GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL TECHNOLOGY (36)

SUBJECT NAME: FUNDAMENTALS OF REACTION ENGINEERING

SUBJECT CODE: 2173612

B.E. VIIth SEMESTER

Type of Course: Chemical Technology

Prerequisite: Reactor design uses information, knowledge and experience of areas like thermodynamics, fluid mechanics, heat transfer and mass transfer & mathematics.

Rationale: The Fundamentals of Reaction Engineering principles learned in these subjects can also be applied in area such as waste water treatment and living systems in addition to the more traditional area of the manufacture of chemicals and pharmaceuticals. Reaction engineering is that engineering activity concerned with the exploitation of chemical reaction on commercial scale.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		PA(V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	3	6	70	20	10	20	10	20	150

L-Lectures; T-Tutorial/TeacherGuidedStudentActivity;P-Practical;C-Credit;ESE-EndSemesterExamination; PA-Progressive Assessment, ALA- Active Learning Assignment, OEP- Open Ended project

Content:

Sr. No.	Topic	Teaching Hours	Module Weightage (%)
01	**Kinetics of homogenous reactions** Classification of reactions, Definitions of reactions rate, variables affecting reaction rate, concentration dependent term of rate equation for single, multiple, elementary and non-elementary reactions. Molecularity and order of reaction. Kinetic models for non-elementary reactions. Temperature dependant term of rate equations from Arrhenius theory and comparison with collision and transition state theory. Activation Energy and Temperature Dependency. Temperature dependency from thermodynamics, comparison of theories. Prediction of reaction rate by theories. Searching for the mechanism.	7	15
02	**Conversion and reactor sizing** Batch reactor design equations, Design equation of flow reactors: CSTR, PFR and PBR. Application of design equations for continuous flow reactors, Reactors in series, combination of CSTRs and PFRs in series, Comparing the CSTR and PFR reactor volumes and reactor sequencing, space-time and space velocity. Introduction to semi batch reactor.	10	20

03	**Collection and Analysis of Rate Data** Constant volume batch reactor, Differential method of analysis, Integral Method, Method of Half lives, Method of initial rates.	10	20
04	**Multiple Reactions** Types of reaction, series – parallel reactions, concept of instantaneous and overall yield, Reactor/reactors selection based on yield of the desired product.	8	15
05	**Temperature and pressure effects** Single Reactions) Calculations of heats of reactions and equilibrium constants from thermodynamics, equilibrium conversion, General graphical design procedure. Adiabatic and non-adiabatic operations, strategies for heat transfer for reactors for exothermic reactions.	7	15
06	**Introduction to Heterogeneous catalysis** Catalyst, Promoter, Inhibitor, Catalyst properties, classification of catalyst, Steps in a catalytic reaction. Synthesizing rate law, Mechanism and rate limiting step, Deactivation of catalyst.	9	15

Suggested Specification table with Marks (Theory):

Unit No	Unit Title	Distribution of Theory Marks (%)					
		R Level	U Level	A Level	N Level	E Level	Total
1	Kinetics of homogenous reactions	9	1.5	1.5	1.5	1.5	15
2	Conversion and reactor sizing	12	2	2	2	2	20
3	Collection and Analysis of Rate Data	12	2	2	2	2	20
4	Multiple Reactions	9	1.5	1.5	1.5	1.5	15
5	Temperature and pressure effects	9	1.5	1.5	1.5	1.5	15
6	Introduction to Heterogeneous catalysis	9	1.5	1.5	1.5	1.5	15

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

Text Books:

1. Octave Levenspiel, "Chemical Reaction Engineering", 3rd Edition, John Wiley & Sons (Asia) Pvt Ltd.
2. H. Scott Fogler, "Elements of Chemical Reaction Engineering" 3rd Edition November, Prentice Hall of India Pvt Ltd.

Reference Books:

1. L. D. Schmidt, "The Engineering of Chemical Reactions", Oxford Press.
2. J.M. Smith, "Chemical Engineering Kinetics", 2nd, McGraw-Hill.

Course Outcomes:

1. To know how to select reasonable design from many available alternatives

2. Selection of reaction system that operates in the safest and most efficient manner can be the key to the economics success or failure of a chemical plant.
3. Synthesis of catalyst and its characterization.

List of Experiments:

1.	Integral Method of analysis
2.	Differential method of analysis
3	Kinetics by Half Lives Method
4	Activation Energy & Frequency factor calculation
5	Isothermal CSTR
6	Plug Flow reactor
7	Adiabatic Batch reactor
8	Study experiment on preparation techniques for catalyst
9	Study experiment on characterization techniques for catalyst

Major Equipment:

1. Batch Reactor
2. Isothermal CSTR
3. PFR
4. Cascade CSTR
5. Combined Flow Reactors.

Open Ended Project fields:-

Students are free to select any area of science and technology based on chemical technology applications to define Projects.

Some suggested projects are listed below:

1. To study the kinetics of various heterogeneous reaction
2. Preparation of review reports based on patents available for recent innovation in catalysis and reaction engineering.
3. Synthesis of catalyst using sol gel method and co-precipitation method.
4. Developing of model which can predict outlet compositions of reactors.

List of Open Source Software/learning website:

1. Literature available on internet
2. Research articles
3. NPTEL Lectures

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide.