Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Institute of Technology
Semester-5 (B.Tech.)

Subject: Mass Transfer Operations II – BETCH15309

Type of course: Professional Core

Prerequisite: Basic knowledge of unit operations and mass transfer operations -1

Rationale: Mass transfer operations are essential tools for manipulating the composition of mixtures, enabling a wide range of industrial processes and contributing to the production of high-quality products, environmental protection, and process efficiency.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	
4	0	2	5	60	30	10	20	30	150

Legends: CI-Class Room Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.

Course Content:

Sr. No.	Course content	Hrs.	Weightage
1	**Distillation** **Basics of distillation;** Vapor liquid- Equilibrium (VLE), Experimental determination of VLE, constant temperature and constant pressure binary equilibria, Raoult's Law and Azeotropes. Enthalpy concentration Diagram. **Flash Vaporization (Flash Distillation)**; Flash Vaporization of Binary mixture. **Steam Distillation, Batch Distillation**. **Continuous multistage reactivation of binary mixture**; Materials and energy balance equations, The McCabe-Thiele method, Assumptions, rectifying section, stripping section, feed line, feed tray location and number of ideal trays, smoker equation, total reflux, Fenske's equation, Minimum reflux ratio, open steam. **Multistage batch distillation with reflux**	20	30%

	The Ponchon- Savarit Method. **Distillation in packed tower.**		
2	**Liquid-Liquid Extraction and Solid Liquid Extraction** Examples of solvent extraction Liquid-Liquid Equilibria (LLE); Experimental determination of LLE data, Graphical representation of LLE, triangular diagrams, effect of temperature on LLE. **Solvent selection** **Design calculation for Stage wise extraction;** Single stage operation, Determination of tie line, Countercurrent Extraction—Determination of the Number of Ideal Stages, Stage-wise Extraction with Reflux, The Minimum Solvent Rate. **Liquid-Liquid Extraction Equipment;** The Mixer-settler, Centrifugal Extractors, Unagitated Extraction Columns, Rotary Agitated Extraction Columns. **Selection Of Extractors.**	15	25%
3	**Humidification and water cooling** **Terminology And Definitions;** Adiabatic Saturation Temperature, Wet-Bulb Temperature, The Psychrometric Chart and Its Use Description of Cooling. **Towers Construction and Operation;** Atmospheric Towers, Natural draft towers, Mechanical draft towers, Structural component and material of constructions. **Cooling Tower Calculations;** Sizing, Gas temperature profile, Dehumidification and Humidification. **Drying of wet solids** Physical Mechanism of Drying; Drying Equilibria, Important Definitions and Terms, The Drying Rate Curve, Calculation of the Drying Time from the Drying Rate Data. **Classification of drying equipment;** direct-heat batch and continuous dryers, indirect heat batch and continuous dryers.	15	25%
4.	**Adsorption** **Commercial adsorbent** Characteristics and properties of adsorbents, adsorption equilibria, heat of adsorption, selection of adsorbents, pressure swing adsorption, ion exchange, chromatography. **Crystallization** Solid-liquid phase equilibrium, nucleation and crystal growth **Membrane Separation** Materials, types and preparation of membranes, membrane characterization, filtration and ultrafiltration, Reverse Osmosis, Concentration driven processes.	10	20%

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1.	**Distillation:** Students in groups (Maximum 3) will have to prepare project based on mass transfer operations processes and upload a report of project on GMIU web portal.	10
2.	**Numerical problem solving**: Students must solve 5 Numerical based on LLE and Humidification and given by the faculty. Upload on GMIU Web portal.	10
3.	**Industrial applications:** Explain dryers, humidifiers, membrane-based units used in chemical industries, Upload a report on GMIU Web portal.	10
Total		30

Suggested Specification table with Marks (Theory): 60

Distribution of Theory Marks (Revised Bloom's Taxonomy)						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage	30%	20%	20%	20%	10%	00

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 the above table.

Course Outcome:

After learning the course, the students should be able to:	
CO1	Understand the importance of Distillation and extraction with its respective industrial application in Chemical Industries.
CO2	Understand Liquid – Liquid extraction, solvent selection and design of extractors with industrial applications.
CO3	Apply humidification and water-cooling concepts and its application in industries in form of cooling towers, Drying operations and different dryers used in industries.
CO4	Identify commercial Adsorbent and its application, able to calculate crystallization equilibrium and learn use of different types of membrane operations.

LIST OF PRACTICALS:

Sr. No.	Description	Unit	Hours
1	Study of Vapor-liquid Equilibrium in VLE setup	1	4
2	Study of Simple Batch Distillation in distillation setup	1	4
3	Study of Liquid-Liquid Extraction in A Packed Tower	2	4
4	Study of Humidification & Dehumidification	3	4
5	Study of drying in rotary dryer	3	2
6	Study of Adsorption in Packed bed column	4	4
7	Study of crystallization in Batch Crystallizer	4	4
8	Study of Ion Exchange in ion exchange set up	4	4
Total			30

Instructional Method:

The course delivery method will depend upon the requirement of content and needs 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.

From the content 10% topics are suggested for flipped mode instruction.

Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory

The internal evaluation will be done based on Active Learning Assignment

Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

Reference Books:

[1] Mass Transfer operations, Robert E. Treybal.

[2] Mass Transfer Operation by B. K. Dutta

[3] Unit operations in Chemical Engineering, McCabe & Smith.

[4] Chemical Engineering, Kolsen & Richardson.