BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY), PUNE, INDIA
PhD Entrance Test – 2020
SECTION-II: Chemical Engineering - 50 Marks

UNIT No.	Topics covered
UNIT-I	**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.
UNIT-II	**Chemical Engineering Thermodynamics:** Introduction to molecular thermodynamics of fluid phase equilibrium; Fundamentals concepts of statistical thermodynamics; Classical thermodynamics of phase equilibrium:open and closed systems, Gibbs-Duhem equation, chemical potential, fugacity and activity; Thermodynamic properties from volumetric data/fugacities at moderate pressure, fugacity of pure liquid or solid; Fugacities in gas mixtures: Virial equation of state, fugacities from Virial equation, third Virial coefficient, chemical interpretation of deviation from gas phase ideality, fugacities at high pressure, cubic equation of state, solubility of solids and liquids in compressed gas; Fugacities in liquid mixture: excess properties, models for excess Gibbs energy, activity and activity coefficient, thermodynamic consistency of experimental equilibrium data; Intermolecular forces and the theory of corresponding states- potential energy functions for different molecular systems, polar and non- polar molecules; Liquid phase models: Scatchard- Hildebrand theory, Lattice theory, two liquid theories, Flory- Huggins theory.
UNIT-III	**Heat Transfer and Mass transfer:** Conduction, convection, radiation; Modelling and design of heat transfer chemical process equipment; Mass transfer theories; Modelling and design of mass transfer equipment for distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification, and adsorption; Mass transfer in gas absorption with and without chemical reaction.
UNIT-IV	**Chemical Reaction Engineering:** Kinetics of homogeneous reactions, 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; Modelling and process design of multiphase reactors: hydrodynamics (pressure drop, hold- up and velocity profiles of phases involved), mixing studies (non-ideal flow behavior: RTD, estimation of dispersion/back-mixing), mass and heat transfer studies
UNIT-V	**Process Dynamics and Control:** Advance control systems: cascade, ratio, smith predictor, selective control, adaptive and inferential control systems and their application; Control systems with multiple loops: Design and control systems for multivariable processes, MIMO control systems, interaction and decoupling of control loops; Controls for nonlinear system; Discrete –time response of dynamic systems;Design of digital controllers.

Text Books/References:	
1.	Luyben, W.L. Process Modeling, Simulation and Control for Chemical Engineers, McGraw-Hill
2.	Govier, G.W.; Aziz, K. The Flow of Complex Mixture in Pipes, Society of Petroleum Engineers
3.	Brenner, C. E. Fundamentals of Multiphase flows, Cambridge University Press
4.	Smith, J. M.; Van Ness, H. C.; Abbott, M. M. Introduction to Chemical Engineering Thermodynamics, McGraw Hill
5.	Bird, R.B.; Stewart,W.E.; Lightfoot, E.N. Transport Phenomena; John Wiley and Sons Publications
6.	Wetly,J.H; Wicks,C.E.;Wilson, R.E. Fundamentals of momentum, heat and Mass transfer, John Wiley and sons
7.	Hines, A.L.; Maddox, R.N. Mass Transfer Fundamentals and Applications, Prentice Hall
8.	King, C. J. Separation Processes, Tata McGraw Hill
9.	Froment, G.F.; Bischoff, K.B. Chemical Reactor Analysis and Design, John Wiley and Sons
10.	Smith J.M. Chemical Engineering Kinetics, McGraw-Hill
11.	Press W.H;Teukolsky S.A.; Vetterling, W.T.; Flannery, B.P. Numerical Recipes in Multi- Language Code, Cambridge University press
12.	Sharma, M. M.; Doraiswamy, L. K. Heterogeneous Reactions, John Wiley and Sons
13.	Levenspiel, O.;Kunni, D. Fluidization Engineering, John Wiley and Sons
14.	Davidson, J. F.; Harrison, D. Fluidization,Academic Press Inc.
15.	Stephanopoulos, G. Chemical Process Control :An Introduction to Theory and Practice, Prentice
16.	Coughanowr, D.R.; Process Systems Analysis and Control, McGraw Hill
17.	Ewing, G.W. Instrumental Methods of Chemical analysis, Tata McGraw Hill

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