GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Chemical Engineering (05)
SUBJECT NAME: Computer Aided Process Synthesis
SUBJECT CODE: 2170507
B.E. 7th SEMESTER

Type of course: Chemical Engineering

Prerequisite: Basics of heat transfer, mass transfer and reaction engineering

Rationale:
Chemical process design requires the selection of a series of processing steps and their integration to form a complete manufacturing system. This course emphasizes selection of the steps as individual operations and their integration to form an efficient process. 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
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	3	7	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**The Design Process:** Objectives, Design Opportunities, Steps in Product Process Design, Environmental, Protection, Safety Considerations, Engineering Ethics, Role of Computers	8	11
2	**Reactor Design and Reactor Network Synthesis:** Objectives, Reactor Models, Reactor Design for Complex Configurations, Reactor Network Design Using the Attainable Region	8	11
3	**Synthesis of Separation Trains:** Objectives, Introduction ,Phase Separation of Reactor Effluent, 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 Vapour Rate Method,Complex and thermally coupled distillation,Sequencing of Ordinary Distillation for the Separation of Nearly Non-Ideal Fluid Mixtures	14	19

4	**Synthesis of Heat Exchanger Networks:** Objectives, Basic Heat Exchanger Network Synthesis (HENS), Minimum Utility Targets, Temperature Interval Method, Hohmann / Lochart Composite Curves (HCC), Grand Composite Curves (GCC), Pinch Design Approach to Inventing a Network, Networks for Maximum Energy Recovery, Minimum Number of Exchangers, Stream Splitting, Threshold and Optimum Approach Temperature, Derivation of Network Superstructures for Minimization of Annual Costs, Multiple Utility Design Problems	24	34
5	**Energy Integrated Distillation Processes:** Heat Integrated Distillation Trains, Impact of Pressure, Multi Effect Distillation, Heat Pumping, Vapour Recompression and Reboiler Flashing, Positioning of Heat Engines and Heat Pumps	8	11
6	**Design and Scheduling of Batch Processes:** Objectives, Introduction, Design of Batch Process Units, Design of Reactor-Separator Processes, Design of Single Product Processing Sequences, Design of Multi-Product Processing Sequencing	10	14

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
14	14	21	7	7	7

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:

1. Lorens T. Biegler, E. Ignacio grossmann, Arthur W. Westerberg, Systematic Methods of Chemical Process Design, Prentice Hall International.
2. Warren D. Seider, J. D. Seader, Daniel R. Lewin, Product and Process Design Principles: Synthesis, Analysis, and Evaluation, 2nd Edition, Wiley.
3. Robin Smith, Chemical Process: Design and Integration, Wiley.
4. James M. Douglas, Conceptual Design of Chemical Processes, McGraw Hill International, 1988.

Course Outcome:
After learning the course the students should be able to:

1. Learn the basic heat exchanger network synthesis (HENS).
2. Develop the pinch design approach to inventing a network.
3. Study the derivation of network structures for minimization of annual costs.
4. Configure the multiple utility design problems.
5. Learn about the Environment Protection, Safety Considerations & Engineering Ethics.

6. Learn about the Energy Integrating in reactor networks
7. Understand the Energy Integrated Distillation Processes.
8. Understand the concept of reactor network synthesis. And enable to do the reactor network design using the attainable region.
9. Understand the production of multiple products
10. Design the Batch scheduling.
11. Understand the Design and Scheduling of Batch Processes.

List of Experiments:
Tutorials/Presentation/Practical based on above topics.

Design based Problems (DP)/Open Ended Problem:
Students are free to select any area of design for the Synthesis of Optimal chemical process based on chemical engineering applications.
1. Synthesis of Optimal Chemical Reactor Networks.
2. Synthesis and Optimization of Distillation Column Sequences for Separation of Multicomponent Products.
3. Synthesis of heat exchanger networks.

Major Equipment:

Computers software (Excel Spread-sheet, GAMS, etc.)

List of Open Source Software/learning website:

➢ Students can refer to video lectures available on the websites including NPTEL lecture series.
➢ Students can refer to the CDs available with some reference books for the solution of problems using software/spreadsheets.
➢ Most of these examples do not require specialist software and can be performed on spreadsheet software. Students can develop their own programs/spreadsheets for the solution of problems. Students can use GAMS software for the solution of LP, NLP, MILP, etc. optimization problems

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.