GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170501
Semester – VII
Subject Name: Chemical Reactions Engineering II

Type of course: Professional core

Prerequisite:
Chemical reaction engineering- 1.

Rationale:
The course is intended to familiarize the students with concepts of gas-solid catalytic and non-catalytic reactors and gas-liquid reactors, concepts of catalysis kinetics and mechanistic aspects of catalysts, design and rating of catalytic reactors and design aspects of Gas-Liquid Reactors

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Heterogeneous Reactions: Introduction: Rate steps involved in heterogeneous systems, Overall rate expression for linear and non linear process, contacting patterns for two-phase systems.	7
2	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.	7
3	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.	7
4	Introduction to 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.	7
5	Solid-Catalyzed 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.	7

6	Catalytic reactions, introduction to LHHW (Langmuir-Hinshelwood-Hougen-Watson) kinetic model. Introduction to Catalytic Reactors: Packed bed catalytic reactors, fluidized bed reactors, trickle beds, slurry reactors. Design concepts, Mass transfer correlations for various reactors, Isothermal and non-isothermal interphase effectiveness factor	**10**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	26	23	7	0	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. H. Scott Fogler, Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall of India Pvt. Ltd
2. Froment, G.B., and K.B. Bischoff, 1990, Chemical Reactor Analysis and Design, 2nd Ed., Wiley, New York
3. O. Levenspiel, Chemical Reaction Engineering, 3rd Edn, Wiley & Sons (1999).
4. Carberry, J.J., 1976, Chemical and Catalytic Reaction Engineering, McGraw-Hill, New York.

Course Outcomes: At the end of the course, the students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	To understand the nature and mechanism of catalytic reactions.	25
CO-2	To identify regions of mass transfer control and reaction rate control and calculate conversion	25
CO-3	To predict the rate controlling step for the fluid - particle reactions	25
CO-4	To develop conceptual framework for designing catalytic reactors.	25

List of Open Source Software/learning website:

Preparation of power-point slides, which include videos, animations, Pictures, graphics for better understanding theory – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus of Chemical Reaction engineering -1 is covered.

Suggested list of experiments to be performed (8 to 10 experiments are to be given)

The analysis will include various experiments with the objective of sample preparation, measurement of concentration, prediction of kinetics and modeling of kinetics data. Along with prediction of errors in experimentation and compare experimental data with models

1	Determination of properties of solids (pertaining to catalyst development and application)
2	Experiment on the Adsorption of oxalic acid (or any other suitable organic compound) on activated Carbon.
3	Study the effect of surface area on adsorption.
4	To conduct any experiment involving heterogeneous catalysis in the fixed bed reactor
5	Synthesize detailed reaction networks for catalytic reactions on solid catalyst surfaces, such as zeolites or TiO_2
6	Experiment on determining the mass transfer zone and an absorber's mass balance and efficiency
7	Experiment on predicting breakthrough curves in adsorption of any selected system with environmental application
8	Experiment on detection of the influencing factors contact time, temperature and mode of operation.
9	Experiment on fluidized bed catalytic reactor.
10	Kinetic modeling study of heterogeneously catalyzed chemical synthesis reactions.
11	Catalytic oxidation experiment to demonstrate the principles of i) reaction rate determination, ii) reactor design, iii) heterogeneous catalysis, etc

List of Open Source Software/learning website: Software:

Students can refer to video lectures available on the websites including NPTEL, Students can refer to the CDs which are available with some reference books for the solution of problems using software. Students can develop their own programs for the solutions of problems.

Open Ended Projects:

1. In the beginning of the academic term, faculties will have to allot their students at least one Open-ended Project / Study Report / Latest outcome in technology.
2. Literature survey including patents and research papers of fundamental process

- Design based small project **or**
- Study report based on latest scientific development or
- Technology study report/ modeling/ simulation/collection report **or**

- Computer based simulation/ web based application/ analysis presentations of basic concept field which may help them in chemical engineering.

3. These can be done in a group containing maximum **three** students in each.
4. Faculties should cultivate problem based project to enhance the basic mental and technical level of students.
5. Evaluation should be done on approach of the student on his/her efforts (not on completion) to study the design module of given task.