CMC – 801 Process Equipment Design-II

Unit I Scale up criteria and scale up of process equipment. Process design calculations for heat exchanges equipment shell and tube heat exchangers general description, heat transfer coefficients and pressure drop by Kerms & Bells methods rating on existing unit.

Unit II Design of a new system having one or more units in series: single effect evaporation, multiple effect evaporator with boiling point elevation.

Unit III Process design calculations for mass exchange equipment plate and packed column for distribution hand adsorption including column diameter and height.

Unit IV Detailed process and mechanical design, Flash drum , Kettle reloerler, condenser, cooling tower rotary drier.

References:

1. Perry, Robert etal; Perry□s Chemical Engg. Handbook; TMH
2. Chemical Engineering Vol-1 Coulson J.M. Richardson J.F .
6. Chemical Engineering Handbook Perry, Robert H., Green Don W
4. Applied Process Design in Chemical Petrochemical Plants E.E. Ludwig
5. Design of Equilibrium Stages. B.D. Smith
6. Kern D; Process Heat Transfer; TMH

List of Experiments:

1. Evaluate the hydraulic performances of two packed towers.
2. Evaluate the heat transfer characteristics of two steam condensers and one liquid/liquid exchanger.
3. Evaluate heat transfer in an agitated, jacketed vessel.
4. Evaluate the heat transfer in a batch (i.e. no flow) agitated vessel.
5. Evaluate the hydraulic performance of a bed of particles operated in packed modes of operation.
6. Evaluate the hydraulic performance of a bed of particles operated in Fluidized modes of operation

CM – 802 Chemical Process Modeling and Simulation

Unit I The role of analysis: chemical engineering problems, basic concepts of analysis; the analysis process, simple example of estimating an order, source of the model equations, conservation equations, constitutive equations, control volumes, dimensional analysis, system of units, dimensional consistency in mathematical descriptions, dimensional analysis and constitutive relationships, final observations.

Unit II Non-Reacting Liquid Systems: Introduction, equation of continuity, simple mass balance, application of the model equations, component mass balances, model behavior: steady state behavior, un-steady state behavior, density assumption, numerical integration methods of ordinary differential equation; Reacting Liquid Systems: Introduction, basic model equations for a tank-type reactor, reaction rate, batch reactor, pseudo first-order reactions, reversible reactions, multiple reactions; consecutive reactions, parallel reactions, complex reactions, constant density assumption, order and stoichiometry.

Unit III Treatment of experimental data: Introduction, criteria for Best Fit, Best Slope-I, Best Slope-II, Best straight line, physical property correlations, fitting a quadratic, simulation examples of gravity fluid flow, heat and mass transfer, Monte-Carlo simulation.

Unit IV Dynamic modeling of simple processes, sequential, simultaneous modular and equation oriented approaches, partitioning and tearing.

Unit V Computer programming of various iterative convergence methods such as Newton-Ralphson, false position, Wegstein, Muller methods.

References:

1. Russell TWF; Introduction to Chemical Engineering Analysis - John Wiley & Sons
2. Luyben W.L; Process Modeling, Simulation And Control For Chemical Engineers; TMH
3. Jana ; Chemical process modeling and computer simulation; PHI Learning
4. Babu, B. V., Process plant simulation

List of Experiments:

1. To introduce students to solving process simulation problems using **MATLAB** and **Aspen-Plus.**
2. The first part of this course will focus on MATLAB, which is a powerful language for engineering applications.
3. The second part will cover process simulation using the **Aspen-Plus** package, which is an industry standard for process simulations.
4. Truncated Taylor's series & errors. Numerical differentiation and integration. ODE-IVP: Understanding Runge-Kutta Method. RK Method in Multiple Variables.
5. Solving and Application to Transient System Reactor simulations.
6. Introduction to Aspen Plus. Simulation of individual equipments.
7. Design specification and sensitivity analysis.
8. Equation oriented approach. Unsteady state simulation. Aspen properties.

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CMC-803 (A) PROCESS PIPING DESIGN

Unit-I Classification of pipes and tubes, IS & BS codes for pipes used in chemical process industries and utilities. Pipes for Newtonian and non-Newtonian fluids, sudden expansion and contraction effects.

Unit-II Pipe surface roughness effects, pipe bends, Shearing characteristics. Pressure drop for flow Newtonian and non-Newtonian fluids through pipes. Resistance to flow and pressure drop. Effect of Reynolds and apparent Reynolds number.

Unit-III Pipes of circular and non-circular cross section – velocity distribution, average velocity and volumetric rate of flow. Flow through curved pipes (Variable cross sections). Effect of pipe-fittings on pressure losses.

Unit-IV Non-Newtonian fluid flow through process pipes, Shear stress, Shear rates behavior, apparent viscosity and its shear dependence, Power law index, Yield Stress in fluids, Time dependant behavior.

Unit-V Thixotropic and rheopetic behavior, mechanical analogues, velocity pressure relationships for fluids, line. Pipe line design and power losses in compressible fluid flow, Multiphase flow, gas-liquid, solid-fluid, flows in vertical and horizontal pipelines, Lockhart Martinelli relations, Flow pattern regimes.

References:

1. Chemical Engineering – Vol I , Coulson JM and Richardson J.F.
2. The flow of Complex Mixtures In Pipe Govier, G.W. and Aziz K
3. Process Piping Design, , Volume 2, Rip Weaver

CMC-803 (B) COMPUTATIONAL FLUID DYNAMICS

Unit-I Conservation equations for mass, momentum and energy; Comparison of various numerical techniques for CFD.

Unit-II Review of finite difference and finite element methods; Solution to discretised algebric equation;

Unit-III Finite-volume method for diffusion problems; Finite-volume method for convection and diffusion problems – pressure velocity coupling.

Unit-IV Construction of geometry and discreation using Gambit-Fluent's manuals; Commercial CFD solvers; Turbulance modeling; Implementation of boundary conditions.

Unit-V Introduction to multiphase flow; Customizing commercial CFD solver; Unsteady state simulations.

References:

1. Computational Fluid Dynamics: The Basics with Application Anderson, J.D
2. Computational Methods for Fluid Dynamics Ferziger, J.H. and Peric, M
3. An Introduction to Computational Fluid Dynamics: The Finite Volume Method‖, H.K. and Malalasekera, W

CMC- 803 (C) ADVANCED PROCESS OPTIMIZATION

Unit-I Objective and Formulation of Optimization, Inequality and Equality Constrains in Models Formulation of the Objective Function, Lower and Upper Bounds, Selecting Functions to Fit Empirical Data, Factorial Experimental Designs, Degrees of Freedom.

Unit-II Economic Objective Functions, Measures of Profitability, Continuity of Function, NLP Problem Statement, Convexity and Its Applications, Quadratic Approximation, Necessary and Sufficient Conditions for an Extremum of an Unconstrained Function.

Unit-III Optimization of Unconstrained Functions: One-Dimensional Search Numerical Methods for Optimizing a Function of One Variable, Scanning and Bracketing Procedures, Newton and Quasi-Newton Methods of Unidimensional Search, Unconstrained Multivariable Optimization.

Unit-IV Linear Programming (LP) and Applications Geometry of Linear Programs, Basic Linear Programming Definitions and Results, Simplex Algorithm, Barrier Methods, Sensitivity Analysis, Linear Mixed Integer Programs, Application of the EXCEL Solver Spreadsheet for Optimisation, Formulation.

Unit-V Introduction to Nonlinear Programming with Constraints and Mixed-Integer Programming, Application of Optimization in Chemical Engineering, Examples of Optimization in Chemical Processes like optimizing recovery of waste heat, Optimal Shell and Tube Heat Exchanger Design, Optimal Design and Operation of binary Distillation Column, Optimal pipe diameter etc.

References:

1. Optimization of Chemical Processes D M Himmelblau and L S Lasdon
2. Optimization theory and practice G. S. Beveridge and R. S. Schechter
3. Optimization for engineering design: Algorithms and examples K. Deb
4. Mixed Integer and Non Linear Optimization C. A. Floudas, W D Seider, J D Seader and D R Lewin

CMC-804 (A) INDUSTRIAL CATALYSIS

Unit-I Review of Heterogeneous Catalysis: Role of catalyst components and other constituents, characterization of catalyst and its support.

Unit-II Transport Processes: Analysis of external transport processes in heterogeneous reactions in fixed bed, fluidized bed and slurry reactors. Intrapellet mass transfer, heat transfer, mass transfer with chemical reaction and simultaneous mass and heat transfer with chemical reaction.

Unit-III Catalyst Selectivity: Effect of intrapellet diffusion on selectivity in complex reactions, effect of external mass transfer on selectivity.

Unit-IV Catalyst Deactivation: Modes of deactivation – poisoning, fouling and sintering. Determination of deactivation routes, combined effect of deactivation and diffusion on reaction rates, effect of deactivation on selectivity.

Unit-V Reactor Design: Design calculation for ideal catalytic reactor operating at isothermal, adiabatic and non-adiabatic conditions. Deviations from ideal reactor performance. Design of industrial fixed-bed, fluidized bed and slurry reactors. Thermal stability of packed bed and fluidized bed reactors, Overview of various areas of Green chemistry, Successful approaches to Green Chemistry education.

References:

1. Chemical Engineering Kinetics Smith, J. M
2. Catalytic Reaction Engineering, Carberry, J. J .
3. Heterogeneous Catalytic Reactors Lee, H. H
4. Catalytic Reactor Design Tarhan, M. O .

CMC- 804 (B) FUELS AND COMBUSTION

Unit-I Energy crisis – Present position in India and the world. Origin and Chemical composition, Classification of fuels, Storage and general use of Industrial fuels, Comparison of various types of fuels, Calorific value of a fuel, LCV and HCV, meaning and definition.

Unit-II Determination of HCV and LCV for solid fuels, Bomb calorimeter, Gas calorimeter. Solid fuels: Wood and charcoal, Coals and their characteristics, combustion and availability of coals in India, Coal washing and blending. High and low temperature coal carbonization.

Unit-III Manufacture of coke and recovery of by products. Pulverized coal and its conduction. Liquid fuels: Petroleum, its origin and occurrence. Distillation, products of distillation, their characteristics and uses. Combustion, Chemistry of combustion, combustion calculations pertaining to different fuels and furnaces used in ceramic industries.

Unit-IV Theoretical air / fuel ratio, Excess air, Flue gas analysis calculations. Gaseous Fuels: Classification, merits and demerits of the gaseous fuels. N gas, LPG, coal gas, Oil gas, Produces gas, Water gas, Semi-water gas etc., their chemical composition.

Unit-V Manufacture and uses in detail. Nuclear fuels, their scope and classification, Types of nuclear fuels, method of generation of nuclear energy from the sources, etc., Nuclear reactor – classification and types Accessories and their study in detail. Nuclear fuel roads, Moderators, Heavy water etc., Alternate sources of energy, Renewable energy, Hydroelectric, Solar, Geothermal, Tidal, Wind and other types, Bio-gas, Bio-fuels, etc.

References:

1. .Fuels Technology Himus
2. Combustion Engineering and Fuels Technology Shaha
3. Principles of Energy conversion Gulp Jr. A.W.
4. Energy resources and supply McMullan, Morgan Murray

CMC- 804 (C) SUSTAINABILITY AND GREEN CHEMISTRY

Unit-I Introduction to Green Chemistry and Sustainability, the Chemistry behind Green Chemistry, Green Chemistry and Natural Resources.

Unit-II Energy Relationships: Energy sources, Energy conversions and renewable energy, potential of biofuels.

Unit-III Water: Properties, Life in, and Contaminants, Designing an Environmentally Safe Marine Antifoulant, Green Chemistry and Ecology.

Unit-IV The Biosphere, The Geosphere, Soil and Food, The Anthrosphere and Industrial Ecology Consumer products, DuPont Petretec Polyester Regeneration Technology.

References:

1. Green Chemistry an Introductory Text, Royal Society of Chemistry Lancaster, M.
2. Green Chemistry, Theory and Practice Anastas, P.T.; Warner, J. C.,
3. Introduction to Green Chemistry Matlack, A.S.,

CMC-805(A) Hydrocarbon Technology

Unit-I To impart knowledge of petroleum refining, hydrocarbon processing, and derived petrochemicals.

Unit-II New trends in refinery. Classification and Characterization: Classification of petroleum, Characterization of petroleum fractions. Atmospheric distillation and vacuum distillation units.

Unit-III Thermal conversion processes, Conventional vis-breaking and soaker visbreaking process, Coking processes, Catalytic conversion processes,

Unit-IV Fluid catalytic cracking, Catalytic reforming, Hydrocracking, Catalytic alkylation, Catalytic isomerization and catalytic polymerization. Finishing Processes:

Unit-V Sulphur conversion processes, Sweetening processes, Solvent extraction process, Hydrotreating process. Lube oil manufacturing Processes: Solvent extraction of lube oil fractions, Manufacture of petroleum wax, Hydrofinishing process.

References:

1. Bhaskara Rao, B.K. Modern Petroleum Refining Processes. Oxford & IBH Publishing Company Pvt. Ltd. New Delhi, (2007) 3rd Ed.
2. Nelson, W. L. Petroleum Refinery Engineering, Tata McGraw Hill Publishing Company Limited, (1958) 4th Ed.
3. Garry,J.H. Petroleum Refining Technology and Economics, Marcel Dekker Inc., (2001) 4 th Ed.
4. Wells G. M.Handbook of petrochemicals and processes, Ashgate Publishing Ltd, (1999) 2 nd Ed.
5. Spitz P. H. Petrochemicals: The rise of an industry, John Wiley & Sons, (1999).
6. Sarkar, G.N. Advanced Petroleum Refining, Khanna Publishers, (2000).

CMC-805 (B) INDUSTRIAL SAFETY & HAZARD MANAGEMENT

Unit-I Introduction: Safety program, Engineering ethics, Accident and loss statistics, Acceptable risk, Public perception, Toxicology: How toxicants enter biological organisms, How toxicants are eliminated from biological organisms.

Unit-II Industrial Hygiene: Government regulations, Identification, Evaluation, Control. Fires and Explosions: The fire triangle, Distinction between fire and explosions.

Unit-III Definitions, Flammability characteristics of liquids and vapors, MOC and inerting, ignition energy, Auto ignition, Auto oxidation, Adiabatic compression, Explosions.Designs to prevent fires and explosions: Inerting, Explosion proof equipment and instruments, Ventilations, Sprinkler systems.

Unit-IV Introduction to Reliefs: Relief concepts, Definitions, Location of reliefs, Relief types, Data for sizing reliefs, Relief systems. Relief Sizing: Conventional spring operated relief's in liquids.

Unit-V Conventional spring operated relief's in vapor or gas service, Rupture disc relief's in liquid, vapour or gas service. Hazards Identification: Process hazards checklists, Hazard surveys, Hazop safety reviews.

References:

1. Chemical Process Safety (Fundamentals with applications), D.A.Crowl & J.F.Louvar
2. Industrial Hygiene and Chemical safety
3. Safety and Accident Prevention in Chemical Operations, H.H.Fawcett and W.S.Wood
4. Chemical engineering Vol.6, Coulson and Richardson's

CMC- 805 (C) OPTIMIZATION TECHNIQUES

Unit-I Optimal problem formulation, Single variable optimization algorithms, Multi variable optimization algorithms including simplex search method; Cauchy‟s steepest descent method; Levenberg Marquardt‟s method.

Unit-II Constrained optimization algorithms including Khun-Tucker conditions, transformation methods; direct search methods; liberalized search techniques; feasible direction method, Specialized algorithms including Integer programming; geometric programming.

Unit-III Nontraditional optimization techniques including simulated annealing, genetic algorithms (GA), introduction to multi objective optimization problems. Application of all the aforesaid techniques with the help of the frequently used benchmark functions for engineering design.

Unit-IV Scope & Objective: Optimization has become a part of computer aided design activities where the goal is not only to achieve a feasible design but also a design objective. The course provides basic knowledge of deterministic algorithms as well as algorithms which are stochastic in nature with probabilistic transition rules, new methods in computational intelligence or „soft computing‟ inspired by evolutionary processes in nature, such as genetic algorithms.

Unit-V The course consists of lectures and a project component, which includes both model building and programming. This course also provides an opportunity to get conversant with optimization toolbox of MATLAB by the Mathworks, Inc.

References:

1. Engineering Optimization Theory & Practice, S. S. Rao,
2. Multi-Objective Optimization Using Evolutionary Algorithms K. Deb,
3. Process Plant Simulation, B.V. Babu
4. Optimization of Chemical Processes, T. F. Edgar, D. M. Himmelblau,

CMC- 806 INDUSTRIAL TRAINING PROJECT-II

The focus of the Industrial Training Project-II is on preparing a working system or some design or Understanding of a complex system using system analysis tools and submit it the same in the form of a write up i.e. detail project report. The student should select some real life problems for their project and maintain proper documentation of different stages of project such as need analysis market analysis, concept evaluation, requirement specification, objectives, work plan, analysis, design, implementation and test plan. Each student is required to prepare a project report and present the same at the final examination with a demonstration of the working system (if any).