



# GUJARAT TECHNOLOGICAL UNIVERSITY

**Bachelor of Engineering**

**Subject Code: 3153617**

**Semester – V**

**Subject Name: Basics of Mass Transfer**

**Type of course: Professional Core Course**

**Prerequisite:** Studied departmental fundamental chemical engineering subjects in previous semesters. Basic knowledge of chemical engineering is required

**Rationale:** The objective of this course is to provide a means to teach undergraduate chemical technology students the basic principles of mass transfer and to apply these principles. The aim of this subject is to study mass transfer in unit operations in chemical Industries and different theories of mass transfer in chemical industries.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

**Content:**

Sr. No.	Content	Total Hrs
1	<b>Basics of Mass Transfer:</b> Classification of mass transfer operation, choice of separation method, Methods of conducting mass transfer operations	3
2	<b>Diffusion:</b> Definition of molecular and eddy diffusivity, Fick's first law, Concept of N & J Flux, Steady state molecular diffusion in fluids at rest and in laminar flow, Diffusivity of gases, Diffusivity of liquids, Concept of effective diffusivity.	6
3	<b>Inter Phase Mass Transfer:</b> Concept of overall mass transfer coefficient, F and k type mass transfer coefficients Film, penetration and surface renewal theory. Concept of equilibrium, diffusion between phases, Two resistance theory, Local overall mass transfer coefficient, controlling mass transfer resistances.	7
4	<b>Humidification Operations:</b> VLE and Enthalpy for pure substances, Saturated and unsaturated vapour-gas mixtures and related terminologies such as Absolute Humidity, dry bulb temperature, dew point, wet bulb temperature, percentage & relative saturation, adiabatic saturation temperature, humid heat, humid volume etc. Psychrometric chart for air-water system, cooling towers.	4
5	<b>Gas Absorption:</b> Equilibrium Solubility of gases in liquids, Ideal and non-ideal solution, Choice of solvent for absorption, Material balance and liquid-gas ratio for absorption and stripping, Counter current multi stage operation (isothermal),	7



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	Absorption factor, Continuous contact equipments, Overall coefficient and Transfer units, Concept of HETP and HTU, NTU	
6	<b>Distillation:</b> Introduction, Vapor-liquid Equilibria, concept of relative volatility and effect of P and T on equilibrium data, Ideal solutions, Raoult's Law, Deviation from ideality, Flash distillation, Simple distillation, Continuous rectification-Binary systems, Determination of number of stages by McCabe-Thiele method, Concept of minimum, total and optimum reflux ratio, Reboilers, Use of open steam, Partial condensers, cold hot circulating reflux Steam distillation, Batch fractionation, Azeotropic Distillation, Extractive Distillation	11
7	<b>Liquid-Liquid Extraction:</b> Ternary liquid- liquid equilibrium and tie line data, system of three liquids-one pair partially soluble, system of two partially soluble liquids, Choice of solvent for extraction, Single stage extraction, multistage-Cross current and counter current extraction, Extraction equipment, Applications of liquid-liquid extraction.	8
8	<b>Drying &amp; Crystallization:</b> Equilibrium relationship & hysteresis, Various types of moisture in drying, Rate of drying, time of drying, Drying at low temperature, Freeze drying. Drying equipment- Tray dryer, Rotary dryers, Spray dryers, Fluidized bed dryer. Saturation, Nucleation, Principle of crystallization, Crystallization rate, Nucleation, Crystal growth, Caking of crystals, Application of crystallization	6

### Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	20	15	10	05	05

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

### Reference Books:

1. "Mass Transfer Operations", R E Treybal, Mc Graw Hill
2. "Unit Operations of Chemical Engineering", Warren McCabe, Jubian Smith and Peter Harriot, Mc Graw Hill, 7th Ed.
3. "Principles of Mass Transfer and Separation Processes" B. K. Dutta, Prentice-Hall of India Private Ltd.



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4. "Transport Processes & Unit Operations in Chemical Engineering", Gean Koplis, Prentice Hall.
5. "Coulson and Richardson's Chemical Engineering Volume 1 - Fluid Flow, Heat Transfer and Mass Transfer" Coulson, J.M.; Richardson, J.F.; Backhurst, J.R.; Harker, J.H. Elsevier, 6th Ed.

### Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To build a basic knowledge of mass transfer introduces the fundamental concepts, principles and applications of mass transfer processes	10%
CO-2	To utilize the technological methods in problem solving of mass transfer operations in industries.	20%
CO-3	To review the practical importance and relevance of mass transfer in chemical industry.	15%
CO-4	To understand the applications of different mass transfer processes and various equipment in which mass transfer operations are conducted	20%
CO-5	To recognize the selection criteria for mass transfer process and equipment required by the industries.	15%
CO-6	Evaluation of extent of mass transfer and efficiency of various separation process practiced in industry	20%

### List of Experiments:

1. Determine diffusion coefficient, or diffusivity
2. Determine the Mass Transfer Coefficient ( $K_r$ ) **with** Chemical Reaction
3. Determine the Mass Transfer Coefficient ( $K_r$ ) **without** Chemical Reaction
4. Determine the Mass Transfer Coefficient and flux ( $N_A$ ) in Gas-Liquid System by Evaporation.
5. Determine the percentage efficiency for single stage extraction
6. Determine the yield of crystals in batch crystallizer
7. Carry out differential distillation for binary liquid-liquid system
8. Tray dryer

### Major Equipment:

Air-vapor diffusion, Mass transfer with/without chemical reaction, Wetted Wall Column, Batch Crystallization, Tray dryer, Vapor liquid equilibrium

### List of Open Source Software/learning website:

- Mass Transfer Operations for the Practicing Engineer by Louis Theodore, Francesco Ricci, Wiley Publishers
- NPTEL
- Website: academia.edu for Laboratory view based e-learning portal for virtual mass transfer operations laboratory