Format K1

Maharashtra State Board of Technical Education, Mumbai

TEACHING PLAN (TP) Academic Year: **2025-26 (EVEN)**

Institute Code and Name: 0078- K. K. Wagh Polytechnic, Nashik **Semester**: Sixth
Programme and Code: Chemical Engineering (CH) **Course Index: 603**
Course and Code: MASS TRANSFER OPERATION (MTO) 316303
Name of Faculty: Mr. P.M.PATHAK **CLASS: TYCH**

INDUSTRY EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified competency through a teaching-learning process.

1. Identify the best possible separation process for a given duty or application
2. Operate and maintain the mass transfer equipment involved in upstream and downstream processes in industrial settings.

COURSE LEVEL LEARNING OUTCOMES (COS)

- CO603.1 - Analyze mass transfer phenomena in gases and liquids by applying fundamental principles of molecular and eddy diffusion.
- CO603.2 - Determine number of theoretical stages in distillation columns by evaluating vapour-liquid equilibrium of binary systems.
- CO603.3 - Select appropriate gas absorption equipment for given gas-liquid separation based on process requirements.
- CO603.4 - Select appropriate solvent and extraction equipment after analysing liquid equilibrium data for effective extraction processes.
- CO603.5 - Crystallize supersaturated solutions followed by drying of crystallized mass by using appropriate equipment.

TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316303	MASS TRANSFER OPERATION	MTO	DSC	4	-	4	2	10	5	03	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem.: 1 Hrs

Abbreviations: CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

THEORY LEARNING OUTCOME (TLO)

TLO No.	Title of TLO
TLO 1.1	Define diffusion and its significance in mass transfer operations.
TLO 1.2	Differentiate between molecular and eddy diffusion.
TLO 1.3	Explain Fick's laws of diffusion and their applications in steady and unsteady-state diffusion.
TLO 1.4	Apply diffusion equations to analyze gas and liquid diffusion processes.
TLO 1.5	Solve numerical problems on molecular diffusion in gases and liquids.
TLO 2.1	Apply the principles of vapor-liquid equilibrium to analyze and optimize distillation processes.
TLO 2.2	Interpret phase diagrams, including boiling point and equilibrium diagrams.
TLO 2.3	Explain different distillation methods such as simple, fractional, and steam distillation.
TLO 2.4	Determine the number of theoretical stages in distillation columns using McCabe-Thiele method.
TLO 2.5	Solve numerical problems related to distillation operations.
TLO 3.1	Define the concept of gas absorption and distinguish it from adsorption.
TLO 3.2	Explain the absorption equilibrium and phase rule governing gas absorption.
TLO 3.3	Describe the selection criteria for solvents used in absorption processes.
TLO 3.4	Analyze the performance of gas absorption equipment such as packed columns and scrubbers.
TLO 3.5	Solve numerical problems on material balance and hydrodynamics in packed columns.
TLO 4.1	Define liquid-liquid extraction and apply its fundamental principles to industrial separation processes.
TLO 4.2	Interpret ternary phase diagrams and equilibrium distribution curves.
TLO 4.3	Explain the criteria for solvent selection in extraction processes.
TLO 4.4	Describe the working principles of different extraction equipment such as mixer-settlers and agitated columns.
TLO 4.5	Apply extraction principles to industrial separation processes.
TLO 5.1	Utilize the principles of crystallization and drying in industrial separation and purification processes.
TLO 5.2	Explain the mechanisms of crystallization including supersaturation and nucleation.
TLO 5.3	Differentiate between types of moisture content and drying equilibrium.
TLO 5.4	Analyze the operation of drying equipment such as tray dryers, rotary dryers, and spray dryers.
TLO 5.5	Solve numerical problems related to drying kinetics and moisture balance.

SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	1	1	1	3	2			
CO2	3	3	3	2	2	3	3			
CO3	3	3	2	2	2	3	2			
CO4	3	3	2	1	2	3	2			
CO5	3	3	2	2	2	3	3			
Legends :- High:03, Medium:02,Low:01, No Mapping: - *PSOs are to be formulated at institute level										

Maharashtra State Board of Technical Education K-1

Teaching Plan (TP)

Academic Year: 2025-26 **Institute Code:** 0078
Program: Chemical Engineering **Course Code:** 315301
Course: MASS TRANSFER OPERATION 316303 **Semester: Sixth** (CH-6K)
Name of faculty: Mr. P.M.PATHAK

Chap No. (Alloted Hrs.)	CO Mention only Number	TLO Mention only Number	Unit Name and Learning Content Title/ Details	No. of Lecture	Plan (From-To)	Actual Execution (From-To)	Teaching method/ Media	Remark
Unit - I Diffusion: Fundamentals and Applications in Mass Transfer								
1 (13)	**CO-1**	**TLO 1.1**	1.1 The concept and significance of diffusion in mass transfer.	02	15/12/2025 to 16/12/2025		Blackboard, Books, media, PPT	
		TLO 1.2	1.2 **Types of diffusion:** Molecular and Eddy Diffusion.	03	18/12/2025 to 22/12/2025			
		TLO 1.3	1.3 Role of diffusion in industrial processes.	03	23/12/2025 to 26/12/2025			
		TLO 1.4	1.4 Fundamental Principles of Diffusion **1.4.1 Fick's First Law of Diffusion:** Diffusional flux, Concentration Gradient, Statement, Equation. **1.4.2 Fick's Second Law of Diffusion:** Unsteady-state diffusion. **MKCL Quiz 1**	03	29/12/2025 to 01/01/2026			**1 extra**
		TLO 1.5	1.5 **Steady State Molecular Diffusion in Gases and Liquids:** 1.5.1 Diffusion of a gas A through a stagnant gas B. 1.5.2 Equimolar counter diffusion.	02	02/01/2026 to 05/01/2026			

Chap No. (Alloted Hrs.)	CO Mention only Number	TLO Mention only Number	Unit Name and Learning Content Title/ Details	No. of Lecture	Plan (From-To)	Actual Execution (From-To)	Teaching method/ Media	Remark
			1.5.3 Binary Diffusion in liquids: Diffusivity,Factors affecting diffusivity. 1.5.4 Numerical based on Steady State Molecular Diffusion in Gases and Liquids					
			Practice test 1 and MKCL Quiz 2*	01	06/01/2026 to 06/01/2026			
Unit - II Distillation								
2(08)	**CO-2**	**TLO 2.1**	2.1 **Introduction:** 2.1.1 Definition 2.1.2 Concept and the basic principle.	2	08/01/2026 to 09/01/2026		Blackboard, Books, media, PPT	
		TLO 2.2	2.2 **Vapour-Liquid Equilibrium (VLE):** 2.2.1 Boiling Point Diagram 2.2.2 Equilibrium Diagram 2.2.3 Relative Volatility 2.2.4 Effect of pressure on VLE 2.2.5 P-x-y diagram: Ideal Solutions: Raoult's Law Non-Ideal Solutions: Henry's Law. **MKCL QUIZ 3**	2	12/01/2026 to 13/01/2026			
		TLO 2.3	2.3 **Distillation Methods:** 2.3.1 Distillation without fractionation: **Flash Vaporization:** Principle, Operation, Material Balance. **Simple Distillation:**	1	15/01/2026 to 15/01/2026			

Chap No. (Alloted Hrs.)	CO Mention only Number	TLO Mention only Number	Unit Name and Learning Content Title/ Details	No. of Lecture	Plan (From-To)	Actual Execution (From-To)	Teaching method/ Media	Remark
			Principle, Operation, Material Balance, Rayleigh's Equation **Steam Distillation:** Principle, Operation, Material Balance					
		TLO 2.4	2.3.2 Distillation with fractionation:**Fractional distillation of binary Mixture:**Principle of fractionation **Reflux:** Total, Minimum and Optimum Reflux, **Material Balance:** Overall and component material balance. **Determination of Theoretical Stages/Plates by McCabe Thiele Method:**Operating lines: For Rectifying and Stripping Sections of the column. Feed Line (q Line): Feed Quality, Equation of Feed Line. Effect of feed quality on the slope of feed line.	2	16/01/2026 to 19/01/2026			
		TLO 2.5	**Numerical:**Based on Determination of Theoretical Stages/Plates by McCabe Thiele Method. **Types of Fractionating column:**Plate Column: Bubble Cap, Sieve Plate, Valve Plate Packed Column:Structured Packings and Random	1	20/01/2026 to 20/01/2026			

Chap No. (Alloted Hrs.)	CO Mention only Number	TLO Mention only Number	Unit Name and Learning Content Title/ Details	No. of Lecture	Plan (From-To)	Actual Execution (From-To)	Teaching method/ Media	Remark
			Packings, **Components of plates in plate columns:** Wiers and Downcomers. **MKCL QUIZ 4 and Practice Test 2**					
Unit - III Gas Absorption								
3(08)	**CO-3**	**TLO 3.1**	3.1 **Introduction:** 3.1.1 Definition 3.1.2 Concept and the basic principle 3.1.3 Difference between Absorption and Adsorption phenomena.	2	22/01/2026 to 23/01/2026		Blackboard, Books, media, PPT	
		TLO 3.2	3.2 **Absorption Equilibrium:** 3.2.1 Solubility of Gases 3.2.2 Phase Rule 3.2.3 Solvents: Selection criteria of solvent for given duty.	2	26/01/2026 to 27/01/2026			
		TLO 3.3	3.3 **Gas Absorption Equipment: Types, Principles and Workings.** **3.3.1 Packed Column and Types of Packings:** **Structured Packings:** Metallic or Plastic Corrugated Sheets, Wire Mesh. **Random Packings:** Raschig Rings,Pall Rings, Berl and Intalox Saddles. **Packed Columns Fundamentals:**	2	29/01/2026 to 30/01/2026			

Chap No. (Alloted Hrs.)	CO Mention only Number	TLO Mention only Number	Unit Name and Learning Content Title/ Details	No. of Lecture	Plan (From-To)	Actual Execution (From-To)	Teaching method/ Media	Remark
			Packing Characteristics, Material Balance, Channelling in packed columns, Hydrodynamics of Packed Column, Loading and Flooding of Packed Column, Height Equivalent to Theoretical Plates (HETP), **Numerical:** Based on Fundamentals of Packed Column. **MKCL QUIZ 5**					
		TLO 3.4	**3.3.2 Mechanically Agitated Vessels:** Principle, Working and Material Balance	1	02/02/2026 to 03/02/2026			**1 extra**
		TLO 3.5	**3.3.3 Ventury Scrubber:** Principle, Working and Material Balance.	1	05/02/2026 to 05/02/2026			
			MKCL Quiz 6, Practice test 3	--	06/02/2026 to 06/02/2026			
Unit - IV Liquid-Liquid Extraction								
4(08)	**CO-4**	**TLO 4.1**	4.1 **Introduction:** 4.1.1 Definition 4.1.2 Concept and the basic principle	2	09/02/2026 to 10/02/2026		Blackboard, Books, media, PPT	
		TLO 4.2	4.2 **Liquid Equilibria** 4.2.1 Equilibrium distribution of solute for immiscible system. 4.2.2 Equilateral triangular coordinates 4.2.3 Ternary Diagram: One Liquid Pair	2	12/02/2026 to 13/02/2026			

Chap No. (Alloted Hrs.)	CO Mention only Number	TLO Mention only Number	Unit Name and Learning Content Title/ Details	No. of Lecture	Plan (From-To)	Actual Execution (From-To)	Teaching method/ Media	Remark
			Partially Miscible, Two Liquid Pairs Partially Miscible 4.2.4 Distribution curve 4.2.5 Numerical based on Distribution Coefficient **MKCL QUIZ 7**					
		TLO 4.3	4.3 **Choice of Solvent:** Selection criteria of solvent.	2	16/02/2026 to 17/03/2026			
		TLO 4.4	4.4 **Extraction Equipment:** Principle, Construction, Working and Applications of: 4.4.1 Mixer Settler-Assemblies: Mixer Settler	2	19/02/2026 to 20/02/2026			
		TLO 4.5	4.4.2 Static Columns: Spray Column, Sieve Plate Column 4.4.3 Mechanically Agitated Columns:Rotating Disc Contactor, Pulse Column. 4.4.4 Centrifugal Contactors **Practice test 4 and MKCL Quiz 8**	--	23/02/2026 to 23/02/2026			
Unit - V Crystallization and Drying								
5(08)	**CO-5**	**TLO5.1**	5.1 **Crystallization:** **5.1.1 Introduction:**Definition, importance and the basic concept of crystallization. **5.1.2 Mechanism:** Saturation, Super Saturation, Mier's Theory	2	24/02/2026 to 26/02/2026		Blackboard, Books, media, PPT	

Chap No. (Alloted Hrs.)	CO Mention only Number	TLO Mention only Number	Unit Name and Learning Content Title/ Details	No. of Lecture	Plan (From-To)	Actual Execution (From-To)	Teaching method/ Media	Remark
			of Supersaturation.					
		TLO 5.2	**5.1.3 Crystallization Equipment:** Principle, Construction and Working of: Agitated Tank Crystallizer, Swenson-Walker Crystallizer	2	27/02/2026 to 02/03/2026			**1 extra**
		TLO 5.3	5.2 **Drying: 5.2.1 Introduction:** Definition, importance and the basic concept of drying. **5.2.2 Drying Equilibrium: Basis of Moisture Content:** Dry Basis and Wet Basis. **Relative Humidity and the Moisture Content:** Equilibrium Moisture, Free Moisture, Bound and Unbound Water,Hysteresis, Soluble Solids	1	03/03/2026 to 03/03/2026			

Chap No. (Alloted Hrs.)	CO Mention only Number	TLO Mention only Number	Unit Name and Learning Content Title/ Details	No. of Lecture	Plan (From-To)	Actual Execution (From-To)	Teaching method/ Media	Remark
		TLO 5.4	**5.2.3 Drying Equipment:** Classification of dryers: Batch and Continuous Dryers Construction, Working and Applications of: Tray Dryer, Rotary Dryer, Drum Dryer, Spray Dryer, Fluidized Bed Dryer.**MKCL QUIZ 9**	1	05/03/2026 to 05/03/2026			
		TLO 5.5	**Numerical:** Based on Drying Equilibrium	1	09/03/2026 to 09/03/2026			
				1	10/03/2026 to 10/03/2026			
		--	**Practice test 5 and MKCL Quiz 10**	--	12/03/2026 to 12/03/2026			**1 extra**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

 Theory:

Comprises of a progressive theory test to be assessed out of 30 Marks Maximum.

Laboratory Learning:

Comprises of a continuous assessment of each LLO to be assessed out of 25 Marks Maximum wherein 60% marks are to be awarded for Process related performance and 40% marks to be awarded for product related part of the experiment.

Summative Assessment (Assessment of Learning)

 Theory:

Comprises of End Semester Examination to be assessed out of 70 Marks Maximum.

Laboratory Learning:

Comprises of an End Semester Examination to be assessed out of 25 Marks Maximum.

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	K.V. Narayanan, B.	Mass Transfer Operations:	CBS Publishers & Distributors Pvt. Ltd.

	Lakshmikutty	Theory and Application	978-9354666094
2	Robert E. Treybal	Mass Transfer Operations	McGraw-Hill 978-0070666153
3	Warren L. McCabe, Julian C. Smith, Peter Harriott	Unit Operations of Chemical Engineering	McGraw-Hill 978-0072848236
4	Binay K. Dutta	Principles of Mass Transfer and Separation Processes	PHI Learning 978-8120345187
5	Christie J. Geankoplis	Transport Processes and Separation Process Principles	Pearson Education 978-0131013674
6	J.M. Coulson, J.F. Richardson	Chemical Engineering: Volume 1 & 2	Butterworth Heinemann 978-0750644457 (Vol. 1), 978 0750644464 (Vol. 2)
7	J.D. Seader, Ernest J. Henley	Separation Process Principles	Wiley 978-0470481837
8	Morton M. Denn	Process Fluid Mechanics Prentice Hall 978-0137232093	Prentice Hall 978-0137232093

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	COMSOL Multiphysics:	This versatile software is used for simulating various mass transfer processes, including diffusion, heat and mass transfer in packed beds, and distillation column performance. It helps in modeling concentration profiles, velocity distributions, and transport mechanisms in mass transfer systems.
2	Aspen Plus:	A widely used process simulation software in chemical engineering, Aspen Plus allows the modeling and optimization of mass transfer operations such as distillation, absorption, liquid-liquid extraction, and drying. It helps in designing separation columns and evaluating mass transfer efficiency.
3	MATLAB:	MATLAB is a powerful tool for numerical analysis and simulation. It can be used to solve mass transfer equations, develop control algorithms for distillation and absorption processes, and perform data analysis related to separation processes.
4	CHEMCAD:	CHEMCAD is an advanced process modeling software that enables simulation, design, and optimization of distillation, absorption, and extraction processes. It helps engineers analyze phase equilibria and mass transfer coefficients for industrial applications.
5	ANSYS Fluent:	ANSYS Fluent is a Computational Fluid Dynamics (CFD) software used to simulate fluid flow, heat, and mass transfer in separation processes such as packed columns, spray dryers, and evaporators. It is particularly useful for analyzing flow patterns and optimizing mass transfer equipment.
6	LabVIEW:	LabVIEW is widely used for data acquisition and process control in mass transfer experiments. It helps in monitoring distillation column performance, gas absorption rates, and drying kinetics through real-time data analysis.
	Note :	

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

Mr. P. M. PATHAK
(Name & signature of staff)

Dr. P. S. Bhandari
(Name & signature of HOD)

CC: Course file –MTO 316303