GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering
Subject Code: 3731606
Semester – III
Subject Name: Advance Chemical Process Synthesis

Type of course: Program Elective – V

Prerequisite: Fundamentals of heat and mass transfer

Rationale: Able to understand the importance of simulation to assist process design in chemical engineering field. Understand the selection of series of process steps and their integration to form a complete manufacturing system which is energy efficient and environmentally benign. Also, the process will normally operate as part of an integrated manufacturing site consisting of a number of processes serviced by a common utility system.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

Syllabus Content:

Sr. No.	Content	Total Hrs
1	Introduction to process synthesis: Objectives, design opportunities, steps in process synthsis, environmental protection, safety considerations, engineering ethics, design softwares.	5
2	Synthesis of Separation Trains: Objectives, introduction, feed and product separation, criteria for selection of separation methods, selection of equipment, sequencing of ordinary distillation for the separation of nearly ideal fluid mixtures, heuristics for determining favourable sequences, marginal annual cost method, marginal vapour rate method, complex and thermally coupled distillation, separation train synthesis for non-ideal fluid mixtures, gas mixture separation, MILP model for distillation sequences, MILP model for continuous and discrete temperature, Design and synthesis with rigorous models.	10
3	Design and Synthesis of Reactor Networks: Reactor Models, Reactor Design for Complex Configurations, Reactor Network Design using the Attainable Region, Reactor Network Synthesis with targeting formulation, Non-	8

	isothermal systems, Improvement to the targeting algorithm, Reactor Network Synthesis in process flow sheets, Energy integrating in reactor networks.	
4	Energy Integration: Introduction to heat exchange network synthesis (HENS), composite curve methods,pinch design approach to inventing a network, Minimum number of heat exchangers and minimum utility requirement targets, Network Superstructures for Minimization of Annual Costs, Multiple Utility Design Problems, MILP model for Heat Exchange Network Synthesis, Energy integration in refrigeration cycles.	**10**
5	Mass Integration: Introduction, minimum Mass Separating Agent (MSA), mass exchanger networks, minimum external MSA, minimum number of mass exchangers	**5**
6	Design and Scheduling of Batch Processes: Single product batch plants, Multiple product batch plants, Transfer policies, Parallel units and intermediate storage, Sizing of vessels in batch plants, Inventories, Synthesis of flow shop plants, design and scheduling of multi-product batch plants, constraints for flow shop plants, MINLP design model for flow shop plants, MILP reformulation for discrete sizes, NLP design model-Mixed product campaigns, Cyclic scheduling in flow shop plants.	**10**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**16**	**18**	**12**	**14**	**-**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and 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 Books:

- Product and Process Design Principles, Warren D Seider, J. D. Seader, Daniel R Lewin, Wiley International.
- Systematic Methods of Chemical Process Design : Lorens T. Biegler , E.Ignacio Grossmann, Arthur W Westerberg, Prentice Hall International, Inc.
- Chemical Process: Design and Integration, Robin Smith, Wiley International

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Course Outcomes: After successful completion of the course, students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Basics of chemical process design principles	10 %
CO-2	Design and synthesis of separation trains	20 %
CO-3	Heat and energy integration of chemical process	30 %
CO-4	Graphical Techniques for simple reacting system	20 %
CO-5	Design and Scheduling of Batch Processes	20%

List of Experiments: NA

Major Equipment: NA

List of Open Source Software/learning website:

- Students can refer to video lectures available on NPTEL.