



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3170502

Semester – VII

Subject Name: Process Equipment Design

Type of course: Professional Core Course

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

Rationale: Equipment design involves determination of all linear dimensions of equipment like diameter, length, etc. It also includes determination of thickness and weight of different parts of equipment. Readymade software's are available for the design of equipments. However, to use these soft wares effectively and correctly fundamental knowledge of this subject is required. With rapid rate of increase in the advancement of knowledge, it is important that the students should know also about the latest development in the design of equipments. Students who like to work as Design Engineer, Process Engineer or as Process Development Engineer, knowledge of this subject is essential. It is also useful for Production Engineer working in process plant for trouble shooting of problem related to operation of equipment.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Process design of Piping and Pumps: Introduction, Process design of piping, NPSHA & NPSHR, Power required by pump, Power required in Fan, Blower and adiabatic compressor, flow meters, Process design of Orifice meter, Rotameter etc	10
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 vaporizes, Tinker's flow model.	12



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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 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.	12
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 N_{OG} , H_{OG} & 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
5	Mechanical design of Pressure Vessel: Selection of material of construction, Concept of internal & external design pressure, design stress & design temperature, Different types of equipments, Static & rotary equipments, Different types of static equipments, Different types of welding joints, Joint efficiency, Radiography. Mechanical design of shell, head, Jacket, coil, agitator, nozzle, etc.,	14

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
0	10	25	30	20	15

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. Introduction to Process Engineering and Design by S B Thakore and B I Bhatt, McGraw Hill, 2nd Edition, 2015.
2. Ray Sinnott, Gavin Towler, Chemical Engineering Design - Principles, Practice and



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Economics of Plant and Process Design, Butterworth - Heinemann, 2008.

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, 2nd Edn., Butterworth - Heinemann, 2010.

Course Outcomes:

After learning, the course the students should be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Design process equipment and modify the design of existing equipment to new process conditions or new required capacity.	30
CO-2	Build a bridge between theoretical and practical concepts used for designing the equipment in any process industry.	30
CO-3	Create understanding of equipment design.	20
CO-4	Review the importance of design concepts in process industry.	20

List of Experiments:

1. Prediction of Physical properties
2. Process design of shell and tube heat exchanger
3. Process design of packed tower type absorber
4. Process design of tray tower type distillation column
5. Process design of packed tower type distillation column
6. Mechanical design of pressure vessel

List of Open Source Software/learning website:

- Open source software like DWSIM, COCO, ChemSep can be used for property prediction and design.
- 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.