GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Computer Aided Process Design

Course / Subject Code: ME01072041

Course / Subject Name : Novel Separation Technology

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PEC

Prerequisite:	A basic course on mass transfer and separation techniques
Rationale:	In this subject emphasis is given on novel separation techniques that can be applied in chemical process industries. After completion of this subject, student can find solution ofdifficult separation problems often faced by chemical process industries applying conventional technologies. The concepts can also be applied in wastewater treatment and water remediation.

Course Outcome:

After completion of the course, student will able to:

No	Course Outcomes
01	Explain advanced concepts of separation techniques used in chemical industries.
02	Understand the principles and functioning advanced separation techniques.
03	Apply advanced separation techniques as per chemical process requirement.
04	Analyze the conventional process for problem solving and suggest suitable advanced separation techniques.
05	Evaluate the selection criteria between advanced separation techniques and conventional separation techniques and justify replacement options.

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 / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Unit No.	Content	No. of Hours	% of Weightage
1.	**Fundamentals of separation processes** Separation factor, chemical potential in interface mass transfer, equilibrium and rate governed separation, drawbacks of the conventional separation processes, need for advanced separation processes. Major areas of applications of advanced separation processes.	4	9
2.	**Super Critical Extraction** Working Principle, Decaffeination, ROSE process, Commercial applications of supercritical extraction, Advantages and disadvantages.	4	9
3.	**Reactive & Catalytic Distillation** Principles, commercial packing, Industrial applications like Etherification process, Esterification Processes, Alkylation Processes and Advantages.	4	9
4.	**Short path Distillation** Concept & working of short path Distillation Unit (SPDU), Difference between short path Distillation & molecular distillation, applications of SPDU.	4	9
5.	**Chromatographic separation** Principle and operation, Chromatographic column Ion exchange chromatography, Gel filtration and affinity chromatography; Thin layer and paper chromatography Liquid chromatography, Advantages and disadvantages of chromatographic separations.	4	9
6.	**Membrane Separation Processes** Principle, Classification of membrane process, Membrane types, materials, synthesis and characterization; membrane modules, Limitations of membrane processes	4	9
7.	**Pressure Driven Membrane Processes** principle, operating parameters, membranes used, transport processes/mechanisms and industrial applications for individual membrane processes such as Reverse osmosis, nanofiltration, ultrafiltration, microfiltration, etc.	5	12
8.	**Membrane Distillation** Working principles, Membrane Characteristics and Membrane Distillation mechanism, Membrane Distillation configurations (arrangements), Factors affecting Membrane Distillation, Effect of operating parameters, Advantages and disadvantages, Applications.	3	6
9.	**Membrane Reactor and Membrane Bio-Reactor** Concept & working, Various modules of membrane used for membrane reactor, Advantages & Disadvantages, Industrial applications.	4	10
10.	**Pervaporization** Working principle, Advantages, Commercial applications.	3	6

11.	**Pressure Swing Operations** Concept & Working of Pressure Swing Distillation and Pressure Swing Adsorption, Advantage & Disadvantages, Industrial applications.	3	6
12.	**Melt crystallization** Concept, Phase equilibrium, Different techniques, Commercial applications	3	6
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	20	15	15	10	0

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

References/Suggested Learning Resources:

(a) Books:

1. Perry Chemical Engineers Handbook' 7th Edition by R.H Perry and D. Green.
2. Encyclopedia of Chemical Engineering by Kirk & Othmer.
3. Transport Processes and Separation Process principles, Christie J Geankoplis Prentice-Hall ofIndia Private Ltd, New Delhi, 4th Edition 2006.
4. Membrane separation Processes by Kaushik Nath, PHI Learning Pvt. Ltd., 2nd edition, 2017
5. Introduction to process Engineering & Design by S.B. Thakore & B.I Bhatt, Tata McGraw-HillLtd.,2nd edition, 2017
6. Separation Process Engineering Includes Mass Transfer Analysis, by Phillip C. Wankat,Pearson Publishing, 2022.

(b) Open source software and website:

1. NPTEL open course on Separation Processes (https://archive.nptel.ac.in/courses/103/105/103105060)
2. MIT Open course lecture on Separation Processes (https://ocw.mit.edu/search/?t=Separation+Processes)

Suggested Course Practical List:

Experiments based on the course content mentioned above can be performed. Some suggestions are providedbelow:

1. Swelling characteristics of membrane
2. Water permeability of a given polymeric membrane (RO/NF/UF membranes can be used)
3. Desalination based experiments on different membrane module
4. Paper chromatography
5. High performance liquid chromatography (HPLC) / Gas chromatography (GC)
6. Melt crystallization
7. Supercritical extraction

Suggested Activities for Students:

Students may be allotted one Open-ended Project / Mini Project on any of the above topic. Detailed literaturereview based on the research papers published in reputed journals to be incorporated.

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