

GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING (05) PROCESS EQUIPMENT DESIGN-I SUBJECT CODE: 2160503 B.E. 6th SEMESTER

Type of course: Chemical Engineering

Prerequisite: The student should have basic understanding of Unit Operations of Chemical Engineering.

Rationale: Equipment design involves modifications and additions to existing plants or creating design layouts of plant / equipments. With rapid rate of increase in the advancement of knowledge, it is important that the students should know the relevant application for equipment design. It has been observed conclusively that practice in using the reference literature and software has helped the students to secure jobs and also to perform better in profession.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		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	Process design of piping, Fluid moving devices and Flow meters: Introduction, Process design of piping, $NPSH_A$ & $NPSH_R$, Power required by pump, evaluation of Centrifugal pump performance when handling viscous liquids, Power required in Fan, Blower and adiabatic compressor, flow meters, Process design of Orifice meter, Rotameter etc	10	14
2	Process design of Heat exchangers: Shell & Tube heat exchangers, Functions of various parts of shell & Tube Heat exchanger, General design method of shell & tube heat exchanger, Criteria of selection among Fixed Tube sheet, U Tube & Floating Head heat exchanger, Process design of without phase change heat exchanger, Process design of condenser, Criteria of selection for Horizontal and vertical condenser, Process design of Kettle type & Thermosyphon Reboilers and vaporizers, Tinker's flow model, Air cooled heat exchangers and air heaters, plate heat exchangers, etc.	20	27
3	Process design of Distillation Column: Introduction, Criteria of selection, Selection of equipment for distillation, Distillation column design, Selection of key components for multi-component distillation, Determination of operating pressure for distillation column, Advantages & disadvantages of vacuum distillation, Determination of nos. of theoretical stages for binary distillation by McCabe Thiele method Determination of nos. of theoretical stages for multi-component distillation by Fenske- Underwood-Gilliland's method, Selection of trays, Calculations for tower diameter & pressure drop of	18	25

	sieve tray tower, Checking of conditions for weeping, down comer flooding, liquid entrainment, etc, tray efficiency, Jet Flooding & down comer Flooding, Different types of weirs & down comers of tray tower, their selection criteria,		
4	Process design of Absorbers: Introduction, Criteria for selection among different types of absorption equipment, Process Design of packed tower type absorber: Determination of actual amount of solvent, Selection of packing, Determination of tower diameter & pressure drop, Determination of <i>NtoG</i> , <i>HtoG</i> & height of packing, Process design & selection criteria of liquid distributors, redistributors & packing support, Process design of Spray chamber or spray tower type absorber, Venturi Scrubber.	12	17
5	Process design of Extractor: Industrial applications of liquid-liquid extraction, choice of solvent, Process design of counter current multistage extractor, Selection criteria among different types of extractor, Process design of mixer-settler type extractor & packed tower type extractor, Guidelines for the design of other types of extractors	12	17

Suggested Specification table with Marks (Theory):

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

1. Ray Sinnott, Gavin Towler, Chemical Engineering Design - Principles, Practice and Economics of Plant and Process Design, Butterworth - Heinemann, 2008.
2. Introduction to Process Engineering and Design by S B Thakore and B I Bhatt, Tata McGraw Hill, 1st Edition, 2007.
3. Brownell and Young, Process Vessel Design, Wiley Eastern, 1977.
4. M. S. Peters and K. D. Timmerhaus, Plant Design and Economics for Chemical Engineers, 4th ed., McGraw - Hill, New York, 1991.
5. Ludwig, E. E., Applied process design for chemical and petrochemical plants , volume 1,2 & 3, Third Edition, Butterworth- Heinemann,1997
6. TEMA Standards.
7. Don W. Green, Robert H. Perry, Perry's Chemical Engineers' Handbook, 8th Edn., McGraw -Hill, New York, 2008
8. James R. Couper, James R. Fair & W. Roy Penney, Chemical Process Equipment - Selection and Design, 2ndEdn., Butterworth - Heinemann, 2010.

Course Outcome:

After learning the course the students should be able to:

1. Design process equipment and modify the design of existing equipment to new process conditions or new required capacity.
2. Build a bridge between theoretical and practical concepts used for designing the equipment in any process industry.
3. Create understanding of equipment design.

4. Review the importance of design concepts in process industry.

List of Experiments:

1. Prediction of Physical properties
2. Estimation of various design parameters for various equipments.
3. Solution of various problem used in the designing of equipments.

Design based Problems (DP)/Open Ended Problem:

Students are free to select any area for designing of equipment based on Chemical engineering applications to define Projects. Some suggested projects are listed below:

- Carry out design of plate / packed type absorber.
- Calculation related to the designing of distillation & extraction column.
- Design of fluid moving machinery (viz. centrifugal pump).
- Project on piping design.
- Design Calculation related to heat exchange equipment and their performance criteria.

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. Students can develop their own programs/spreadsheets for the solution of problems.
- MIT Open course lecture on Equipment design.
- Literature available for Process design of equipment in plant / industry.

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.