GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Chemical Engineering

Subject Code: DI04005021

Subject Name: Mass Transfer-I

w. e. f. Academic Year:	2025-26
Semester:	IV
Category of the Course:	PCC

Prerequisite:	Student should have knowledge regarding Unit Operations and Basic Chemistry
Rationale:	Mass transfer is crucial in chemical industries as it corresponds to many separation, purification, and reaction processes. Diploma Chemical Engineers play a crucial role in operating equipment and machinery, monitoring process parameters, ensuring smooth production flow, supervising specific sections of a chemical plant including mass transfer operations, ensuring process control, quality control, safety and environment regulations. Using the fundamental concepts of diffusion and interphase mass transfer the basic mass balance equations of mass transfer operations and separation of molecules can be estimated. The knowledge of the basic laws and principles of mass transfer helps to operate smooth and proper operation of various mass transfer operations like Gas Absorption, Liquid Liquid Extraction, Leaching, and Membrane Separation. Hence the course has been designed to develop this competency and its associated cognitive, practical and affective domain learning outcomes.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Interpret the basics of Mass Transfer Operation.	R,U
02	Make use of concept of diffusion in fluids & Interphase mass transfer in separation techniques.	R,U,A
03	Utilize the mass transfer operations equipments for various applications.	R,U, A
04	Compute material balance for mass transfer operations in different condition.	A

**Revised Bloom's Taxonomy (RBT)*

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Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA(M)	PA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
Unit – I Fundamental of Mass Transfer	1.1 Introduction of Mass transfer operations 1.2 Classification of mass transfer operations based on phases 1.3 Basic principles and application of Membrane separation 1.4 Direct and Indirect operations 1.5 Choice of separation method 1.6 Different methods of conducting mass transfer operation 1.6.1 Solute recovery and fractionation 1.6.2 Unsteady state operation 1.6.3 Steady state operation 1.6.4 Stage wise operation 1.6.5 Continuous contact operation	06	12
Unit – II Molecular Diffusion in Fluids	2.1 Molecular and Eddy diffusion 2.2 Rate of diffusion in Fluids 2.3 Molar flux, diffusivity and concentration gradient in Fluids 2.4 Fick's law of diffusion 2.5 Effect of temperature, pressure and concentration on diffusivity 2.6 Derivation of diffusivity equation ($D_{AB}=D_{BA}$) 2.7 General equation for steady state molecular diffusion in fluids at rest & in laminar flow 2.8 Molecular diffusion in gases with numerical Derive Equation for (a) Steady state diffusion of component A through non diffusing B (b) Equimolal counter diffusion of A and B 2.9 Molecular diffusion in liquids with numerical Derive Equation for a) Steady state diffusion of A through non diffusing B with simple numerical	09	20

	(b) Steady state equimolal counter diffusion with simple numerical		
Unit – III Interphase Mass Transfer	3.1 Concept of equilibrium 3.2 Diffusion between phases (two resistance concept) 3.3 Local and overall two phases mass transfer co-efficient and their uses 3.4 Stage and Stage Efficiency and Types of Cascade	04	10
Unit – IV Gas Absorption	4.1 Types of gas absorption 4.2 Industrial application of gas absorption 4.3 Equilibrium solubility of different gases in liquids 4.4 Effect of temperature and pressure on absorption 4.5 Ideal liquid solutions and Raoult's law 4.6 Choice of solvent for gas absorption 4.7 Material balance for one component transfer with numerical 4.7.1 Counter current flow 4.7.2 Co-current flow 4.8 Minimum liquid-gas ratio for absorber 4.9 HETP 4.10 Construction and working of continuous contact equipments for gas absorption 4.10.1 Tray Tower 4.10.2 Packed Tower	08	18
Unit – V Liquid Liquid Extraction	5.1 Introduction and Industrial applications of liquid extraction 5.2 Liquid Equilibria 5.3 Equilateral-Triangular Co-ordinates 5.4 Systems of Three Liquids-One Pair Partially Soluble 5.4.1 Effect of temperature and pressure 5.5 System of Three Liquids-Two Pairs Partially Soluble 5.6 Choice of solvent 5.7 Stage wise operation 5.7.1 Material Balance for Single stage extraction with numerical 5.7.2 Material Balance for Multistage cross current extraction with numerical 5.8 Stage wise extractor - Construction and working of 5.8.1 Agitated Vessel 5.8.2 Gravity Settlers 5.8.3 Sieve Tray Towers 5.9 Continuous Extractors - Construction and working of	10	22

	5.9.1 Packed Tower 5.9.2 Rotating Disk Contactor 5.9.3 Centrifugal Extractors		
Unit – VI Leaching	6.1 Introduction and Industrial applications of leaching 6.2 Preparation of solid 6.3 Temperature of leaching 6.4 Methods of operation and equipment 6.4.1 Unsteady State Operation- In place leaching, Heap leaching, Leaching by shanks system, Percolation in closed vessels. 6.4.2 Steady State Operation - Leaching during grinding, Door Agitator, Continuous Countercurrent Decantation (CCD), Leaching of vegetable seeds - Rotocell and Bollman Extractor 6.5 Material balance for single stage leaching	08	18
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**45**	**35**	**---------**	**_____**	**_____**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Unit Operations of Chemical Engineering	McCabe, Warren L., Julian C. Smith	McGraw Hill Publication, New York 2004 7th Edition
2	Mass Transfer Operations	Robert E. Treybal	Mc Graw- Hill, 3rd Edition, 1981
3	Separation Process Principles	Ernest J. Henley, J. D. Seader, D. Keith Roper	Wiley India, 2nd Edition, 2005
4	Unit Operation-II	K.A. Gavhane	Nirali Prakashan, Pune 2009

5	Unit Operations of Chemical Engineering, Volume-1	P. Chattopadhyay	Khanna Publishers, New Delhi, 1995
6	Introduction to Chemical Engineering	L.Badger, Julius T. Banchero	McGraw Hill Publication, New York, 7th Edition, 2004

(b) Open-source software and website:

1. https://ndl.iitkgp.ac.in/
2. https://www.vlab.co.in/
3. https://swayam.gov.in/
4. https://onlinecourses.nptel.ac.in
5. www.unitoperation.com
6. MIT Open Learning Library

Suggested Practical List:

Sr. No.	Practical/Exercise (Course Outcomes in Psychomotor Domain according to NBA Terminology)	Approx. Hrs Required
1	Describe different methods for conducting mass transfer operation (study experiment).	2
2	Determine diffusivity of gas-liquid system at room temperature	2
3	Determine diffusivity of gas-liquid system showing its dependency on temperature	2
4	Determine diffusivity of liquid-liquid system at room temperature	2
5	Determine diffusivity of liquid-liquid system showing its dependency on temperature	2
6	Find out rate of gas absorption in a packed tower	2
7	Find out rate of gas absorption in a tray tower	2
8	Determine the efficiency of single stage extraction	2
9	Determine the efficiency of two stage cross current extraction	2
10	Prepare ternary diagram for a system of three liquids	2
11	Obtain tie-line data for Acetic Acid, Benzene and water	2
12	Determine the distribution coefficient for toluene- acetic acid & chloroform - acetic acid mixture	2
13	Measure recovery of salt using sand-salt mixture in single stage leaching	2
14	Measure recovery of salt using sand-salt mixture in two stage leaching	2
15	Describe different methods for unsteady state and steady state leaching operations. (study experiment)	2

Suggested Activities for Students:

1. Assignments
2. Technical Quiz/MCQ Test
3. Preparation of non-working models of various mass transfer equipments and its importance.
4. Preparation of power-point slides, which include videos, animations of various mass transfer equipments.

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