MASS TRANSFER II

ENCH 353

Lecture	**: 3**	**Year : III**
Tutorial	**: 1**	**Part : II**
Practical	**: 3/2**	

Course Objectives:

The objective of this course is to provide students with comprehensive understanding of the fundamental principles of phase equilibria and mass transfer mechanisms and various separation processes.

1 Liquid-Liquid Extraction (8 hours)

1.1 Equilibria, system of three liquids, effect of temperature on liquid-liquid equilibria, other coordinate system
1.2 Solvent selection, stage-wise contact, insoluble system
1.3 Equipment for liquid-liquid extraction, selection of extractors

2 Solid-Liquid Extraction (6 hours)

2.1 Classification of solid-liquid extraction, rate of leaching
2.2 Methods of operation and equipment, equilibrium and its types, methods of representing equilibrium data
2.3 Separation operation, analytical determination of number of stages, supercritical fluid extraction

3 Adsorption (9 hours)

3.1 Types of adsorption, nature and characteristics of adsorbents, adsorption equilibria
3.2 Adsorption isotherm and its types, stage-wise operations, continuous adsorption, equipment for adsorption
3.3 Ion exchange and principles
3.4 Chromatography and principles

4 Membrane Separation Process (7 hours)

4.1 Desired properties of membrane, membrane material and its types
4.2 Membrane classification, membrane characterization, membrane module
4.3 Transport in membranes, pressure driven membrane process for liquid separation, concentration driven processes

4.4 Membrane for gas separation, industrial examples of membrane based separation

5 Drying (7 hours)

5.1 Mechanism of drying, drying equilibria, definitions and terms in drying
5.2 Drying rate curve, calculation of drying time, classification of drying equipment
5.3 Drying calculation, cross circulation drying, through circulation of drying, material and energy balance in continuous dryer, drying time in a continuous countercurrent dryer

6 Crystallization (8 hours)

6.1 Types of crystal geometry, solid-liquid phase equilibrium
6.2 Nucleation and crystal growth, batch crystallization
6.3 Design of crystallizer, crystallization equipment (Circulating magma crystallizer, circulating liquor crystallizer, tank crystallizer)

Tutorial (15 hours)

1. Stage-wise liquid-liquid extraction calculation
2. Leaching calculation and determination of number of stages
3. Determination of number of stages for multistage adsorption process
4. Design of a membrane for CO_2 capture
5. Drying rate curve and drying time calculation
6. Analysis of a batch evaporative crystallizer

Practical (22.5 hours)

1. Extraction of benzoic acid from toluene by water in a packed bed extractor
2. Extraction of oil from oil seeds
3. Adsorption of acetic acid or dye from aqueous solution using activated carbon
4. Removal of hardness from water using ion exchange resin
5. Determination of critical moisture content and drying characteristics of a solid under forced draft condition
6. Separation and purification of organic compounds by crystallization technique

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	8	10
2	6	8
3	9	12
4	7	10
5	7	10
6	8	10
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Treybal, R. E. (1981). Mass transfer operations (Latest Edition). McGraw-Hill.
2. McCabe, W. L., Smith, J. C., Harriott, P. (2005). Unit operations of chemical engineering (7th ed.). McGraw-Hill Education (India) Private Limited.
3. Seader, J. D., Henley, E. J., Roper, D. K. (2011). Separation process principles. John Wiley & Sons.
4. Geankoplis, C. J. (2003). Transport processes and separation process principles (including unit operations) (Latest Edition). Prentice Hall of India.
5. Dutta, B. K. (2007). Principles of mass transfer and separation process. PHI Learning Private Limited.