



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Computer Aided Process Design

Subject Code: ME02072081

Subject Name: Advance Chemical Process Synthesis

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Fundamentals of heat and mass transfer
Rationale:	Advance Chemical Process Synthesis is a specialized course focusing on designing and optimizing complex chemical processes. It builds upon foundational chemical engineering principles, applying techniques like energy and mass integration, reactor network synthesis, and separation train design to real-world challenges. Students develop analytical and innovative skills to design sustainable and efficient processes, minimizing waste and energy consumption.

Course Outcomes:

After Completion of the Course, Student will able to:

No.	Course Outcomes	
01	Apply heat integration techniques to design energy efficient process	A, N, E, C
02	Understand the fundamental principles of mass integration.	R, U, A
03	Use graphical methods to develop attainable regions for reacting systems.	R, U, A
04	Utilize various methods in determining optimal separation sequences.	U, A, N
05	Develop Gantt charts to implement effective scheduling strategies for batch processes.	U, A, N

Teaching and Examination Scheme:

Total Credits L+T+ (PR/2)				Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA / CA (M)	ESE (V)	PA/C A (I)	
3	0	2	4	70	30	30	20	150

Course Content:

w.e.f. 2024-25

<https://syllabus.gtu.ac.in/>

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Unit No.	Content	No. of Hours	% of Weightage
1.	Introduction to Process Synthesis: Objectives, Design Opportunities, Hierarchy of Chemical Process Design, Steps in Process Synthesis, Environmental Protection, Safety Considerations, Engineering Ethics, Design Software.	3	7
2.	Energy Integration: Introduction to Heat Exchange Network Synthesis (Hens), Composite Curve Methods, MILP Model for MER (Maximum Energy Recovery) Targeting, 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, Design for Multi Pinch Problems, HEN Optimization, MILP Model for Heat Exchange Network Synthesis, Energy Integration in Refrigeration Cycles.	12	27
3.	Mass Integration: Introduction, Minimum Mass Separating Agent (MSA) through Concentration Interval Method and Composite Curve Method, Mass Exchanger Networks for Minimum External MSA, Minimum Number of Mass Exchangers.	6	13
4.	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-Isothermal Systems, Improvement to the Targeting Algorithm, Reactor Network Synthesis in Process Flow Sheets, Energy Integrating in Reactor Networks.	6	13
5.	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 Favorable 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	22
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	8	18



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Design Model-Mixed Product Campaigns, Cyclic Scheduling in Flow Shop Plants.		
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
25	20	20	20	10	05

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

References/Suggested Learning Resources:

(a) Books:

- (1) L.T. Biegler, E.I. Grossmann, and A.W. Westerberg, Systematic Methods of Chemical Process Design, Prentice Hall International Inc. Series in the Physical and Chemical Engg. Sciences, 1997.
- (2) W.D. Seider and J.D. Seader, Product and Process Design Principles: Synthesis, Analysis and Evaluation, 2nd ed., John Wiley, 2004
- (3) R. Smith, Chemical Process Design, McGraw Hill, New York, 1995.
- (4) J. Douglas, Conceptual Design of Chemical Processes, McGraw Hill, 1989.

(b) Open-source software and website:

1. NPTEL lecture series on "Process Integration"

Suggested Activities for Students:

1. Students may visit and collect stream data from any industry and apply the principles of heat integration to find minimum utility consumption.
2. Students may use multiple software/tools like GAMS, Scilab, Excel, MATLAB etc. and compare their performance.
