BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY), PUNE, INDIA
PhD Entrance Test – 2024
SECTION-II: Chemical Engineering - 35 Marks

Topics covered
Engineering Mathematics Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors; Calculus: Functions of single variable, Limit, continuity and differentiability, Taylor series, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima; Numerical methods for Chemical Engineering: Roots of polynomial equation, curve fitting, interpolation; Numerical differentiation and integration: Differentiation by Euler's, Runge Kutta, Milne' Predictor method, Integration by trapezoidal and Simpson's rule. Single and multi-step methods for numerical solution of differential equations.
Process Calculation and Chemical Engineering Thermodynamics ***Process Calculations:*** Basic Chemical Calculations; Energy balance; Material balance; recycle, bypass and purge calculations. ***Chemical Engineering Thermodynamics:*** 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, thermodynamic consistency of experimental equilibrium data; Chemical reaction equilibrium, Introduction to molecular thermodynamics of fluid phase equilibrium.
Transport Processes ***Fluid Flow Operations:*** Fluid Statics; Newtonian and non-Newtonian fluid behavior; Flow of incompressible fluids in pipe: friction factor, Hagen Poisuille equation; Flow of compressible fluids: Processes of compressible flow, adiabatic frictional flow, isothermal frictional flow; Flow past immersed bodies: drag and drag coefficient, Kozeny-Carman equation, motion of particles through fluids, Fluidization: Conditions for fluidization, minimum fluidization velocity, applications of fluidization; Two phase flow: Gas/liquid, liquid/liquid and gas/solid flow, flow types and regimes in horizontal and vertical flow, regime map, behavior of non-Newtonian fluids in two phase flow. ***Heat Transfer and Mass Transfer*:** Basic modes of heat transfer: Conduction, convection, radiation; Heat exchangers and evaporators: Design of double pipe, shell and tube heat exchangers, and single and multiple effect evaporators; boiling, condensation. Fick's law of diffusion and mass transfer theories; Heat mass and Momentum analogies; HTU and NTU concept; Process design concepts of

mass transfer equipments: distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification, and adsorption.

Chemical Reaction Engineering and Process Dynamic and Control

Chemical Reaction Engineering: Kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, kinetics of solid catalyzed reactions: diffusion with reaction in porous catalyst, mechanism of catalytic reactions, development of rate equations, estimation of kinetic parameters, external/internal mass and heat transfer resistances in catalyst particles; non ideal reactors; residence time distribution; single parameter model; non-isothermal reactors; rate and performance equations for catalyst deactivation.

Process Dynamics and Control: Transfer function and dynamic responses of various systems: first order, second order, interacting, non interacting, transportation lag, inverse response system; Controller modes P, PI, PID; Stability testing methods: Routh stability, Root locus, Bode diagram, Nyquist plot; Controller tuning: Z-N, Cohen Coo, process reaction curve method; Control systems with multiple loops: MIMO control systems, interaction and decoupling of control loops; Advance control systems: cascade, ratio, smith predictor, selective control, adaptive and inferential control systems.

Project Engineering and Economics

Techno economic feasibility report; Primary utilities; Secondary utilities; Process design development; Process selection; Principles of process economics; Cash flow for industrial operation; Total product cost: Manufacturing cost, direct production cost, fixed charges, general expenses; Balance sheet; Depreciation; Break even chart; Plant location and layout; Critical path method (CPM); Program evaluation and review technique (PERT); Basic engineering data for plant design.

Text Books/References:

1.	B. S. Grewal, Higher Engineering Mathematics, 42nd Ed., Khanna Publication, Delhi, 2017.
2.	P. N. Wartikar and J. N. Wartikar, Applied Mathematics (Volumes I and II), 7th Ed., Pune Vidyarthi Griha Prakashan, Pune, 2013.
3.	S.C. Chapra, R.P. Canale, Numerical Methods for Engineers, 6th Edition, Tata-McGraw Hill Publications, 2012.
4.	W. L. McCabe, J. C., Smith, and P. Harriott, Unit Operations of Chemical Engineering, McGraw-Hill, 6th. Ed., 2001
5.	J.M. Coulson, J. F.Richardson, J. R. Backhurst, J. H. Harker, Chemical Engineering Volume 1, 6thedition, Pergamon Press, 2003.
6.	B. I. Bhatt and S. M. Vora, Stoichiometry (SI Units), 5th Ed., Tata McGraw Hill Publishers, New Delhi, 2010.
7.	J. M. Smith and H. C. Van Ness, "Introduction to Chemical Engineering Thermodynamics",

	McGraw- Hill Publication
8.	K.V. Narayanan, Chemical Engineering Thermodynamics, PHI Learning Pvt. Ltd.
9.	J. P. Holman, Heat Tansfer , 9th edn. The McGraw-Hill Companies, 2008
10	D. Q. Kern, Process Heat Transfer, Tata McGraw-Hill Edition, 1997
11.	J. H. Wetly, C.E. Wicks and R. E. Wilson, Fundamentals of momentum, heat and Mass transfer, John Wiley and sons
12.	A. L. Hines, and R. N. Maddox, Mass Transfer Fundamentals and Applications, Prentice Hall
13.	C.J. King, Separation Processes, Tata McGraw Hill
14.	G. F. Froment and K.B. Bischoff, Chemical Reactor Analysis and Design, John Wiley and Sons
15.	J. M. Smith Chemical Engineering Kinetics, McGraw-Hill
16.	W.H. Press, S A Teukolsky S.A., W. T. Vetterling, and B.P. Flannery, Numerical Recipes in Multi-Language Code, Cambridge University press
17.	Sharma, M. M. and L. K. Doraiswamy, Heterogeneous Reactions, John Wiley and Sons
18.	G. Stephanopoulos, Chemical Process Control :An Introduction to Theory and Practice, Prentice Hall
19.	D.R. Coughanowr, Process Systems Analysis and Control, McGraw Hill
20.	M. S. Peters and K. D. Timmerhaus, Plant Design and economics for chemical engineers, fourth edition, Mc Graw Hill Publications, 2002.

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