VI CHE356 Chemical Reaction Engineering

Course Outlines

- **Title:** Chemical Reaction Engineering
- **Code Number:** CHE356
- **Semester:** 5th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** N.A
- **Learning Outcomes:**

  Upon successful completion of the course, the students will be able to:

  1. Define and explain key terminologies in chemical reaction engineering
  2. Analyse rate equations using integral and differential methods, based on concentration and time data, for homogeneous reactions.
  3. Apply performance equations and evaluate reactor system combinations to design ideal batch and flow reactors for both homogeneous and heterogeneous systems
- **Contents**

  Unit I: Introduction to Chemical Reaction Engineering

  1.1 Concept of chemical reaction engineering
  1.2 Terminologies used in chemical reaction engineering

  Unit II: Kinetic data interpretation

  2.1 Kinetics of homogeneous reaction
  2.2 Variables affecting the rate of reaction
  2.3 Order and mechanism of reaction
  2.4 Activation energy and temperature dependency
  2.5 Interpretation of constant and variable volume batch reactor data
  2.6 Integral method and differential methods of analysis for constant and variable volume batch reactors to develop rate equation
  2.7 Concept of half-life /fractional life.
  2.8 Empirical rate equation for nth order reactions.
  2.9 Reversible and irreversible reactions in parallel

  Unit III: Design of Ideal homogeneous reactors

3.1 Ideal isothermal reactors
  3.1.1 Batch reactors
  3.1.2 Mixed Flow reactors
  3.1.3 Plug Flow reactors
3.2 Plug flow reactors in series/parallel
3.3 Equal and different size of mixed reactors in series and parallel
3.4 Design of reactors for multiple reactions, parallel and series reactions.
3.5 Optimum reactor size
3.6 Concept of Recycle reactors

Unit IV: Heterogeneous reactors

4.1 Kinetics of heterogeneous reactions
4.2 Catalyst design and characterization
4.3 Design of isothermal heterogeneous reactors
  4.3.1 Packed bed reactor design
  4.3.2 Fluidized bed reactor design
4.4 Industrial catalytic reactors

Unit V: Simulation of Chemical Reactors

5.1 Introduction to Process Simulation
  5.1.1 Overview of process simulation and its importance in chemical engineering.
  5.1.2 Introduction to commonly used process simulators
5.2 Kinetic Data Implementation
5.3 Optimization of Reactor Performance and sensitivity analysis to evaluate the impact of various parameters on reactor performance

- **Teaching-learning Strategies**

The teaching and learning strategy have been designed on the understanding of concepts and the ability to critically analyze and apply the learned content through lectures, discussion, activities, case studies using computer, multi-media and writing board instructional aids.
Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

- **Textbooks and reference readings**

1. Fogler, H.S. (2016) *Elements of chemical reaction engineering*. 5th ed. Prentice Hall.
2. Levenspiel, O. (1999) *Chemical reaction engineering*. 3rd ed. John Wiley & Sons.
3. Froment, G.F., Bischoff, K.B. and De Wilde, J. (2011) *Chemical reactor analysis and design*. 3rd ed. John Wiley & Sons.
4. Ross, J.R.H. (2012) *Heterogeneous catalysis: fundamentals and applications*. Elsevier.
5. Nauman, E.B. (2018) *Chemical reactor design, optimization, and scale-up*. 2nd ed. John Wiley & Sons.
6. Hill Jr., C.G. and Root, T.W. (2014) *Introduction to chemical engineering kinetics and reactor design*. 2nd ed. John Wiley & Sons.
7. Conesa, J.A. (2019) *Chemical reactor design: mathematical modeling and applications*. John Wiley & Sons.