M. Engg. in Chemical Engineering
Course Content

CH-501: Chemical Thermodynamics – III

Review of First and Second Laws of Thermodynamics; Entropy Calculations; Maxwell Relations, Development of Equation of State; Thermodynamics of Phase Equilibria; Gibbs Deuham Equation; Chemical Potential; Activity Coefficient; Fugacity and Fugacity Coefficient; Excess Gibbs Free Energy; Phase Equilibrium at low to moderate pressure; Ideal and Non-Ideal Solutions; Residual and Excess property relation; Property changes of mixing; Heat Effects of Mixing; VLE with Cubic Equation of state; Mixing Rules; Liquid models using UNIFAC and UNIQUAC; Chemical Reaction equilibrium; Gibbs Free Energy Change and Equilibrium Constant; Evaluation of Equilibrium and conversions; The Phase Rule and Duhem Theorem for Reaction Systems; Statistical Thermodynamics

CH-502: Advanced Reaction Engineering

Isothermal Reactors; Non-Isothermal Reactor; Batch, Tubular and Stirred Tank Reactors; Stable Operating Conditions in Stirred Tank Reactor; Non-Ideal Reactors; Residence Time Distribution; Conversion Models in Non-Isothermal Reactors.

Catalysis and Adsorption; Solid Catalysts; Preparation and Classification of Catalysts; Surface Area, Density and Void Volume of Catalysts; Rate Equation of Fluid-Solid Catalytic Reactions.

External Transport Processes in Heterogeneous Reactions; Fixed Bed and Fluidized Bed Reactors; Internal Transport Processes; Reaction and Diffusion in Porous Catalysts; Effectiveness Factors; Interpretation of Experimental Data from Laboratory Reactors; Design of Heterogeneous Reactors.

CH-503: Transport Phenomena

Momentum Transport; Viscosity; Shell Momentum Balances; Equations of Change; Momentum Transport with Two Independent Variables; Interphase Transport in Isothermal Systems.

Energy Transport; Thermal Conductivity; Shell Energy Balances; Equations of Change; Energy Transport with Two Independent Variables; Interphase Transport in Non-Isothermal Systems. Mass Transport; Diffusivity; Shell Mass Balances; Equations of Change; Mass Transport with Two Independent Variable; Interphase Transport with Multicomponent Systems.

Transport in turbulent flow: Fluctuations and time-averaged quantities. Time averaged form of the governing equations of momentum, energy, and mass transport. Expressions for the Reynolds stresses, turbulent energy and mass flux. Temperature and concentration distribution in turbulent pipe flows.

CH-504: Advanced Process Control

Development of Process Models; Dynamic Behavior of Linear Systems; Frequency Analysis; Stability Analysis; Feedback Control Systems; Cascade, Feed-forward and ratio control; multivariable system; cascade control; over-ride control; selective control; Dead time Compensation, inferential control, adaptive control; Multi-input and output systems – process and control loop interactions, control systems – Z transforms, discrete time models, closed loop analysis, digital control system implementation.

CH-505: Mathematical Methods in Chemical Engineering

Classification of Ordinary and Partial Differential Equations, Analytical Solutions of Ordinary and Partial Differential Equation; Integrating Factor; Method of Characteristics; Separation of Variables; Similarity Transformation; Laplace Transformation.

Numerical Solutions of Ordinary and Partial Deferential Equations; Initial and Boundary Value problems; Solution of non-linear and Stiff Ordinary Differential Equations; Solution of Partial Differential Equations Using Finite Difference and Finite Element Methods, Numerical Integration, Matrix Algebra, Linear and Non-Linear Algebraic Equations; Eigen values and Eigenvectors; Computer Programming of Numerical Methods.

CH-510: Polymer Science

Introduction; Molecular Weight Distribution; Polymer Synthesis; Cross Linking Plasticizers and Fillers; The Solubility Parameter; Thermodynamics of Mixing; Dilute Solutions; Determination of Number Average Molecular Weight of Common Polymers; Intrinsic Viscosity.

Phase Separation Behavior; Diffusion and Permeability in Polymers; The Amorphous State of Polymers; The Crystalline State of Polymers; Glass Rubber Transition Behavior.

Cross Linked Polymers and Rubber Elasticity; Polymer Visco-elasticity and Rheology; Mechanical Behavior of Polymers.

CH-511: Polymer Processing

Simple Model Flows; Poiseuill Flow, Couette Flow; Applications in Wire Coating, Combined Flow of Power Law Fluid.

Extrusion; Newtonian Isothermal and Adiabatic Analysis of Extrusion; Non-Newtonian Isothermal and Adiabatic Analysis, Optimal Design, Extrusion with Improved Heat Transfer: Injection Molding; Isothermal Newtonian Flow into Cavity; Viscous Heating in a Runner; Runner Cavity Combinations; Power Law Flow into Cavity; Balancing of Runners.

Elastic Phenomena; Die Swell and Melt Fracture; Stability of Flows; Coating; Calendaring and Mixing of Processes.

CH-512: Applied Statistics

Introduction; Simple Comparative Experiments; Concept of Sampling and Sampling Distribution.

Analysis of Variance; Experiments with Single Factor; Regression Approach to ANOVA; Randomized Blocks; Latin Square and Related Designs.

Factorial Designs; 2k Factorial Designs with Blocking and Confounding; Two Level Fractional Factorial Designs; Three Level and Mixed Level Factorial and Fractional Factorial Designs.

Fitting Regression Models; Optimization of Regression Models; Experiments with Random Factors; Nested and Split Plot Designs.

CH-513: Advanced Composite Materials

Synthetic fibers (organic and inorganic), their properties, production, and selection; Matrix materials/selection; Control of interface properties through design, coatings, and treatments; Metal matrix composites; Ceramic matrix composites; Polymer matrix composites; Stiffness of a unidirectional (orthotropic) lamina; Micromechanics predictions of stiffness; Strength of a unidirectional lamina; Deformation of laminates, matrix formulation; Special laminates, stress distribution; Short Fiber Composites;
Thermal conductivity and use of composites for thermal management; Effects of fiber orientation and composite damage on thermal conductivity and CTE; Moisture absorption coefficients, transport properties, and mass diffusion; The design process; Manufacturing techniques, RTM, Injection Pultrusion, Filament Winding etc., including selection considerations and methods.

CH-514: Petroleum Refining Engineering

Introduction; Overall Refinery Flows; Refinery Products; Refinery Feed Stocks; Petroleum Composition; Crude Distillation Curves.
Crude Distillation; Desalting; Atmospheric and Vacuum Distillation.
Catalytic Reforming; Reforming Catalysts, Reactor Design, Yield and Costs; Catalytic Cracking; Fluidized Bed Catalytic Cracking; Cracking Reactions; Catalyst used in Cracking; yield Estimation; Capital and Operating Costs.
Hydrotreating; Hydro treating Catalysts; Reaction; Process Variables; Operating Costs; Catalytic Hydro cracking and Hydroprocessing; Hydrocracking Reactions; Feed Preparation; Catalysts; Process Variables Yields, Investment and Operating Costs.
Supporting Processes; Hydrogen Manufacture; Acid Gas Removal; Sulfur Recovery; Control Estimation Techniques.

CH-515 : Computational Fluid Dynamics

Introduction; Governing Equations of Fluid Flow and Heat Transfer; Classifications of Equations; Turbulence and its Modeling; Closure Models; The Finite Volume Method for Diffusion Problems in Two and Three Dimensions; Difference between Finite Volume and other Numerical Methods; Examples; LES and DNS methods and their Solution Techniques.
The Finite Volume Method for Convection/Diffusion problems; Central Difference Scheme; Discretizations, Conservativeness, boundedness, transportiveness; Up winding Differencing Scheme; Hybrid Differencing Scheme; The SIMPLE and PISO Algorithms; Applications of Boundary Conditions.
The Finite Volume Method of Unsteady Flows; Crank-Nicolson Scheme, Transient SIMPLE and PISO algorithms; Steady state Calculations using Pesudo-Transient Approach
Solution of Discretized Equation; Gaussian Elimination; The Tri- Diagonal Matrix Algorithm for 2D and 3D Applications; Use of CFD Software FLUENT to Solve Typical Chemical Engineering Problems.

CH-516: Advanced Mass Transfer

Diffusive and convective mass transfer; Applications of the Stefan-Maxwell equation; Fick's Law; Prediction of Diffusion Coefficients, Convective Mass Transport, correlations for mass transfer coefficients, Film Theory, Penetration Theory, Higbie's Theory, Gas-Liquid Mass Transfer with Chemical Reaction, Analogies with Heat Transfer, boundary Layers with Mass Transfer, Mass Transfer with CFD

CH-517: Corrosion

Introduction, definition of corrosion, forms of corrosion, cost of corrosion; Electrochemistry, oxidation/reduction reactions, corrosion as an electrochemical reaction; Reference Electrodes, Galvanic Series, Nernst Equation, Pourbix Diagrams; Faraday's Law, area effects, Galvanic Corrosion, Active/Passive Cells, Thermo galvanic Corrosion.

Environment-related corrosion; Physical and Chemical Soil Characteristics; Moisture effects; Electrical Resistivity; Engineering Materials, metals and non- metals; Forms of Corrosion, pitting, crevice corrosion, fill form corrosion, galvanic corrosion, environmental cracking, flow assisted corrosion, intergranular corrosion etc.

Methods of Corrosion Control, material selection, modification of environment, protective coatings, cathodic and anodic protections; Corrosion Monitoring Techniques, introduction, inspection methods, specimen exposure, cathodic protection monitoring.

CH-518: Fluidization Engineering

Introduction; Fluidized Bed Behavior; Advantages and Disadvantages of Fluidized Beds; Industrial Applications; Distributors, gas jets and pumping power; Bubbling Fluidized Beds; Entrainment and Elutriation from Fluidized Beds; High Velocity Fluidization; Solid Movement, mixing segregation and staging; Dispersion and Gas Interchange in Bubbling Beds; Particle to Gas Mass and Heat Transfer; Heat Transfer between Fluidized Beds and Surfaces; Design of Fluidized Bed Reactors.

CH-519: Biochemical Engineering

Introduction; Enzyme Kinetics; Enzyme Engineering; Biosensors; Metabolic Stoichiometry; Metabolic Engineering; Metabolic Growth Equations; Bio-Reactor Design; Biological Reaction Engineering; Oxygen Transfer in Bio-Reactors; Applications; Downstream Processing and Product Recovery; Process Design and Scale Up Criteria; Bio-Process Engineering Design.

CH-520: Advanced Heat Transfer

Optimal design of shell and tube heat exchangers. Pinchtechnology. Flow arrangements of increased heat recovery. Condensation of single vapours, condensation of single and mixed vapours. Vaporizers, evaporators and reboilers. Extended surfaces heat transfer, cooling towers, furnace design and operation. Process design of equipment of heat transfer operation based on performance and economic optima.

ME-543: Combustion Engineering

Principle of combustion; thermo chemistry; equilibrium, chemical kinetics, flame temperature, flame velocity, flame stability, diffusion flames, spray combustion, detonation, equations of motion including reaction, heat and diffusion.

Application of combustion: Discussion of combustion problem including pollution fire, explosion hazards, furnace combustion chambers, combustors for reciprocating engines, jets and rockets.

Boiler: Modular sectional and condensing types, burners for fuel, gases liquid and solid fuels and part load characteristics, safety supply, storage, solid fuel storage, mechanical handling, automatic stokers and ash disposal. Fuels, Natural and forced draught operation with and without acid condensation. Flue dilution systems, gas analysis for efficiency and pollution monitoring. Control application and feedback theory to produce practical systems for plant and zone / emission output controls on / off. Step and analogue controls, centralized systems and modern computer control using optimization, self-adaptive and self-tuning conditions

and energy monitoring. Standard, legal aspects, codes of practice for design, installation, operation, insurance and safety.

Environmental Issues: Flue emissions, CO, CO_2, NOX, particulars and combustible emissions, acid rains, asbestos removal