# 19CH213 MASS TRANSFER OPERATIONS-II

***Source:***
*http://www.hitekengineers.com/distillation-column.html*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 60 | - | - | 5 | 5 |

**PRE-REQUISITE COURSES :** Mass Transfer Operations-I

**COURSE DESCRIPTION AND OBJECTIVES:**

The course deals with mass transfer phenomena and its usage for engineering application. The general objectives of this course are to explain various separation mechanisms and fundamental concepts involved in separation operations such as distillation, extraction, leaching, adsorption and other modern separation techniques such as membrane separation and ion exchange. To educate the design aspects of various mass transfer operation equipment widely used in industry along with determination of number of equilibrium stages required for a desired separation.

**COURSE OUTCOMES :**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Design several mass transfer equipment that encounters the specific prerequisites with approximate concern of economics, public health and safety. | 3 |
| 2 | Recognize and differentiate mass transfer process to analyze and interpret experimental and theoretical data along with their application in various process industries. | 3,4 |
| 3 | Apply and correlate their theoretical knowledge of mass transfer in multiphase contact processes to understand the impact of engineering solutions in environmental perspectives and society. | 1,7 |
| 4 | Conduct experiments in teams related to various mass transfer operations and design various prototype or pilot plant setup for mass transfer. | 4,9 |
| 5 | Interpret experimental data to estimate and deliver effectiveness. | 4,12 |

**SKILLS:**

- ✓ *Estimation of vapor liquid equilibrium data.*
- ✓ *Assessment of working condition of fractionating column with varying reflux ratio.*
- ✓ *Design specification and equilibrium stage calculation of distillation column.*
- ✓ *Model development of multistage co-current and counter current extractor.*
- ✓ *Design of adsorption and leaching equipments.*

**UNIT - I** **L-9**

**DISTILLATION I :** Introduction; Fields of application; VLE -miscible liquids, Immiscible liquids, VLE phase diagrams, tie lines, mixture rules; Flash vaporization; Differential distillation-binary, multi-component mixtures.

**UNIT - II** **L-9**

**DISTILLATION II :** Continuous fractionation of binary mixtures; McCabe -Thiele method & Ponchon – Savarit method - determination of no of ideal plates for binary mixtures, optimum reflux ratio, plate efficiencies, condenser and reboiler duties; Principles of azeotropic and extractive distillation.

**UNIT - III** **L-9**

**LIQUID-LIQUID EXTRACTION :** Fields of application of ternary liquid systems; Triangular and solvent free coordinate systems; Choice of solvent and selectivity; Extraction with insoluble and partially soluble systems; Single stage extraction; Multi-stage extraction; Cross and counter current extraction with reflux; Equipment for liquid – liquid extraction.

**UNIT - IV** **L-9**

**SOLID-LIQUID EXTRACTION :** Introduction; Fields of application; Preparation of solid for leaching;Types of leaching; Leaching equilibria; Constant under flow conditions; Equipment for leaching operation.

**MEMBRANE SEPARATION :** Introduction; Types of membranes; Principles and applications; Membrane characterization; Membrane module; Microfiltration; Ultrafiltration; Osmosis; Reverse osmosis; Nanofiltration.

**UNIT - V** **L-9**

**ADSORPTION AND ION-EXCHANGE :** Principles and applications; Types of adsorption; Use of adsorbents; Adsorption equilibria; Adsorption isotherms for vapor and dilute solutions; Break through curve; Fixed bed adsorber; Ion exchange; Isotherm and separation factors in ion exchange.

## LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS: 30**

1. Verification of Rayleigh's equation using batch distillation.
2. Determination of steam distillation temperature, percentage recovery and vaporizing efficiency.
3. Estimation of capacity coefficient of packing in a packed bed distillation column under total reflux condition.
4. Determination of solubility characteristics of given ternary system.
5. Determination of VLE data for a binary mixture.
6. Determination of percentage adsorption of ternary system.
7. Estimation of number of equilibrium trays in distillation.
8. Estimation of NTU, HTU & height of packed column.
9. Adsorption studies on a binary mixture.
10. Leaching studies on a ternary mixture.
11. Plate column distillation- to study the performance of a rectification column.
12. Estimation of overall efficiency for a three-stage counter-current and cross current system.
13. Determination of the rate of distillation by steam distillation.
14. Estimation of the number of heat transfer units (HTU) & height equivalent to the theoretical plate (HETP) of the packed distillation column.
15. Study of adsorption of acetic acid on activated charcoal -To verify adsorption isotherms.

**TEXT BOOKS:**

1. Treybal R. E., "Mass Transfer Operations", 3rd edition, McGraw-Hill, 2005.
2. Binay. K. Dutta, "Principles of Mass Transfer and Separation Processes", 2nd edition, Prentice Hall of India, New Delhi, 2012.

**REFERENCE BOOKS:**

1. Christie J. Geankoplis., "Transport Processes and Separation Process Principles", 4th edition, Prentice Hall India Pvt. Ltd., 2003.
2. Judson King C., "Separation Processes", 2nd edition, McGraw-Hill, 2005.
3. Seader J. D., Henley E. J. and Keith Roper D., "Seperation Process Principles- Chemical and Biochemical Operations" 3rd edition, John Wiley & Sons, Inc, 2011.