Subject: Mass Transfer

<table>
<tr><td rowspan="2">CHE-220

Pre-req.</td><td rowspan="2">Mass Transfer</td><td colspan="2">4CH</td></tr>
<tr><td colspan="2">Theory+Lab (3+1)</td></tr>
<tr><td>Nil</td><td>Category</td><td>Foundation Course</td></tr>
<tr><td colspan="4">Course Contents as per PEC Guidelines 2023-2024</td></tr>
<tr><td colspan="4"><u>Contents</u>:
• Mass transfer basics; Introduction, gradient driven transport, Fick’s law, diffusivity, diffusion through gases and liquids, equimolar and un-equimolar diffusion, diffusion through a stagnant gas, dimensionless and dimensional analysis in mass transfer.
• Interface mass transfer; mass transfer theories, the two-film theory, the penetration theory, film penetration theory, concentration profiles, concept of resistance to mass transfer and mass transfer coefficients(overall and film)
• Phase equilibrium and phase diagrams; single component systems, multi component systems and gas-liquid equilibrium.
• Absorption; Calculation of the number and height of transfer units for various cases of countercurrent and co current operations.
• Adsorption; Overview
• Introduction to distillation
• Application and fundaments of distillation
• Lewis-Sorel; McCabe -Thiele methods.
• Importance of the reflux ratio; calculation of minimum reflux ratio; number of plates at total reflux; underwood and Fenske methods: selection of economic reflux ratio.
• Effect of multiple feeds and side streams.
• Plate efficiency and Murphree's formula. Concept of a theoretical plate and HETP.
• Concept of NTU and HTU
• Method of transfer units and HTU. Enthalpy-concentration method. Multi-component distillation: degrees of freedom in separation specifications. Key components in multi-component mixtures and recovery fraction. Continuous flash distillation with heat balancing
• Equilibrium and enthalpy expressions; numerical examples of multi- component separation problems; side streams and partial condensers.
• Column design; tray design; hydraulics and performance.
• Batch distillation: operation at constant product composition or constant reflux ratio. Calculation of column diameter and height.
• Heterogeneous azeotropes; Illustrative examples of azeotropic distillation. Reactive distillation.
• Extension of design techniques to absorption.
• Introduction to Adsorption The nature of adsorbents.
• Adsorption equilibria,
• Adsorption from liquids.
• structure of adsorbents,
• Adsorption equipment and regeneration of spent adsorbents.</td></tr>
<tr><td colspan="4">Weekly plan/ Reference Books</td></tr>
<tr><td>1</td><td colspan="3">Introduction to mass transfer: basic concepts and examples</td></tr>
<tr><td>2</td><td colspan="3">Types of diffusion, Fick’s law for steady state diffusion</td></tr>
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3-4	Molecular diffusion in gases, steady-state molecular diffusion in a binary mixture through a constant area and non-equimolar counter-diffusion of two components
5-6	Multi-component diffusion, diffusion through variable area (cone and sphere) and diffusion coefficients.
7-8	Molecular diffusion in liquids, stagnant diffusion, equimolar counter diffusion and liquid phase diffusivity, eddy diffusion, Fick's second law for unsteady state diffusion
9	Mid-term
10-12	Distillation
13-15	Gas-liquid absorptions basics and design calculations
16-17	Adsorption
18	Final Exam

TEXT AND REFERENCE BOOKS:

- MeCabe Warren L., Smith Julian C., Harriott peter "Unit Operations of chemical Engineering" 7th Ed. 2005. McGraw Hill Inc.
- Coulson J.M., Richardson J.F. "Chemical Engineering" Vol-II, 5th Ed. 2002. The English Book Society and Pergamon Press.
- Incropera Frank P., De Witt David P. "Fundamentals of Heat and Mass Transfer" 3rd Ed. 1990. John Wiley and Sons.
- Treybal Robert E. "Mass Transfer Operations", 1981, McGraw Hill Book Company.