Chemical Reaction Engineering-2

1.1 Course Number: CH352

1.2 Contact Hours: 2-1-2 Credits: 10

1.3 Semester-offered: 3rd Year-Odd

1.4 Prerequisite: Chemical Reaction Engineering-1

1.5 Syllabus Committee Member: Dr Amit Ranjan, Dr V S Sistla

2. **Objective:** The students will learn various heterogeneous reactions and catalytic mechanism, the kinetics and design of chemical reactors for heterogeneous systems, adsorption of fluid on solid surfaces, and the transport processes within the pores of solid catalysts. The students will also learn various types of industrially relevant catalytic reactors.

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topic	Lectures
1	Introduction	Heterogeneous processes, Catalysis and adsorption, Classification and preparation of catalysts, Promoters and inhibitors	2
2	Characterization	Surface area and pore size distribution, Introduction to other characterization techniques (XRD, electron microscopy, electron spectroscopy, thermal analysis, desorption spectroscopy)	5
3	Rate Equations & Kinetics	Rate equations of heterogeneous reactions, Hougen-Watson and power law models, Procurement and analysis of kinetic data, Kinetics of catalyst deactivation and regeneration	4
4	Pore/internal heat and mass transport	External transport processes and their effects on heterogeneous reactions, Yield and selectivity Reaction and diffusion in porous catalysts; Isothermal and non-isothermal effectiveness factors, Effect of intra-phase transport on yield, selectivity and poisoning, Global reaction rate	5
5	Design of catalytic reactors	Isothermal and adiabatic fixed bed reactors, Staged adiabatic reactors, Non-isothermal non-adiabatic fixed bed reactors, Fluidized bed reactors; slurry reactors, Trickle bed reactors, Reactors with novel configurations- radial flow reactors, honey-comb reactors, membrane reactors	7
6	Non-catalytic Reactions	Models for fluid-solid non-catalytic reactions, Controlling mechanisms and global reaction rates, Reactor design for fluid-solid reactions including	5

		fluidized bed reactors, Gas-liquid and liquid-liquid reactions, Rate equations based on film theory, Reactor design for instantaneous reactions and slow reactions	
7	Laboratory Classes	There will be 10-12 experiment designed based on the theory covered in the lectures to provide hand-on experience and in-depth understanding of the Chemical Reaction Engineering.	2 hours/ week
		Total	Lecture: 28

4. Readings

4.1 Textbook

1. Levenspiel, O., “Chemical Reaction Engineering”, John Wiley & Sons., Inc., New York
2. Smith, J.M., “Chemical Engineering Kinetics”, McGraw-Hill Book Co. Inc., New York
3. Fogler, H. C., “Elements of Chemical Reaction Engineering”, Prentice-Hall, Inc., Englewood Cliffs, NJ

4.2 Reference books

1. Peter Harriot (Ed). Chemical reactor design, CRC press, New York, 2016
2. J.M.Thomas and W.J.Thomas (eds) Principles and Practice of Heterogeneous Catalysis, Wiley-VCH, 2015.

5 Outcome of the Course: Students will obtain deeper understanding of overall and intrinsic rate determination for heterogeneous catalytic reactions and design aspects of industrial catalytic reactors.