

All affiliated Engineering Colleges/ Institute, Shivaji University, Kolhapur.

# Subject: Regarding revised syllabus of Ph. D. Coursework of Chemical Engineering under the Faculty of Science and Technology.

#### Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the syllabus of **Ph. D. Coursework of Chemical Engineering** under the Faculty of Science and Technology.

This syllabus will be implemented from the academic year 2022-23 i.e. from June 2022 onwards.

You are therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully Registra

Copy to:

1	The I/c Dean	6	Appointment Section	
	Faculty of Science & Technology			
2	The Chairman, Respective Board of Studies	7	Affiliation Section (T.1)	
3	Director, Examination and Evaluation	8	Affiliation Section (T.2)	
4	Eligibility Section	9	P.G.Admission Section	
5	O.E. – 4	10	P.G Seminar Section	



# SHIVAJI UNIVERSITY, KOLHAPUR

**Course Work Syllabus** 

For

Ph.D.

**IN CHEMICAL ENGINEERING-2022-23** 

#### Ph.D. COURSE WORK: Theory paper II

(One paper out of two)

#### **Advances in Chemical Engineering-I**

Lectures: 4 Hrs. /Week Marks Theory: 100

Note: All Units are compulsory

#### Unit I

Advanced Transport Phenomena: Boundary conditions, Macroscopic balances. Governing equations of heat transfer: Energy balance, governing equations of mass transfer: Species mass balance, Constitutive equations, Simultaneous heat and mass transfer.

#### Unit II

**Advanced Chemical Engineering Thermodynamics**: Classical thermodynamics and statistical thermodynamics, phase equilibria and chemical reaction equilibria; phase non-ideality measurement using advanced models viz. NRTL, activity coefficient model, etc.; Energy calculations, Multi reaction Equilibria; Combined Phase and Reaction Equilibria; Basics of statistical thermodynamics

#### Unit III

**Catalysis, Reactor and Reaction Engineering:** Heterogeneous reactor analysis and design Special reactors, Molecular catalysis, Solid catalyst, supported catalyst, Hydrodynamic characteristics of different reactors: mechanically agitated contactors, bubble columns, slurry reactors, spray columns, loop reactors and modified versions; Design aspects of multiphase reactors: Determination of controlling step, determination of intrinsic kinetics and factors affecting intrinsic kinetics, pressure drop, fractional phase hold- up, mass and heat transfer coefficient, extent of mixing, etc.

#### Unit IV

Advanced Process Control: Modeling of a few complicated systems, State space and transfer function matrix models, Stability criterion of transfer function matrix models, Development of empirical model from process data, Identifying Discrete-Time models from experimental data, Mathematical analysis of automatic process control. Analysis and synthesis of linear and nonlinear feedback control systems. Introduction to computer aided control. Digital simulation and computation of control systems, Computer solutions to optimum control and control problems.

#### **Reference Books:**

Unit 1.

i) Transport Phenomena Bird R.B., W.E. Stewart and E.N. Lightfoot John Wiley and Sons, Academic Press 2007

ii) Fundamental of Momentum, Heat and Mass Transfer Welty, J.R., C.E. Wicks and R.E. Wilson John Wiley & Sons, New York 2014

iii) Elements of Transport Phenomena Sissom L.E. and D.R.Pitts McGraw Hill Book Company, New York 1972

iv) Transport Phenomena - A Unifed Approach Brodkey R.S. and H.C.Hershey McGraw Hill Book Company 1988

Unit 2.

i) Thermodynamics and Its Applications Jefferson W. Tester, Michael Modell Prentice Hall, India 1997

ii) Textbook of Chemical Engineering Thermodynamics Narayanan, K.V Prentice Hall, India 2001

iii) Introduction to Chemical Engineering Thermodynamics J.M. Smith and Van Ness H.C McGraw Hills, New York 1996

Unit 3.

i) Chemical Reaction Engineering Octave Levenspiel John Wiley and sons, New York 1999

ii) Catalysis (Vols. I & II) Emmett, P.H. Reinhold Publishing Corporation, New York 1954

iii) Elements of Chemical Reaction Engineering Fogler H.S Prentice Hall, New York 1986

iv)Chemical Engineering Kinetics Smith J.M McGraw- Hill Book Company, New York 2014

v) Chemical Reactor Design and Analysis Bischoff and FromentAddision Wesley, New York 2011

Unit 4.

i) Richardson and Coulson- Chemical Engineering Vol. 1-6

ii) Process systems Analysis &Control: Donald R. Coughanowr, McGraw Hill publications.

iii) Chemical Process Control: An Introduction to theory & Practice: By George Stephenopoulos, Person education.

# Theory paper II

# Advances in Chemical Engineering-II

Lectures: 4 Hrs. /Week Marks Theory: 100

Note: All Units are compulsory

# Unit I

Advanced Separation Technology: Separation techniques using LEM, Ionic liquids, extractive separation reactive crystallization reactive separation and modeling, Separations involving Lyophilization, Pervaporation and permeation techniques for solids, liquids and gases. Industrial viability and examples, Zone melting, Adductive crystallization, Other separation process, Supercritical fluid extraction, Oil spill Management, Industrial effluent treatment by modern techniques

# Unit II

**Computational Fluid Dynamics:** Introduction to computational modeling, index notation of vectors and tensors, control volume, Reynolds's transport theorem, governing equations, phenomenological models, numerical methods for CFD, PDE's, properties of numerical solutions, accuracy and error, Navier – Stokes equation, implicit and explicit methods, turbulence modeling, reactive flows and combustion, multiphase flow, polymeric liquids, rheological models, circulation, Die swell, extensional flows, DEM-Lattice Boltzmann-Immersed Boundary-Boundary Elements.

# Unit III

**Process Equipment Design:** Detailed Engineering & Process and Mechanical aspects and sketches with sectional front view full top and side view of Double pipe heat exchanger , Detailed Engineering & Process and Mechanical aspects and sketches with sectional front view full top and side view of shell and tube heat exchanger, Detailed Engineering & Process and Mechanical aspects and sketches with sectional front view full top and side view of horizontal and vertical condenser , Detailed Engineering & Process and Mechanical aspects and sketches with sectional front view full top and side view of evaporator , Detailed Engineering & Process and Mechanical aspects and sketches with sectional front view full top and side view of evaporator , Detailed Engineering & Process and Mechanical aspects and sketches with sectional front view full top and side view of evaporator , Detailed Engineering & Process and Mechanical aspects and sketches with sectional front view full top and side view of evaporator , Detailed Engineering & Process and Mechanical aspects and sketches with sectional front view full top and side view of evaporator , Detailed Engineering & Process and Mechanical aspects and sketches with sectional front view full top and side view of evaporator , Detailed Engineering & Process and Mechanical aspects and sketches with sectional front view full top and side view of bubble cap distillation column and Absorption column

Unit IV

Advanced Modeling, Simulation and Optimization: Multiscale simulations in materials, Industrial flow modeling, Data driven modeling, Non-linear system dynamics, modeling of chemical process optimization, advanced simulation approaches using CFD, etc. multi-variable and multi-objective optimization.

### **Reference Books:**

Unit I.

i) Separation Processes King, C.J Tata McGraw Hill 2013

ii) Separation Process Principles Seader, J. D and Ernest J. Henley John Wiley and Sons 2011

iii) New Chemical Engineering Separation Techniques Herbert M. Schoen Interscience Publishers 1962

iv) Perry's Chemical Engineering Hand book Robert H. Perry, Don W. Green Mc Graw Hills 1999

# Unit II.

i) Computational Fluid Dynamics – The basic with applications J. D. Andersor Jr Mc Graw Hill 2000

ii) Computational Fluid Dynamics for Engineering (vol. III) K A Hoffman Engineering Education System 2001

iii) Computational Fluid Flow and Heat transfer K. Muralidhar, T. SundarajanNarosa 2011

iv) Anderson, D. A; Tarmeheil, J. C; Pletcher, R. H., Computational Fluid Mechanics and Heat transfer, Hernispher, New York, 1984.

v) Ferziger, J. H and Peric, M., Computational methods for Fluid Mechanics, Springer, New York, 2002

Unit III.

i) Process Heat Transfer Kern. D. Q. McGraw Hill Book Company 2008

ii) Introduction to Process Design Equipment B.I. Bhatt & Thakore Tata McGraw Hill Book Company, New Delhi 2007

iii) Joshi's Process Equipment Design V. V. Mahajani and S. B. Umaeji MacMillan Publications India Ltd, New Delhi 2009

iv) Chemical Engineering Design (Vol. 6) Coulson and Richardson Butter-Worth Heinemann Ltd., New York 2005

v) Perry's Chemical Engineering Hand Book Don W. Green & Robert H. Perry McGraw Hill Book Company 2008 Unit IV.

i) Process Modeling, Simulation and Control for Chemical Engineers Luyben International Student Edition 1981

ii) Modeling and Simulation in Chemical Engineering Franks R.E. John Wiley 1972

iii) Process Modelling and Simulation Gaikwad R.W, and Dr.DhirendraDenetted& Co. 2006

iv) Optimization Techniques for Chemical Engineers T.F. Edgar and D.M. Himmelblau McGraw-Hill 1985

v) Optimization Techniques K. Deo Wiley Eastern 1995