BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
Instruction Division

SECOND SEMESTER 2014-2015

Course Handout (Part II)

Date: 11/01/2016

In addition to Part I (General Handout for all courses appended to the Time Table), this portion gives further specific details regarding the course.

Course No. : **CHE G641**
Course Title : **Reaction Engineering**
Instructor-in-charge : **Srinivas Appari**

1. **COURSE DESCRIPTION**

Non-isothermal reactor design (steady and unsteady state), Gas – solid reactions and reactors with emphasis on external and internal diffusion effects, Non-ideal reactors with emphasis on models for predicting conversion, design on heterogeneous reactor systems, Biochemical reaction systems

2. **SCOPE AND OBJECTIVE OF THE COURSE**

This course includes basic and advanced topics in Chemical Reaction Engineering. The initial part of the course aims to understand the basics in Kinetics and Reactor design gained at First Degree/ Undergraduate level to solve complex problems in reaction engineering. The emphasis will be on designing different heterogeneous reactor systems commonly encountered in practice.

3. **TEXT BOOK**

    1. O. Levenspiel, Chemical Reaction Engineering, John Wiley, 3rd Ed., 1999
    2. H. Scott Fogler, Elements of Chemical Reaction Engineering, PHI, 4th Ed, 2007

4. **REFERENCE BOOKS**

    1. Y. T. Shah, Gas-solid-liquid reactor design, McGraw Hill, 1979
    2. J.M. Smith, Chemical Engineering Kinetics, McGraw Hill, 3rd Ed., 1981

3. L. D. Schmidt, The Engineering of Chemical Reactions, Oxford University Press, 2nd Ed., 2014
4. G. F. Froment, K. B. Bischoff, J. De Wilde, Chemical Reactor Analysis and Design, John Wiley & Sons, 3rd Ed., 2011.
5. R. J. Kee, M. E. Coltrin, P. Glarborg, Chemically Reacting Flow: Theory and Practice, John Wiley & Sons, 2003.

5. COURSE PLAN

Lecture No.	Learning Objectives	Topics to be covered	Reference
1 – 2	Introduction	Review of fundamentals, Reactor types, Design equations and reactor design algorithm, Catalysis	T1, T2
3 – 4	Non isothermal reactor design	Review of Energy balance, Steady state reactor design of CSTR and PFR	T2, Chap. 8
5 – 7	Additional topics	Equilibrium conversion, non-adiabatic operation, multiple study states, multiple reactions	T2, Chap. 8
8 – 10	Non-ideal reactors	Review of concepts of RTD, Models for non-ideal reactors	T1 Chap. 12 – 16 T2, Chap. 13, 14
11 – 12	Heterogeneous reactions	Introduction, Rate equation and concept of rate controlling step, contacting patterns for 2 phase systems	T1 Chap. 17
13 – 16	Solid Catalyzed reactions (emphasis on intra-particle diffusion)	Review of catalysis and rate equation for surface kinetics, External diffusion (review only), Combined pore diffusion and surface kinetics, Heat Effects, Reactor Performance equations, Experimental methods for finding rates, Catalyst deactivation	T1 Chap. 18, 21 T2 Chap. 10 - 12
17 – 19	Packed and Fluidized bed	Overview, Staged reactor systems,	T1 Chap.

	catalytic reactors	Bubbling and circulating fluidized bed reactors, Reactor models	19, 20
20 – 22	Gas liquid reactions on solid catalysts	General rate equation, Reactor performance equations with one excess reactant, Contactor selection	T1 Chap. 22
23 – 25	Fluid – Fluid Reactions	Kinetics and rate equation, Rate equations mass-transfer with and without chemical reaction, Role of Hatta number, Use of solubility data to determine kinetic regime	T1 Chap. 23
26 – 28	Design of Fluid – Fluid Reactors	Contactor selection criteria, Straight Mass Transfer, Mass transfer plus not very slow reaction (counter and co-current towers, agitator and bubble-tank contactors etc.)	T1 Chap. 24
29 – 31	Fluid – Particle Reactions	Selection of Model (PCM and SCM), Shrinking Core Model for particles of unchanging size, Rate of reaction for varying particle size, Limitations of SCM	T1 Chap. 25 T2 Chap. 11
32 – 34	Design of Fluid – Particle Reactors	Contacting Schemes/ Patterns, Particle mixing involving size and gas composition, Fluidized bed with entrainment of Solid fines	T1 Chap. 26
35 – 37	Biochemical reaction Systems (Enzyme fermentation)	Non-elementary reaction kinetics, Reaction Pathways, Michaelis – Menten Kinetics, Batch and plug flow fermentors	T1 Chap. 27 T2 Chap. 7
38 – 40	Biochemical reaction Systems (Microbial fermentation)	Introduction, Batch and Mixed flow fermentors, Kinetic expressions, Substrate Limiting Microbial fermentation (Monod Kinetics), Optimum operating parameters, Product Limiting Microbial fermentation	T1 Chap. 28 – 30 T2 Chap. 7

6. **EVALUATION SCHEME**

No.	Evaluation Component	Duration	Weightage %	Date & Time	Remarks**
1.	Mid Sem. Test	1.5 hrs	20	16/3 11:00 - 12:30 PM	CB+ OB
2.	Assignments	-	10	-	-
3.	Surprise tests*	15 min	15	-	CB
4.	Project	-	15	-	-
5.	Comprehensive Examination	3 hrs	40	7/5 AN	CB+ OB

* Surprise tests will be conducted during class hours. Best **five** performances out of **six** will be considered for final grading.

** **CB** = Close book, **OB**= Open book

- Chamber consultation hours will be announced in the class.
- The notices will be displayed on the Chemical Engineering Notice Board
- Make-up will be granted for genuine cases only. Prior permission of IC is compulsory.

Instructor-in-charge (CHE G641)