

Syllabus for Ph.D. entrance test in Chemical Engineering Department

Unit1: Engineering Mathematics

Linear Algebra: Matrix algebra, Systems of linear equations, eigenvalues and eigenvectors.

Calculus: Functions of a single variable, Limit, continuity and differentiability, Taylor series, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First-order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one-dimensional heat and wave equations and Laplace equation.

Complex variables: Complex number, polar form of complex number, triangle inequality.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions, Linear regression analysis.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations. Integration by trapezoidal and Simpson's rule. Single and multi-step methods for numerical solution of differential equations.

Unit 2: Process Calculations and Thermodynamics

Steady and unsteady state mass and energy balances, including multiphase, multicomponent, reacting, and non-reacting systems. Use of recycle, bypass, and purge calculations; Gibb's phase rule and degree of freedom analysis.

First and Second laws of thermodynamics. Applications of first law to close and open systems. Second Law and Entropy. Thermodynamic properties of pure substances: Equation of State and residual properties; properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibrium.

Unit 3: Fluid Mechanics and Mechanical Operations

Fluid statics, surface tension, Newtonian and non-Newtonian fluids, transport properties, shell-balances including differential form of Bernoulli equation and energy balance, equation of continuity, equation of motion, equation of mechanical energy, Macroscopic friction factors, dimensional analysis and similitude, flow through pipeline systems, velocity profiles, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds, Turbulent flow: fluctuating velocity, universal velocity profile, and pressure drop.

Particle size and shape, particle size distribution, size reduction and classification of solid particles; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, agitation and mixing; conveying of solids.

Unit 4 Heat and Mass Transfer

Steady-state heat conduction, convection and radiation, heat transfer coefficients, boiling and condensation, types of heat exchangers, and their process calculations.

Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film theory, momentum, heat, and mass transfer analogies; design and operation of distillation absorption, adsorption, and drying.

Unit 5 Chemical Reaction Engineering

Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, kinetics of enzyme reactions (Michaelis-Menten and Monod models)

Unit 6: Process Instrumentation and Analytical Techniques

Temperature, pressure, and flow measurement devices, acoustic measurement, control valves, and signal converting elements. Analytical techniques Principles of characterization techniques, GC / GC-MS / Spectrophotometer /HPLC / AAS / ICP, FTIR, BET, XRD, SEM, TEM.

Unit 7: Chemical and Bio-Technology

Inorganic chemical industries (sulfuric acid, phosphoric acid); fertilizers (Ammonia, Urea, and SSP); polymerization industries (polyethylene, polypropylene, PVC and polyester synthetic

fibers). Cells, types of cells, cell structure, biomolecules, structure and functions, enzymes-kinetics, microorganisms, microbial growth and nutrition.

Unit 8: Environment Science

Air and water pollution control technologies, Industrial wastewater treatment, Solid waste management, Air quality testing, Water quality assessment parameters, and drinking water quality assessment. Operation of Sewage treatment plant (STP) and Common Effluent treatment plant (CETP).