GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING (30)
ADVANCED REACTION ENGINEERING
SUBJECT CODE: 2713008
SEMESTER: I

Type of course: Chemical Engineering

Prerequisite: Basics of Chemical Reaction Engineering

Rationale: Reaction engineering is useful for the design of various conventional and non-conventional reactors to obtain higher conversion and yield. This course will enable students to understand effect of reactor geometry and operating conditions on its performance. The focus will be particularly on modifications and advancement in reactor systems by applying knowledge of homogeneous and heterogeneous reaction mechanism, catalysis, regeneration rate and recycling.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks		Practical Marks				
				ESE (E)	PA (M)	PA (V)		PA (I)		
						ESE	OEP	PA	RP	
3	2#	2	5	70	30	20	10	10	10	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction:** Introduction to heterogeneous reacting systems, linear and non linear rate expressions.	4	7
2	**Heterogeneous Catalytic Reaction Systems:** Fixed Bed Reactors, Moving Bed Reactors, Fluidized Bed Reactor Design, Design of Combination of Catalytic Reactor and Regenerator, Heat & Mass Transfer Effects, New Development in Catalysis, Straight Through Transport Reactor	14	26
3	**Reactors for Multiple Reactions:** Types of Reaction, Maximizing the Desired Products in Parallel Reactions for One Reactant and Two Reactants, Maximizing the Desired Products in Series Reactions	12	22
4	**Non Isothermal Reactors:** Energy Balance, Adiabatic Operation, Steady State Tubular Reactor with Heat Exchange, Equilibrium Conversion, Reactor Staging with Inter Stage Cooling or Heating, CSTR with Heat Effects, Multiple Steady States	14	26
5	**Design of Non conventional Reactors:** Kinetics of Bio-Reaction, Monod Equation, Design of Bioreactors, Reactions in Solids – Reactors for Solid Reactions, CVD Reactors, Monolithic Reactors, Gauze Reactors	10	19

Reference Books:

1. Chemical Reaction Engineering by Octave Levenspiel.

2. Elements of Chemical Reaction Engineering by H.Scott Fogler.
3. Chemical Engineering Kinetics by J. M. Smith, McGraw Hill
4. Shuler M. L. & Kargi F., Bio process Engineering-Basic Concepts
5. G. F. Froment, K. B. Bischoff, Chemical Reactor Analysis and Design, John Wiley, New York
6. J. J. Carberry, "Chemical and Catalytic Reaction Engineering", McGraw Hill, New York, 1976.

Course Outcome:

After learning the course the students will be able to:

1. identify the types of experimental data needed for the design of reactors
2. design catalytic reactor with regenerator
3. determine the operating conditions for reactions at which maximum conversion of desired product can be achieved.
4. be familiar with the advanced reactors, its geometry, applications and design.
5. describe the different types of multiple reactions and to select a reaction system that maximizes the selectivity.
6. design reactors that operate at steady state and involve heat effects.

List of Experiments:

1. Experiments based on determination of conversion in various types of reactors.
2. Solving various design problems of Non-isothermal reacting systems and multiple reactions using various software like MATLAB, SCILAB, POLYMATH etc.

Open Ended Projects:

The practical work at masters must be largely consisting of open ended projects. In each case a sample set may be provided and the faculty member may be empowered to select appropriate problems for practical work. At the end of semester before submission of marks of PA and term work, the faculty member will upload the three best problems done by the students during the practical hours.

Minimum 5 practicals including design problems using software to be performed and remaining time should be allotted to open-ended projects / study reports / latest outcomes in technology study :-

1. In the beginning of the academic term, faculties will have to allot their students at least one Open-ended Project.
2. Literature survey including patents and research papers of fundamental process
   - Design based small project 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. Evaluation should be done on approach of the student on his/her efforts (not on completion) to study the design module of given task.
5. In the semester student should perform minimum 5 set of experiments and complete one small open ended dedicated project based on engineering applications.

Major Equipments: Fluidized Bed Reactors, Various Types of Rectors like Spiral, Sine-tube, CSTR Followed by PFR, Fixed Bed Reactors, etc.

List of Open Source Software/learning website:

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 softwares/spreadsheets. Students can develop their own programs/ spreadsheets for the solutions of problems