Subject Code: 01CH0702
Subject Name: Chemical Reaction Engineering-II
B.Tech. Year – IV (Semester – 7)

Objective: The course is intended to heterogeneous reaction engineering and non-ideal reactors, catalysis, leading finally to design considerations. The subject deals with residence time distributions, Kinetics and design of reactors for non-catalytic fluid-fluid and fluid-particle reactions and catalysis and catalytic reaction kinetics.

Credits Earned: 4 Credits

Course Outcomes: After completion of this course, student will be able to:

1. Analyse the RTD studies for any flow reactor, to predict the deviation from ideal reactors by evaluating the dispersion number

2. Predict the rate controlling step for the fluid – particle, Fluid-Fluid, and Fluid - Catalytic reactions.

3. Classify catalysts and predict physical properties of catalyst, surface area, void volume, solid density pore volume distribution.

4. Understand the nature and mechanism of catalytic reactions.

Pre-requisite of course: A course on Chemical Reaction Engineering-I

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	IA (I)	CSE (C)	Viva (V)	Term work (TW)	
3	0	2	4	50	30	20	25	25	150

Theory Contents:

Unit	Topics	Contact Hours
1	**Non-Ideal Flow:** Basics of non-ideal flow, Residence time distribution, stimulus response techniques, The E,F and C Curves, their interrelationship, conversion in non-ideal flow reactors, Dispersion model, Chemical Reaction and dispersion, Intensity of fluid mixing. Tanks in series model, Deviation from plug flow, Models for real stirred tanks.	8
2	**Heterogeneous Reactions: Introduction:** Rate steps involved in heterogeneous systems, Overall rate expression for linear and nonlinear process, contacting patterns for two-phase systems	4

3	**Fluid-Fluid systems:** Rate equation, rate equation for straight mass transfer, kinetic regimes of mass transfer and chemical reaction, rate equation for mass transfer and chemical reactions, film conversion parameter, fluid-fluid reactor design.	6
4	**Fluid-Particle systems:** Fluid partial reaction kinetics, selection of a model, Shrinking Core Model for unchanging and changing size spherical partials, Diffusion through gas film and through ash layer controlling, Chemical reaction controlling, Shrinking core model, its limitations, Determination of rate controlling step.	6
5	**Catalysis:** Catalysts, Physical properties of catalyst, surface area, void volume, solid density, pore volume distribution, Classification and preparation of catalyst, catalyst promoters. Catalyst inhibitors, Catalyst poisons, Nature and Mechanism of Catalytic reactions.	4
6	**Solid-Catalysed reactions: Kinetics:** Adsorption isotherms and rates of adsorption and desorption. Kinetic regimes, rate equations for surface kinetics, Pore diffusion, determining rate controlling step, experimental methods for finding rates, product distribution in multiple reactions	4
7	**Introduction to Catalytic Reactors:** Packed bed catalytic reactors, fluidized bed reactors, trickle beds, slurry reactors.	4
	Total Hours	**36**

List of Experiments:

1) To find the kinetics of dissolution of benzoic acid.
2) To find the RTD data in tube for Pulse Input and to predict the conversion of given 1st order reaction with known rate constant by applying dispersion model & tank in series model.
3) To determine E and F curves for the Packed bed reactor and to predict the conversion for the 1st order reversible reaction of known rate constant. (3 Experiments at 3 different flow rates.)
4) To determine E and F curves for CSTR and to predict conversion for 1st order irreversible reaction known rate constant. (3 Experiments at 3 different flow rates.)
5) To determine E and F curves for PFR and to predict conversion for 1st order irreversible reaction known rate constant. (3 Experiments at 3 different flow rates.)

Reference Text Books:

1. Octave Levenspiel, “Chemical Reaction Engineering”, 3rd Edition, John Wiley & Sons (Asia) pvt. Ltd.
2. 2. H. Scott Fogler, “Elements of Chemical Reaction Engineering” 3rd Edition November, Prentice Hall of India Pvt Ltd

3. 3. J.M.Smith, “Chemical Engineering Kinetics”, 2nd edition, McGraw-Hill
4. 4. L. D. Schmidt, the Engineering of Chemical Reactions, Oxford Press.
5. 5. J. J. Carberry, “Chemical and Catalytic Reaction Engineering”, McGraw Hill, New York, 1976

Suggested Theory distribution:

The suggested theory distribution as per Bloom’s taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember	Understand	Apply	Analyse	Evaluate	Create
10%	**20%**	**25%**	**25%**	**10%**	**10%**

Instructional Method:

a. The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

b. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.

c. Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

d. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory

Design Based Problems (DP)/ Open Ended project (OEP):

In the beginning of the session, subject faculty will allot an OEP / DP to the students. Students will be free to choose a topic of their choice which will be relevant to the syllabus and they will either prepare a working model/ report / presentation / poster on their topic.

Online Web Resources:

1. http://nptel.ac.in/courses/103103029/
2. http://www.unitoperation.com/