SYLLABUS for PGQP56
Chemical & Polymer Engineering/ Thermal Engineering

Engineering Thermodynamics

Thermodynamic systems; thermodynamic laws; equations of state; reversible and irreversible processes; entropy; application of first and second laws to steady/unsteady processes in open/closed systems; Gibbs and Helmholtz free energies; chemical potential and criteria of equilibrium; Maxwell equations and thermodynamic properties of pure substances; phase equilibria; chemical reaction equilibria; homogeneous reaction system.

Fluid Mechanics

Properties and classification of fluids; fluid statics; velocity field; stream function; irrotational flow; integral and differential analysis for fluid motion: Reynolds' transport theorem; Navier-Stoke's equation; Euler & Bernoulli's equation; dimensional analysis and similitude; internal and external fluid flow: friction factor; energy losses in fittings, valves etc.; flow measuring devices; fluid machinery: pump, blower; agitation; introduction to non-Newtonian fluid; introduction to compressible flow.

Heat Transfer Operation

Basic modes of heat transfer. Conduction: basic equations of one-dimensional, two-dimensional and three-dimensional conduction; steady conduction in slabs, cylinders and spheres; critical thickness of insulation; transient conduction: analytical solution for slabs; use of transient temperature charts for slabs, cylinders, and spheres; lumped system of analysis. Convection: equation of motion; equation of energy; hydrodynamic and thermal boundary layers; forced convection inside tubes, over cylinders and spheres; natural convection, Empirical equations for free and forced convection; boiling and condensation heat transfer; basic types of heat exchangers; overall heat transfer coefficient; LMTD method, effectiveness-NTU method. Radiation: black body and gray body radiation; shape factor; Kirchhoff's law; Radiation shields; radiation from gases. Evaporation: evaporator capacity, economy and types; single and multiple effect evaporators, forward and backward feed evaporation, evaporator calculations.

Mass Transfer Operation

Concepts of molecular diffusion and mass transfer coefficient; interphase mass transfer; the equilibrium stage approximation; conservation relations; reflux; constant molal overflow; batch distillation; Ponchon-Savarit and McCabe-Thiele analysis of binary distillation; introduction to multi-component distillation; equilibrium solubility of gases in liquids; counter-current multi-stage absorption; continuous contact equipment; multi-component systems; absorption with chemical reaction

Environmental Pollution Control

Sources of water, air and land pollution; environmental laws & standards; design of pollution abatement systems for particulate matter and gaseous constituents; hazardous waste disposal and treatment; solid-waste disposal and recovery of useful products; specification of clean technologies and recovery schemes of useful chemicals; pollution prevention through process modification; recovery of by-products; energy recovery; waste utilization and recycle and reuse and waste generation minimization; design of control equipment and systems.

Polymer Science and Technology

Basic concepts and definitions of polymers, classification of polymers, nomenclature of polymers, polymerization mechanism, thermal transition in polymer, polymer additives and reinforcements, mechanical properties of polymers, polymer degradation and the environment, processing of thermoplastics, thermosets, and rubbers. Principle and theories of polymer processing, basic concept of compounding and processing, classification, and type of additive for Plastics. Rheology of polymer melt. Mixing process: distributive mixing, dispersive mixing, and mixing devices. Molecular weight, weight distribution of polymers. Structure property relationship of polymers.

Polymer Processing methods: extrusion (single screw and double screw), injection moulding, blow moulding, compression moulding, calendaring, etc. Polymer blends, advantages, disadvantages, types of polymer blends.

Rubber Science and Technology

Source, isolation and processing of latex, various natural rubber grades and products, Chemistry of rubber and rubber additives, compounding and vulcanization mechanism, chemistry of vulcanization, degradation and aging of rubber, modification of rubber, theory of rubber elasticity, rubber reinforcement. Synthetics rubber, their types, and applications

Chemistry

Organic, inorganic chemistry and physical chemistry, nanoscience and technology, surface, interfaces and catalyst, advanced functional organic materials, separation techniques, energy storage materials and devices, green chemistry, environmental chemistry. Analytical techniques and data analysis.

Biochemical Engineering

Introduction to Microbiology: Cell structure, characterization, classification of microorganisms; environmental and industrial microbiology; cell nutrients and growth media. Chemicals of Life: Repetitive and non-repetitive biological polymers, lipids, fatty acids and other related lipids, carbohydrates, mono-, di- and polysaccharides, amino acids and proteins, structure of proteins, protein denaturation and renaturation, antibodies, nucleic acids, nucleotides to RNA and DNA, DNA double helix model.

Material Science

Atomic structure and interatomic bonding; structure of crystalline solids; imperfections; diffusion; Mechanical properties of metals; dislocation; strengthening; failure; phase diagram; structure, properties, applications, processing of ceramics and polymers; composites; corrosion degradation of materials; corrosion protection; electrical, thermal, magnetic and optical properties; property requirements and material selection.

Fuels and Combustion

Combustion of gaseous and vaporized fuels, combustion of liquid fuels, combustion of solid fuels, fluidized bed combustion