I CHE 361 Separation Process-II

Course Outlines

- **Title:** Separation Processes-II
- **Code Number:** CHE361
- **Semester:** 6th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** CHE231
- **Learning Outcomes:**

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

  1. Explain key concepts of separation processes including equilibrium stages, reflux, counter current contacting, stage wise and differential contacting, efficiency etc.
  2. Select appropriate separation technique for intended problem
  3. Solve design problems of separation processes
- **Contents**

  Unit I: Distillation

  1.1 Introduction
  1.2 Vapour-Liquid Equilibrium
  - 1.2.1 Partial Vaporization and Partial condensation
  - 1.2.2 Partial Pressure, Dalton's, Raoult's and Henry's Laws
  - 1.2.3 Relative volatility

  1.3 Methods of distillation
  - 1.3.1 Differential distillation
  - 1.3.2 Flash distillation
  - 1.3.3 Rectification

  1.4 The fractionating column
  - 1.4.1 Number of plates required in a distillation column
  - 1.4.2 Lewis-Sorel method
  - 1.4.3 McCabe and Thiele method
  - 1.4.4 The equation of q-line

  1.5 The importance of reflex ratio
  - 1.5.1 Calculation of the minimum reflex ratio
  - 1.5.2 Underwood and Fenske equations

1.5.3 Selection of economic reflex ratio

1.6 Conditions for varying overflow in non-ideal binary systems

1.6.1 Determination of the number of plates on H-x diagram

1.7 Batch distillation

1.7.1 Operation at constant product composition

1.7.2 Operation at constant reflex ratio

1.8 Azeotropic and Extractive distillation

1.9 Steam distillation

1.10 Plate efficiency

Unit II: Liquid- Liquid Extraction

2.1 Introduction

2.2 Extraction processes

2.2.1 Rate of extraction

2.2.2 Equilibrium data and Triangular diagrams

2.2.3 Selection criteria of solvent

2.3 Calculation of the number of theoretical stages

2.3.1 Co-current contact with partially miscible solvents

2.3.2 Co-current contact with immiscible solvents

2.3.3 Countercurrent contact with immiscible solvents

2.3.4 Countercurrent contact with partially miscible solvents

2.4 Continuous extraction in columns

2.4.1 Capacity of a column operation as continuous counter-current unit

2.5 Classification of extraction equipment

2.5.1 Stage-wise equipment for extraction

2.5.2 Differential contact equipment for extraction

Unit III: Leaching

3.1 Introduction

3.2 Equipment for leaching

3.3 Principles of continuous counter-current leaching

3.4 Calculation for the number of ideal stages

Unit IV: Adsorption

4.1 Adsorbents

4.2 Adsorption processes and equipment

4.3 Adsorption isotherms

4.4 Structure of adsorbents

4.5 Adsorber design

Unit V: Membrane Separation

5.1 Classification of membrane processes
5.2 Nature of synthetic membranes
5.3 General membrane equation
5.4 Reverse osmosis
5.5 Gas separation
5.6 Pervaporation
5.7 Electrodialysis

- **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. McCabe, W.L., Smith, J.C., Harriott, P., (2005),”Unit operations of Chemical Engineering”. 7th Edition McGraw Hill
3. Welty, J.R., Rorrer, G.L., Foster, D.G., (2019), ‘’Fundamentals of Momentum, Heat, and Mass Transfer’’. 7th Edition, Wiley & Sons.

4. Green, D.W., Southard, M.Z., (2018), Perry's Chemical Engineers Handbook. 9th Edition, McGraw-Hill.
5. Baker, R. (2012), "Membrane Technology and Applications", 3rd Edition, Wiley
6. Seader, J.D., Henley, E.J., Roper, D.K., (2016), "Separation Process Principles with Applications using Process Simulators", 4th Edition, Wiley.
7. Wankat, P.C., (2021), "Separation Process Engineering: Includes Mass Transfer Analysis", 4th Edition, Prentice Hall.