Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Institute of Technology
Semester-6 (B.Tech)

Subject: Chemical Reaction Engineering-II -BETCH16319

Type of course: Major (Core)

Prerequisite: Basic knowledge of Chemical Reaction Engineering.

Rationale: The course aims to acquaint students with ideas related to gas-solid catalytic and non-catalytic reactors, gas-liquid reactors, catalysis kinetics, mechanistic features of catalysts, catalytic reactor design and rating, and gas-liquid reactor design.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	150
4	0	2	5	60	30	10	20	30	

Legends: CI-Classroom Instructions; T – Tutorial; P - Practical; C – Credit; ESE – End Semester Examination; MSE- Mid Semester Examination; CA - Continuous Assessment; ALA-Active Learning Activities.

Course Content:

Sr. No	Course content	Hrs	% Weightage
1	**Heterogeneous Reactions:** Introduction: Rate steps involved in heterogeneous systems, Overall rate expression for linear and nonlinear process, contacting patterns for two-phase systems.	12	20

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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.	12	20
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.	12	20
4	**Catalytic reactions** 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.	12	20
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.	12	20

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1	**Case study:** Case study on different type of catalytic reaction and reaction mechanism and upload in on the GMIU Web Portal.	10
2	**Presentation** Students will give a presentation on the topic assigned by the faculty and upload PPT on the GMIU Web Portal.	10
3	**Simulation:** Students will simulate for any one type of reactor and also explain reaction Mechanism and upload PDF on the GMIU Web Portal.	10
Total		30

Suggested Specification table with Marks (Theory): 60

Distribution of Theory Marks (Revised Bloom's Taxonomy)						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage	30%	20%	30%	10%	05%	05%

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.

Course Outcome:

After learning the course, the students should be able to:	
CO1	Understand the nature and mechanism of catalytic reactions.
CO2	Identify regions of mass transfer control and reaction rate control and calculate conversion
CO3	Predict the rate controlling step for the fluid - particle reactions
CO4	Develop conceptual framework for designing catalytic reactors.
CO5	Structure of Solid catalyst and their uses in process.

List of Suggested Practical

Sr. No	Suggested Practical	Unit No	Hrs.
1	Determination of properties of solids (pertaining to catalyst development and application)	1	2
2	Experiment on the Adsorption of oxalic acid (or any other suitable organic compound) on activated Carbon	1	2
3	Study the effect of surface area on adsorption.	2	2

4	To conduct any experiment involving heterogeneous catalysis in the fixed bed reactor	2	4
5	Synthesize detailed reaction networks for catalytic reactions on solid catalyst surfaces, such as zeolites or TiO2	3	4
6	Experiment on determining the mass transfer zone and an absorber's mass balance and efficiency	3	4
7	Experiment on predicting breakthrough curves in adsorption of any selected system with environmental application	4	4
8	Experiment on detection of the influencing factors contact time, temperature and mode of operation	5	4
9	Experiment on fluidized bed catalytic reactor	5	4

Instructional Method:

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

From the content 10% topics are suggested for flipped mode instruction. Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses. The internal evaluation will be done on the basis of Active Learning Assignment.

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

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