Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NCHD513	Catalytic Processes and Reactors	3	0	0	3

Course Objective

- This course aims to help students utilize the concepts of heterogeneous catalysis and catalytic reactor design in industry and R&D.
- The course is primarily concerned with the recent advances in heterogeneous catalysis occurring at the interfaces, in particular, e.g., solid-gas phases interface, three-phase interface, and enzymatic catalysis. In particular, the course provides a holistic overview of the concepts of modern catalysts, as well as their synthesis, characterization, and application in reactors.

Learning Outcomes

- Upon completing this course, the students will be able to understand the recent advances in heterogeneous catalysis and different types of catalytic reactors. In particular, the course will help students develop expertise in catalyst synthesis and characterization and understand their kinetics.
- In addition, the students will have a detailed understanding of different types of modern catalytic processes and reactors, such as static reactors, stirred reactors, flow reactors, fluidized bed reactors, pulse reactors, micro-reactors, etc.

Unit No.	Description of Lectures	Contact Hours	Learning Outcomes
1.	**Introduction:** Introduction to heterogeneous catalysis, surfaces and adsorption, Langmuir isotherm,	7	A comprehensive introduction to heterogeneous catalysis, its fundamentals, and insights into working different working principles.
2.	**Catalysts and Catalytic Processes:** Different catalytic processes, e.g., unimolecular, bimolecular, and reversible.	7	The students will become adept in different types of catalysts and catalytic processes. In particular, how different catalysts function, application of kinetic and thermodynamic principles in catalysis
3.	**Catalysts Synthesis and Characterization:** Catalysts preparation, different types of supports, catalysts impregnation, co-precipitation, characterization techniques for chemical composition	7	The students will become adept in synthesizing different types of catalysts and its characterization techniques that includes wet analytical techniques, XRF, electron microscopy, and XRD etc.

4.	**Catalytic Reactors and Measurements:** Static reactors, stirred reactors, flow reactors	7	Learning outcomes will be in the form of understanding of a wide range of catalytic reactors used in the industry and how one can measure catalytic behavior in these reactors.
5.	**Kinetics and Mechanisms of Catalytic Reactions:** Kinetic of unimolecular reaction, bimolecular reactions, Langmuir-Hinshelwood kinetics, Eley-Rideal kinetics	7	This section will make students adept in developing kinetic models mathematically and mechanistically which will help them to design different catalytic reactors.
6.	**Mass and Heat Transfer Limitations:** External diffusion, internal diffusion, Heat transfer effects	7	The students will get understanding of the major challenges in reactor design caused due to mass transfer and heat transfer limitations.
	Total	**42**	

Text Books:

1. Julian H. Ross, *Contemporary Catalysis*. Elsevier, 2019

2. J.M. Thomas, W.J. Thomas, *Principles and Practice of Heterogeneous Catalysis*. VCH Publishers, 1997

Reference Books:

1. Boris Imelik, Jacques C. Vedrine, *Catalyst Characterization Physical Techniques for Solid Materials*. Springer Science, 1994

2. James T. Richardson, *Principles of Catalyst Development*. Springer, 1989