. Walas S.M. Butterworth Heinamen, McGraw Hill book company, New York
7. Brownell, N.E and Young, H.E; Process Equipment Design; John Wiley
8. Perry RH; Hand book of Chemical Engrs; Mc Graw Hill

List of Experiments:

1. Evaluate the performance of a series of a piping system consisting of various fittings.
2. Evaluate the hydraulic performance of a bed of particles operated in three distinct modes of operation: Packed, Fluidized,
3. Evaluate the hydraulic performances of two towers filled with the same type , but different heights, of packing.
4. Evaluate the residence time distributions (RTDs) of two tubular flow vessels of identical volume but different length/diameter (L/D) ratios.
5. Estimation of the Reynolds number range over which CSTR behavior is approached

CMC- 702 Chemical Reaction Engineering –II

Unit-I Heterogeneous processes: Catalysis and adsorption; Classification of catalysts, Preparation of catalysts, Promoters and Inhibitors, General mechanism of catalytic reactions surface area and pore size distribution Rate equation of fluid solid catalytic reactions, Hougen - Watson & Poinule law models, Procurement and analysis of kinetic data, kinetics of catalyst deactivation.

Unit –II External transport processes and their effects on heterogeneous reactions yield and selectivity Reaction and diffusion in porous catalysts, Isothermal and non-isothermal effectiveness factors, Effect of intra-phase transport on yield, selectivity & poisoning, Global reaction rate.

Unit –III Design of catalytic reactors, Isothermal & adiabatic fixed bad reactor staged adiabatic reactors, Non isothermal, non adiabatic fixed bed reactors, Fluidized bed reactors, Slurry reactors, Trickle bed reactors.

Unit-IV Models for fluid - solid non-catalytic reactions, controlling mechanisms, Diffusion through gas film controls. Diffusion through ash layer controls, Chemical reaction controls, fluidized bed reactors with and without elutriation.

Unit – V Gas-liquid reactions and liquid-liquid reaction, Rate equation based on film theory, Reaction design for instantaneous reactions and slow reactions, Aerobic Fermentation, Application to Design Tools for Fast Reactions.

References:

1. Smiili J.M; Chemical engg. Kinetics; TMH
2. Denbig K.G & Turner KG; Chemical theory - an introduction to reactors; United press
3. Cooper G. & Jeffery JVJ; Chemical kinetics and reactor engg.; PHI
4. Rajaram J, Kuriacose JC; Kinetics and mech. of Chemical Transformations; MacMillan
5. Levenspiel O; Chemical reaction engg; Wiley Eastern Singapore.
6. Hougen, watson & Ragatz; Chemical process principles part 3
7. Fogler, HS; Elements of chemical reaction engg.; PHI

List of Experiments:

1. To determine the order and rate constant of saponification reaction at room temperature.
2. To determine the order and rate constant of esterification reaction at room temperature .
3. To study homogeneous catalytic reaction in a batch reactor under adiabatic conditions.
4. To study the kinetics of decomposition of H_2O_2 catalyzed by iodine ion.
5. To study the dissolution of benzoic acid on reaction with aqueous NaOH solution.
6. To study a non-catalytic homogenous reaction in a PFR.

CMC-703 Transport Phenomena

Unit- I Transport Properties: Continuum fluids, Newton's law of viscosity, Introduction to non-Newtonian fluids, pressure and temperature dependency of viscosity, Viscosity of gases at low density, Laminar flow, shell momentum balance, boundary conditions, selected applications.

Unit- II Momentum Transport: Equations of change for isothermal systems – Navier-Stokes equation, use of equations of change to set up steady state flow problems with Newtonian fluids,

Unit- III Microscopic mass, momentum and energy balance for isothermal systems, Bernoulli's equation, compressible flow, pipe flow. Introduction to Macroscopic momentum balances.

Unit- IV Energy Transport: Shell energy balances, Fourier's Law of heat conduction, boundary conditions. Application to steady and unsteady problems, convective heat transfer, heat transfer coefficients for forced convection around submerged objects, for free convection for condensation of pure vapors on solid surface. Introduction to Macroscopic energy balances.

Unit-V Mass Transport: Fick's Law of diffusion, analogy with heat transfer, shell mass balances, boundary conditions, applications, species continuity equation, conductive mass transfer, mass transfer coefficients, applications, correlations. Introduction to Macroscopic Mass Balances.

References:

1. Bird, R. B., Stewart, W. E. and Lightfoot, E. N., "Transport Phenomena," John Wiley, 1960.

2. Thomson, W. J., "Introduction to Transport Phenomena," Pearson Education Asia, 2000.

3. Brodkey, R. S. and Hershey, H. C.,"Transport Phenomena: A Unified Approach,"McGraw-Hill, NY, 1988.

4. Geancoplis; Transport processes & separation process principles; PHI learning.

List of Experiments:

1. Fundamentals of fluid dynamics
2. Fundamentals of conduction and convection heat transfer
3. Fundamentals of diffusion mass transfer
4. Fundamentals of design of experiments and data analysis

CMC -704 (A) FLUIDIZATION ENGINEERING

Unit-I Introduction: The phenomenon of fluidization; liquid like behaviour of a fluidized bed; Comparison with other contacting methods; Advantages and disadvantages of fluidized beds. Industrial applications of fluidized beds.

Unit-II Coal gasification; gasoline from other petroleum fractions; Gasoline from natural and synthesis gases; Heat exchange; Coating of metal objects with plastics; Drying of solids; Synthesis of phthalic anhydride; Acrylonitrile; Polymerization of olefins; FCCU; Fluidized combustion of coal; incineration of solid waste; Activation of carbon; gasification of waste; bio-fluidization.

Unit-III Fluidization and mapping of regimes: Minimum fluidization velocity; Pressure drop vs. velocity diagram; effect of temperature and pressure on fluidization; Geldart classification of particles; terminal velocity of particles; turbulent fluidization; pneumatic transport of solids; fast fluidization; solid circulation systems;

Unit-IV Voidage diagram; Mapping of regimes of fluidization. Bubbles in dense bed: Single rising bubbles; Davidson model for gas flow at bubbles; Evaluation of models for gas flow at bubbles, Bubbling Fluidized beds: Experimental findings; Estimation of bed porosities; Physical models: simple two phase model; K-L model.High velocity Fluidization: Turbulent fluidized bed; Fast fluidization pressure drop in turbulent and fast fluidization. Solids Movement, Mixing, Segregation and staging: Vertical movement of solids;

Unit-V Horizontal movement of solids; Staging of fluidized beds.Gas Dispersion and Gas interchange in Bubbling Beds: Dispersion of gas in beds; Gas interchange between bubble and emulsion; Estimation of gas interchange coefficients. Particle to Gas Mass Transfer: Experimental interpolation of mass transfer coefficients; Heat transfer; Experimental heat transfer from the bubbling bed model.

References:

1. Fluidization Engineering Kunil, Diazo and Octave Levenspiel
2. Fluidization Max Leva.
3. Fluidization Engineering O. Levenspiel and D. Kunii,
4. Gas-Liquid-Solid Fluidization Engineering Liang-Shih Fan,

CMC-704 (B) MULTI PHASE FLOW

Unit-I Introduction to the flow of multiphase mixtures: gas or vapor liquid, liquid-liquid, liquid-solid, gas-solid, solid-liquid-gas and gases carrying solids (pneumatic transport) stratification and dispersion, Flow regimes and flow patterns.

Unit-II Gas (Vapor) and Liquid Flows: Horizontal flow, Vertical flow, pressure, momentum and energy relations, methods of evaluating pressure drop, Lockhard - Martinell, Chisholm correlations, critical flow, non-Newtonian flow.

Unit-III Solid-Gas Flow: Effect of pipeline diameter, inclination, bends, valves and length. Liquid and its physico-chemical properties, rheology, corrosive nature, viscosity, Solid particle size, distribution phase, and density i.e. their factors effecting behavior in a fluid, Concentration of particles and the flow rates of both solids and liquid.

Unit-IV Solid-Gas Flow: Horizontal flow, Suspension mechanism, determination of voids, energy requirements for conveying, pressure drop and solid velocities in dilute phase flow, dense phase conveying, vertical transport.

Unit-V Bubble and drop formation: Phase holdups, Interfacial areas, mixing and pressure drops, multiphase (gas liquid solid) operations.

References:

1. The flow of complex mixtures in pipe Govier, G.W. and Aziz, K
2. Chemical engineering, Vol I, Coulson JM and Richardson J.F
3. Multiphase Flow Handbook Crowe, C.T.
4. Fundamentals of Multiphase Flow Brennen, C.E

CMC- 704 (C) COMPUTER AIDED PROCESS CONTROL & DESIGN

Unit-I Hardware: Analog and digital interfacing, sensors and transducers.

Unit-II System software: real time programming, Application software:

Unit-III Data logging, filtering, digital control: Z-transforms, discrete time dynamic systems, adaptive control,

Unit-IV Introduction to MIMO control systems. Laboratory exercises.

References:

1. Chemical Engineers Handbook Green DW and Malony, perrys

CMC-705(A) Multiphase Reactions

Unit-I Introduction: reaction kinetics for multiphase reactions, brief idea of multiphase reactors and design.

Unit-II Catalyst deactivation and regeneration, Review of reaction kinetics and reactor design.

Unit-III Industrial reactors: Trickle bed, Bubble column, segmented bed, fluidized bed and slurry reactor, models for analysis gas-liquid, gas-liquid-solid reactions.

Unit-IV RTD and macro mixing models, brief description of laboratory reactors.

Unit-V Intrinsic kinetics: catalysis, Langmuir-Hinshelwood models, catalyst pellets, effectiveness factors.

References:

1. Gas Liquid Reactor Design Y. T. Shaha .
2. Chemical Reactor Deign and Operation Westerterp K. R., Van Swaaji and Beevackers
3. Multiphase Chemical Reactor – Theory, Design, Scale-up Gianetta and Silverton
4. Heterogeneous Reactions Vol-I and II Sharma and Doraiswam

CMC-705 (B) NANO TECHNOLOGY IN CATALYSIS

Unit-I Introduction to nano-technology, definition, history. What makes the nanoscale so different from the other length scales by considering the underpinning science (i.e. nanoscience) and some key examples of nanotechnology.

Unit-II Methods of synthesis of nanomaterial's fabrication-—Top-down‖ vs. —bottom-up‖ approaches. Equipment and processes needed to fabricate nanodevices and structures.

Unit-III Fundamental understanding of catalysis at nano-scale. Wet chemical synthesis, preparation and properties of iron, platinum, gold, cadmium, silver, copper and nickel nano-particles.

Unit-IV Synthesis and properties of composite nano-particles and coated nano-particles.

Unit-V Characterization of nano particles by Scanning probe microscopes (Atomic Force Microscopy, Scanning Tunneling Microscopy), Transmission Electron Microscopy, Scanning Electron Microscopy.

References:

1. Nanotechnology: Principles and Practices, . S. K. Kulkarni .
2. Nano science and technology: novel structures and phenomena, Tang, Zikang and Sheng, Ping, Taylor and Francis,
3. Nanotechnology: Understanding small systems B. Rogers, S. Pennathur, J. Adams
4. Nanotechnology in Catalysis Pinzhan.

CMC-705 (C) Cleaner Technologies in Chemical Process Industry

Unit I Introduction to Cleaner Technology (CT), Technology adoption for Cleaner Production (CP), Cleaner Production: The basis, necessity and potential, C.P. tools, techniques, methodology and applications, Overview of Good House Keeping, Process Modification / Changes, Process Technology Innovations, Equipment Modification, Reuse and Recycle. Principles and Concepts of Green Chemistry.

Unit-II Thermodynamics and Reaction Engineering Principles for C.P., Role of Environmental Biotechnology in C.P.Use of Unit Operations – Adsorption, Absorption and Extraction in C.P.

Unit-III Energy Audit and Energy Conservation, Use of clean fuels inclusive of H2 as a clean fuel of tomorrow, Power Plants, C.P. & C.T. as Remedial Measures for Mitigating Climate Change, Ozone layer depletion and current practices to avoid depletion.

Unit-IV Resource recovery / by product recovery from manufacturing process by Cleaner Production Technology (CPT) with special reference to Small Scale Industries. Industrial waste minimization and Waste Minimization Circles, Hazard Prevention by C.P. Technology

Unit-V Alternatives, Designing Cleaner Production – Green Processes, Cleaner Production and Cleaner Technology implementation, Typical case studies.

Reference:

1. Cleaner Production: Training Resource Package, UNEP IE, Paris, 1996
2. Engineers Guide to Cleaner Production Technologies Paul M. Randall
3. Green Chemistry : Environmentally Benign Reactions V. K. Ahluvalia
4. Chemical Process Safety: Learning from case Histories, R. E. Sanders, Oxford

CMC-706 (A) BIO ENERGY TECHNOLOGY

Unit-I Sources and Classification. Chemical composition, properties of biomass. Energy plantations. Size reduction, Briquetting, Drying, Storage and handling of biomass.

Unit-II Feedstock for biogas, Microbial and biochemical aspects- operating parameters for biogas production. Kinetics and mechanism- High rate digesters for industrial waster water treatment.

Unit-III Thermo chemical conversion of lignocelluloses biomass. Incineration, Processing for liquid fuel production. Pyrolysis -Effect of particle size, temperature, and products obtained.

Unit-IV Thermo chemical Principles: Effect of pressure, temperature , steam and oxygen. Fixed and fluidized bed Gasifiers- Partial gasification of biomass by CFB.

Unit-V Combustion of woody biomass-Design of equipment. Cogeneration using bagasse- Case studies: Combustion of rice husk.

References:

1. Biotechnology and Alternative Technologies for Utilization of Biomass Chakraverthy A
2. Biogas Systems: Principles and Applications Mital K.M
3. Biomass Energy Systems Venkata Ramana P and Srinivas S.N
4. Gasification Technologies, A Primer for Engineers and Scientists Rezaiyan. J and N. P.

CMC-706 (B) SOLID WASTE MANAGEMENT

Unit-I Introduction- Philosophy and organization, Status of solid waste management, Compotation an integrated waste management strategy. Evolution of solid waste management.

Unit-II Legislation and Government agencies, Planning solid waste management progress. Generation of solid waste, Onsite handling, Storage and processing.

Unit-III Transfer and transport, Processing techniques and equipment. Recovery of resources- Conversion, Chemical and Biological methods.

Unit-IV Disposal of solid waste- Landfilling, Ocean disposing, Source reduction, Recycling, Composting. Hazardous waste and their management, Process management issues, Planning.

Unit-V Case studies on major industrial solid waste generation units- Coal fired power plant, Textile industry, Brewery, Distillery, Oil refinery, Radioactive generation units. Case studies on spills, Sludge lagooning and incineration.

References:

1. Handbook of Solid Waste b Frank Krieth
2. Solid Wastes, Martell
3. Solid Wastes, George Tchobanuglour, H.Theisen and R.Eliassen.
4. Solid Waste Management, Luis F. Diaz, George M. Savage, Linda L. Eggerth, Larry.

CMC-706 (C) ADVANCED ANALYTICAL TECHNIQUES

Unit-I Introduction to spectroscopic methods of analysis, electromagnetic radiation and quantitative spectroscopy.

Unit-II Molecular Spectroscopy, UV Spectroscopy, IR Spectroscopy.

Unit-III Atomic Spectroscopy: AAS Spectroscopy, Electrometric Methods of Analysis, XRD Analsyis.

Unit-IV Thermal Methods: DSC, DTA, Chromatographic Methods: GC, HPLC.

References:

1. Instrumental methods of analysis Willard, H.H., Merritt. I.I., Dean J.a., and Settle, F.A
2. Instrumental Methods of Analysis Sharma, B.K.,
3. Absorption spectroscopy of organic molecules Parikh V.M.,.
4. Fundamentals of Analytical Chemistry Skoog D.A. and West D.M.,
5. Fundamentals of molecular spectroscopy Banwell, G.

CMC-707 Industrial Training - II

The following objective should be fulfilled in industrial training–II, and student must participate in any Chemical, Petrochemical, Pharmaceutical, Oil and Gas industry where they can learn to apply the Technical knowledge in real Industrial situations.

- Gain experience in writing Technical reports/projects.
- Expose students to the engineer's responsibilities and ethics.
- Expose the students to future employers.
- Understand the social, economic and administrative considerations that influence the working environment of industrial organizations.