Course Type	Course Code	Name of Course	L	T	P	Credit
DC	NCHC507	Advanced Chemical Reaction Engineering	3	1	0	4

Course Objective
• To provide a comprehensive study of chemical reaction engineering including design of equipment and practical applications.
Learning Outcomes
• The students will have knowledge of multiphase reactor design with non-isothermal, heterogeneous catalysis and catalytic reaction engineering.

Unit No.	Description of Lectures	Class Hours	Learning Outcomes
1.	**Non- ideality:** Review of analysis of isothermal reactors and non–ideality in reactors.	**8 L + 3 T**	Students learn the concepts of residence time distribution and micromixing and non-ideal reactor models.
2.	**Non catalytic Kinetics:** Kinetics of fluid– particle non–catalytic reactions, fluid–fluid non–catalytic reactions and application to design.	**10 L + 4 T**	Students understand how to design reactors to carry out non-catalytic reactions.
3.	**Heterogeneous reactions:** Diffusion and reaction: External diffusion effects on heterogeneous reaction, diffusion and reaction in spherical pellets, internal effectiveness factor, estimation of diffusion and reaction limited regimes, Wisz-Prater criterion for internal diffusion, Mears criterion for external diffusion, inter pellet heat and mass transfer.	**10 L + 4 T**	Students recognize the importance of diffusion effects in solid catalyzed reactions.
4.	**Solid catalysis:** Introduction, definitions, catalytic properties, classification of catalysts, steps in catalytic reaction, adsorption isotherm, chemisorption's, synthesizing rate law, mechanism and rate limiting steps, deducing a rate law from the experimental data, finding a mechanism consistent with experimental observation, evaluation of rate law parameters, catalyst promoters and inhibitors, catalyst deactivation.	**9 L + 3 T**	Students learn the salient aspects of solid catalysts and apply the LHHW methodology to derive the rate law for heterogeneous reactions.

5.	**Catalyst characterization:** Catalyst synthesis: impregnation and other techniques, physico-chemical characterization of catalyst.	**5 L + 0 T**	Students learn different methods to synthesize a catalyst and understand different catalyst characterization techniques.
	Total	**56**	

Textbooks:

1. Fogler, H. S. (2008). *Elements of Chemical Reaction Engineering*. 4th Ed., Prentice Hall.
2. Levenspiel, O. (2006). *Chemical Reaction Engineering*. 3rd Ed., Wiley.

Reference Books:

1. Carberry, J. J. (2001), *Chemical and Catalytic Reaction Engineering*. McGraw–Hill.
2. Froment, G. F., Bischoff, K. B., and De Wilde, J. (1979). *Chemical Reactor Analysis and Design*. Wiley.
3. Smith, J. M. (1981). *Chemical Engineering Kinetics*, McGraw–Hill. 3rd Edition.