Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Institute of Technology
Semester-5 (B.Tech.)

Subject: Chemical Reaction Engineering-I– BETCH15310

Type of course: Professional Core

Prerequisite: Basic Understanding of Chemical Reactions and stoichiometry

Rationale: Chemical Reaction Engineering (CRE) provides a rational and systematic approach to understanding, designing, and optimizing chemical reactors and processes, focusing on reaction kinetics, mass and heat transfer, and reactor performance for efficient and sustainable chemical production.

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	
4	0	2	5	60	30	10	20	30	150

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

Course Content:

Sr. No.	Course content	Hrs.	Weightage
1	**Overview of CRE;** Classification of reactions, rate of reaction, speed of chemical reactions. **Kinetics of Homogeneous Reactions;** **The rate equation, Concentration dependent terms** (Single and Multiple reactions, elementary and non-elementary reactions, molecularity and order of reaction, rate constant and its representation, kinetic models and its testing). **Temperature dependent term of rate equation;** Arrhenius Law, Comparison of theories with Arrhenius Law, Activation energy. **Mechanisms and predictability of reaction rate.** **Interpretation of Batch Reactor Data;**	20	30%

	Constant-Volume Batch Reactor; Irreversible, reversible, autocatalytic reactions of different orders. **Varying-Volume Batch Reactor;** Differential and Integral Method of analysis (for Zero, First, Second and nth order reactions.		
2	**Ideal Reactors for a Single Reaction;** **Ideal Batch Reactor;** Space Time and Space Velocity. Steady-State Mixed Flow Reactor Steady-State Plug Flow Reactor Holding Time and Space Time for Flow Reactors **Design for Single Reactions;** Size Comparison of Single Reactors, Mixed Versus Plug Flow Reactors, First- and Second-Order Reactions **Multiple-Reactor Systems;** Plug Flow Reactors in Series and or in Parallel, Equal-Size Mixed Flow Reactors in Series, Mixed Flow Reactors of Different Sizes in Series, Reactors of Different Types in Series **Recycle Reactor** **Autocatalytic Reactions**	15	20%
3	**Non-Ideal Reactors;** Basics of Non-Ideal Flow, The Residence Time Distribution, RTD, State of Aggregation of the Flowing Stream, Role of RTD, State of Aggregation, and Earliness of Mixing in Determining Reactor Behaviour **E, The Age Distribution of Fluid, The RTD;** Experimental Methods (Nonchemical) for Finding E, Pulse and Step experiment, Relationship between the F and E Curves, The Convolution Integral **Conversion in non-ideal flow reactors;** **The Dirac Delta Function** **Compartment Models** **Dispersion Models;** Fitting the Dispersion Model For Small Extents Of Dispersion, Large Deviation From Plug Flow, Correlations For Axial Dispersion, Chemical Reaction And Dispersion	15	30%
4.	**Tank in series Model** **Pulse Response Experiments and the RTD;** for first, second and nth tank, independence, one shot tracer input, closed recirculation system, recirculation with throughflow, Step Response Experiments and the F Curve **The Convection Model for Laminar Flow** **Earliness of Mixing, Segregation, and RTD**	10	20%

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1.	**Basics of CRE:** Explain Reaction Mechanisms and their predictability for reaction rate with examples in presentation and submit ppt on GMIU web portal	10
2.	**Numerical problem solving:** Students must solve 3 Numerical based on Design for Single Reactions given by the faculty. Upload on GMIU Web portal.	10
3.	**Identification of Reactors in chemical industries:** Identify the different types of ideal and non-ideal reactors used in chemical industries, prepare a mini report on reaction and material balance of reactors Upload on 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%	15%	15%	20%	00

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 the above table.

Course Outcome:

After learning the course, the students should be able to:	
CO1	Understand the basics of chemical reaction engineering.
CO2	Use principles of ideal reactors and design different types of ideal reactors.
CO3	Design Non ideal reactors and its application for various reaction kinetics.
CO4	Solve problem based on different Models for reactors with different type of reactions

List of Practicals:

Sr. No.	Description	Unit	Hours
1	Study of Isothermal Continuous Stirred Tank Reactor	1	4
2	Study of Plug Flow Tubular Reactor (Straight Tube Type)	1	4
3	Study of Kinetics of Dissolution of Benzoic Acid	2	4
4	Study of Adiabatic Batch Reactor	3	4
5	Study of Combined Flow Reactors (CSTR and PFR)	3	2
6	Study of Cascade Continuous Stirred Tank Reactor	4	4
7	R.T.D. Studies in Plug Flow Tubular Reactor	4	4
8	R.T.D. Studies in Packed Bed Reactor	4	4
Total			30

Instructional Method:

The course delivery method will depend upon the requirement of content and needs of students. The teacher in addition to conventional teaching method by black board, may also use any of 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, Virtual Laboratory

The internal evaluation will be done based on Active Learning Assignment

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

Reference Books:

[1] Chemical Reaction Engineering, Octave Levenspiel.

[2] Elements of Chemical Engineering by Fogler

[3] An Introduction to Chemical Engineering Kinetics & Reactor Design By Charles G. Hill

[4] Fundamentals of Chemical Reaction Engineering by Davis and Davis

[5] Chemical Reactor Design, Optimization, And Scaleup By E. Bruce Nauman