

**Objective:** To apply the basics of mass transfer to build the allied mechanisms and operations those are essential for process industries.

**Credits Earned:** 4 Credits

**Course Outcomes:** After completion of this course, student will be able to:

1. To analyse mass transfer operation.
2. To select suitable mass transfer operation for particular separation process.
3. To determine the use and implication of distillation process with suitable number of stages and desired type.
4. To determine number of stages and height of packed column in distillation and extraction operation.
5. To understand the phenomenon of mass transfer in various operations using advanced techniques.

**Pre-requisite of course:** Mass Transfer operation- I

#### Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	CSE	Internal (I)	Viva (V)	Term work (TW)	
3	0	2	4	50	20	30	25	25	150

#### Contents:

Unit	Topics	Contact Hours
1	<b>Distillation</b> Introduction, Vapor liquid equilibrium, methods of distillation two component mixtures, The fractionating column, Conditions for varying overflow in non-ideal binary systems, Batch Distillation, Multicomponent Mixtures, Azeotropic and Extractive distillation, Steam Distillation, Plate columns, Packed column for distillation,	8
2	<b>Leaching</b> Introduction, Mass transfer in leaching Operation, Equipment for leaching, Countercurrent washing of solids, Determination of number of stages, Graphical methods to determine number of stages.	8

3	<b>Liquid-liquid Extraction</b> Introduction, Extraction Processes, Equilibrium data, Determination of number of theoretical stages, Classification of extraction equipment, Stage-wise equipment for extraction.	8
4	<b>Evaporation</b> Introduction, Heat transfer in evaporators, Single effect Evaporators, Multiple-effect evaporators, Improved efficiency in evaporation, Evaporator operation, Equipment for evaporation	8
5	<b>Product Design and Process Intensification</b> Introduction, Green Chemistry, New Processing Techniques, Process Intensification, Principles and advantages of process intensification, case studies in mass transfer.	5
<b>Total Hours</b>		<b>37</b>

**List of Experiments:**

1. To perform separation of Benzene-Water mixture by using Batch Distillation.
2. To study distillation column operation to find out number of stages.
3. To verify Rayleigh's equation for differential distillation.
4. To verify Henry's law for steam distillation.
5. To Plot the Vapour-Liquid Equilibrium Curve for Carbon Tetrachloride- Toluene mixture.
6. To Study Operation of Natural & Forced Draught Water Cooling Tower.
7. To study the operation of single effect evaporator.
8. To study the operation of multiple effect evaporator.
9. To study the flow visualisation software for mass transfer.

**References:**

1. McCabe Smith, "Unit Operation in Chemical Engineering" 5<sup>th</sup> ed. McGraw Hill (1985).
2. Coulson and Richardson's Chemical Engineering, Volume 2, Particle Technology & separation Processes, Butterworth Heinemann Publications.
3. Treybal R.E., Mass Transfer Operations, McGraw Hill, 3<sup>rd</sup> Edition, 1981.

**Suggested Theory distribution:**

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation
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Remember	Understand	Apply	Analyze	Evaluate	Create
10%	20%	25%	25%	10%	10

**Instructional Method:**

- a. The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
- b. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.
- c. Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
- d. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory

**Online Web Resources:**

1. <https://nptel.ac.in/courses/103104046/>
2. <https://nptel.ac.in/courses/103103034/>
3. <https://nptel.ac.in/courses/103103035/>