Birla Institute of Technology & Science, Pilani
Hyderabad Campus

Second Semester 2019- 2020
Course Handout (Part-II)

Date:28/11/2019

In addition to Part I (General Handout for all courses appended to the Time Table), this portion gives further specific details regarding the course.

Course No.	**:**	**CHE G641**
Course Title	**:**	**Reaction Engineering**
Instructor-in-Charge	**:**	**Pankaj Kumar**
Other Instructors	**:**	**SrikantaDinda, P Pradeep Reddy**

Course Description :
Design of multi-phase reactors; analyses of gas-liquid and gas-liquid-solid reactions; intrinsic kinetics of catalytic reactions; residence time distribution models for micro-and macro-mixing; mathematical models for gas-liquid-solid reactors; laboratory reactors; dynamics and design of various multi-phase reactors such as trickle bed reactors, bubble column reactors, segmented-bed reactors, slurry reactors, spouted bed reactors, pulsating reactors, fluidized bed reactors, etc.; optimization of chemical reactors.

Scope & Objective
This course includes basic and advanced topics in Chemical Reaction Engineering. The initial part of the course includes reaction mechanisms, basic reaction kinetics (like rate, concentration, conversion and selectivity) and ideal reactor configurations. The design of catalytic and other multiphase reactors are elaborated. The characterization of non-ideal reactors and modeling of these, especially with reference to Residence Time Distribution (RTD Models) are dealt with. Thermal and Mass Transfer effects are also explained in multi-phase reactors. The main objective of this course is to give the student better understanding of Chemical Reaction Engineering of Multi Phase Non-ideal reactors encountered in Industry from the point of view of design and performance evaluation of such actual reactors.Short projects/assignments and industrial visits shall be planned to imbibe the concepts learnt better.

Learning outcomes:

After studying this course, students will be able to

- To understand, how efficiently feed can convert to product by just changing the design of reactor.
- It also gives the knowledge to what kind of reactor system is to be used for what situation.
- Student will be able to analyze the kinetic related data to find the size of reactor for a specific reaction
- Lab exposer will help to know the how to find the reaction kinetics of an unknown system

Text Books

T1 Levenspiel, Octave, *Chemical Reaction Engineering*, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2000 (or higher edition if available!).

T2 Fogler, H. Scott, *Elements of Chemical Reaction Engineering*, Prentice Hall of India Pvt. Ltd., New Delhi, 4th Ed., 2006 (or higher edition if available!).

Reference Books

R1 Salmi, Tapio O., Jyri-Pekka M. and Johan P,W., *Chemical Reaction Engineering and ReactorTechnology*, CRC Press, Taylor &Francis, New York, 2011(or higher edition if available!).

Course Plan

Lecture No.	Learning Objectives	Topics to be covered	Reference
1-6	Review of chemical kinetics and ideal reactor concepts and ideal reactor designs, conversion and sizing of ideal reactors including multiple reactors in series or parallel	Review of kinetics and ideal reactors	Chap No. 1-8 of T1 Chap No. 1-3 of T2 Chap No. 1-3 of R1
7-10	Reaction mechanisms, elementary and non-elementary homogeneous reactions, order of reactions	Review of mechanism of reactions, order and effect on reactor design	Chap No. 1 of T1 Chap No. 7 of T2

10-12	Laboratory reactors, collection and analysis of rate data, getting rate data	Rate models and rate expressions, Laboratory data analysis and Interpretation	Chap No. 1 of T1 Chap No. 5 of T2
13-19	Multiple reactions – series parallel and effect on ideal reactor design	Multiple reactions	Chap No. 7-8 of T1 Chap No. 6 of T2 Chap No. 4 of R1
20-21	Temperature and pressure effects on single and multiple reactions	Effects of temperature and pressure	Chap No. 9 of T1 Chap No. 5 of R1
22-24	Catalysis and Catalytic reactors, catalyst deactivation, fouling, poisons, mitigations	Heterogeneous catalysis introduction	Chap No. 17-19 of T1 Chap No. 10 of T2
25-29	Packed bed catalytic reactors and external and internal diffusion	Heterogeneous catalysis with mass transfer	Chap No. 19 of T1 Chap No. 10-11 of T2
30-32	Multiphase reactors including gas solid and liquid slurry, bubble columns and fluid bed reactors, trickle bed reactors	Multiphase catalytic reactors	Chap No. 20-22 of T1 Chap No. 12 of T2
33-35	Non-Catalytic systems, fluid-fluid, fluid-particle kinetics and reactor design	Multi-phase non-catalytic reactors	Chap No. 23-26 of T1
36-41	Tracers, methods of obtaining Residence time Distribution(RTD), models for flow patterns	Residence time Distribution (Macro mixing)	Chap No. 11-16 of T1 Chap No. 13-14 of T2 Chap No. 6 of R1

Lab experiments:

Lab Name	Experiment Name & Objective
CRE lab	Batch Reactor: To study the order and rate constant for the reaction between KOH and ethyl acetate in a batch reactor @30 °C.
CRE lab	Batch Reactor: To study the order and rate constant for the reaction between KOH and ethyl acetate in a batch reactor @40 °C.
CRE lab	Batch Reactor: To study the order and rate constant for the reaction between KOH and ethyl acetate in a batch reactor @50 °C.
CRE lab	Batch Reactor: To study the order and rate constant for the reaction between KOH and butyl acetate in a batch reactor @30 °C.
CRE lab	Continuous Stirred Tank Reactor: To study the order and rate constant for the reaction between KOH and ethyl acetate in a CSTR @ 30 °C.
CRE lab	Plug Flow Reactor: To study the order and rate constant for the reaction between KOH and ethyl acetate in a PFR @ 30 °C.
CRE lab	RTD study using CSTR
CRE lab	RTD study using PFR
CRE lab	Analysis of gas sample
CRE Lab	To find conversion of a reaction using spectrophotometric method
CRE Lab	To find conversion of a reaction using GC analysis
Multiphase lab	To find adsorption capacity of an adsorbent for adsorption of gas on solid adsorbent
Petroleum lab	Cracking of liquid fuel

Evaluation scheme

EC No.	Evaluation Component	Duration	Weightage %	Date, Time	Remarks
1.	Mid sem	90 min	25	2/3, 11: 00 – 12:30 PM	CB
2.	Compre	180 min	35	01/05 , AN	25%CB & 10%OB
3.	Assignment & / seminars (2)		10		OB
4	Quizzes (2)		10		CB
5	Lab experiments		20		OB

- **Min. marks required to secure a valid grade is above 15% of total marks of all components.**

- **Chamber consultation hour**will be announced in the class.
- The **notices,** if any**,** concerning the course, will be displayed on the notice board of the Department of Chemical Engineering.
- **Make-up**will be granted for**genuine cases only**. Prior permission of IC is compulsory.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor-in-charge | CHE G641