III CHE353 Mass Transfer

Course Outlines

- **Title:** Mass Transfer
- **Code Number:** CHE353
- **Semester:** 5th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** CHEM125
- **Learning Outcomes:**

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

  1. Understand the principles of diffusive, convective and inter-phase mass transfer.
  2. Calculate diffusivities and mass transfer coefficients; and understand their significance
  3. Analyze problems involving diffusive and convective mass transfer in one phase and two-phase systems.
  4. Solve problems related to stage-wise and continuous contact differential processes.
- **Contents**

  Unit I: Basics of Mass Transfer

  1.1 Introduction to mass transfer
  - 1.1.1 Mechanical and concentration driven processes
  - 1.1.2 Application of mass transfer principles
  - 1.1.3 Concept of mass transfer by molecular and turbulent motion

  Unit II: Diffusion

  2.1 Diffusion in binary gas mixtures
  - 2.1.1 Mass transfer concentrations, velocities and fluxes
  - 2.1.2 Fick's law of diffusion
  - 2.1.3 Maxwell's law of diffusion
  - 2.1.4 Diffusive laws of mass, heat and momentum transport

  2.2 Principles of diffusive mass transfer
  - 2.2.1 Mass transfer through a stationary second component
  - 2.2.2 Equimolar counter diffusion

  Unit III: Diffusivities

1.1 Diffusivities of liquids, gases and solids
    1.1.1 Experimental determination of diffusivities
    1.1.2 Prediction of diffusivities

Unit IV: Convective mass transfer

4.1 Introduction
    4.1.1 Mass transfer coefficients
4.2 Mass transfer across phase boundary
    4.2.1 Two film theory
    4.2.2 Penetration theory
    4.2.3 Surface renewal theory
4.3 Dimensionless groups in mass transfer
4.4 Dimensional analysis of free and forced convective mass transfer.

Unit V: Countercurrent mass transfer

5.1 Introduction
    5.1.1 Stage-wise processes
    5.1.2 Continuous differential contact processes
5.2 Mass transfer and chemical reaction
5.3 Mass transfer to pipes and cylinders, mass transfer to particles

Unit-VI: Absorption of gases

6.1 Introduction
6.2 Conditions of equilibrium between gas and liquid
6.3 The mechanism of absorption
6.4 Experimental measurement of mass transfer coefficients
    6.4.1 Wetted wall columns
    6.4.2 Packed columns
    6.4.3 Spray columns
6.5 Operating line equations for continuous contact towers
    6.5.1 Counter-current flow
    6.5.2 Co-current flow
6.6 Continuous contact equipment analysis

- **Teaching-learning Strategies**

  The teaching and learning strategy has 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. Ray, A.K., (2023), "Coulson and Richardson's Chemical Engineering: Volume 2b: Separation Processes". 6th Edition, Butterworth-Heinemann.
2. Chhabra, R., Shankar, V., (2018) "Coulson and Richardson's Chemical Engineering: Volume 1b: Heat and Mass Transfer: Fundamentals and Applications", 7th Edition, Butterworth-Heinemann.
3. McCabe, W.L., Smith, J.C., Harriott, P., (2005),"Unit Operations of Chemical Engineering", 7th Edition McGraw Hill
4. Basmadjian, D. (2007), " Mass Transfer and Separation Process: Principles and Applications'',2nd Edition, Taylor & Francis
5. Bergman, T.L., Lavine, A.S., Incropera, F.P., DeWitt, D.P. (2020), "Fundamentals of Heat and Mass Transfer", 8th Edition, John Wiley & Sons.
6. Welty, J.R., Rorrer, G.L., Foster, D.G., (2019), ''Fundamentals of Momentum, Heat, and Mass Transfer''. 7th Edition, Wiley & Sons.
7. Green, D.W., Southard, M.Z. (2018) Perry's Chemical Engineers Handbook. 9th Edition, McGraw-Hill.