B. Tech. Semester V

Subject Name: Mass Transfer Operation-I **Subject Code: BTCH13501**

Type of course: Professional Core Course

Prerequisite: Material & Energy Balance Calculations, Physical Chemistry, Organic Chemistry-I and II, Chem. Eng. Thermodynamics-I, Momentum and Mass Transfer

Rationale: This is a core Chem Engg. Course. It is required in almost all the courses, such as, Separation Processes, Chemical Engineering Laboratory, knowledge and application of mass transfer principles in Equipment design, Process Modeling and Simulation, Optimization, Process Integration.

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	150
3	0	2	4	60	15	25	30	20	

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	**INTRODUCTION**: Introduction to Mass Transfer Operation, classification & methods.	2	4%
2.	**DIFFUSION AND MASS TRANSFER**: Molecular diffusion in fluids, steady state diffusion (both gases & liquids), diffusivity of liquids & gases, introduction to diffusion in solids, Fick's law, types of solid diffusion.	6	13%
3.	**MASS TRANFER COEFFICIENTS**: Mass Transfer co-efficient in laminar & turbulent flow, Mass, Heat and Momentum transfer analogies.	6	13%
4.	**INTER PHASE MASS TRANSFER**: Equilibrium, diffusion between phases, material balance, stages, murphee efficiency	4	9%
5.	**ABSOPRTION**: Equilibrium, material balance for single component transfer, multi-stage & packed tower operation, multicomponent system, non-isothermal operation, absorption with chemical reaction, tower design.	8	18%
6.	**HUMIDIFICATION & DEHUMIDIFICATION**: Phase diagram (temp/solubility relationship) Vapor-gas mixtures, Vapour-liquid equilibrium, gas-liquid contact operations, adiabatic & non-adiabatic operations, and its application. Working of Humidifiers and cooling towers.	6	13%
7.	**GAS-LIQUID CONTACTORS:** Sparged vessels, Agitated vessels, Venturi scrubber, and Spray tower. Tray Towers: Tray tower internals, Different types of trays, Weirs, Downcomers and criteria of their selection, Flooding, Loading,	8	18%

	Coning, Weeping & dumping in tray tower Packed Towers: Packed tower internals, Different types of packing and their selection criteria, Different types of liquid distributors, Redistributors, Packing supports, Mist eliminators and packing restrainers and their selection criteria, Flooding, Loading and channelling in packed tower, Tray tower vs. Packed tower.		
8.	**CRYSTALLIZATION**: Theory of solubility and crystallization, Supersaturation, Nucleation, Crystal Growth, Population balance analysis, method of moments for rate expressions for, volume, area and length growth, CSD distribution, MSMPR operation, evaporative and cooling (rate expressions) , Melt crystallization, Process design of crystallizers and their operation	4	9%

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
25	25	25	10	10	05

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

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1	Mass-Transfer Operations	Treybal R.E.	McGraw-Hill, New York	1981	3rd Edition
2	Unit Operations in Chemical Engineering,	McCabe W.L, Smith J.C., Harriott P.	Mc Graw Hill, New York	2001 & 2005	6th & 7th Edition.
3	Chemical Engineering Vol. 1, Backhurst J. R., Harker J.H.	Coulson J.M., Richardson J.F.	Elsevier, New Delhi.	2004	6th Edition
4	Mass Transfer	Sherwood, T.K., Pigford, R.L., Wilke, C.R.	Cambridge University Press, Cambridge.	1997	2nd Edition
5	Introduction to Process Engineering and Design	S B Thakore and B I Bhatt	Tata McGraw Hill	2007	2nd Edition
6	Perry's Chemical Engineers' Handbook,	Green D. and Perry R.	McGraw-Hill Professional, Edinburgh.	2007	Eighth Edition
7	Applied process design for chemical and petrochemical plants ,Vol-1, 2 &3	Ludwig, E.	Butterworth-Heinemam	1997	Third Edition

Course Outcome:

Sr. No.	CO Statement After learning this subject, students will be able to	Marks % weightage
CO-1	Describe a basic knowledge of mass transfer operations, gas liquid equipment and separation processes carried out in chemical industries.	25
CO-2	Explain the mass transfer process and equipment required by the industries	25
CO-3	Implement different mass transfer operations such as Extraction, Absorption, Diffusion, leaching and crystallization in industries	25
CO-4	Check the designing of mass transfer equipment used in the chemical industries as per the process requirement	25

Mapping with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO-1	2	1	1	1	1	2	3	3	3	2	2	3	2	2	3
CO-2	2	2	2	3	2	2	3	3	3	2	3	3	3	2	3
CO-3	3	3	3	3	2	2	2	3	3	3	2	3	3	3	3
CO-4	3	3	3	1	2	3	3	3	3	2	3	3	3	3	3
Rationale*	10	9	9	8	7	9	11	12	12	9	10	12	11	10	12

Rationale*: This Chem Engg. Course is required in almost all the courses, such as, Separation Processes, Chemical Engineering Laboratory, knowledge and application of mass transfer principles in Equipment design, Process Modeling and Simulation, Optimization, Process Integration.

LIST OF PRACTICALS: (Minimum 6-8 performed.)

Experiments need to be performed during the semester.

1. Humidification and dehumidification
2. Mass transfer coefficient
3. Crystallization
4. Determination of Diffusivity
5. Diffusion coefficient in stagnant air
6. Diffusion coefficient in moving air
7. CO_2 absorption
8. Cooling tower
9. Packed Column
10. Simulation of the unit operation using process simulator should be included to study the behaviour of mass transfer operation in each experiment

Major Equipment:

1. Cooling tower
2. Packed Column
3. CO_2 absorption

List of Open Source/learning website:

- https://nptel.ac.in/courses/103/103/103103145/ Chapter-1,2,3,4,5 &7
- https://nptel.ac.in/courses/103/103/103103035 Chapter-1,2,3,4,5,6 &7
- https://nptel.ac.in/courses/103/103/103103154/ Chapter-1,2,3,4,5,6,7 & 8

List of Open Source Software:

- https://openfoam.org/
- https://www.smartdraw.com/process-flow-diagram/process-flow-diagram-software.htm
- https://dwsim.inforside.com.br/new/
- https://www.cocosimulator.org/index_download.html