



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3173617

Semester – VII

Subject Name: Principles of Process Equipment Design

Type of course: Professional Core Course

Prerequisite: The student should have basic understanding of Unit Operations of Chemical Engineering and also knowledge of various subjects like fluid mechanics, heat transfer and mass transfer & mathematics.

Rationale: Equipment design involves modifications and additions to existing plants or creating design layouts of plant / equipment. 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	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Introduction to Process Equipment Design Criteria and factors for design, need for design, basic considerations in equipment design, nature of design, types of process, codes and standards, factor of safety, degree of freedom and design variables..	3
2	Process design of piping, Fluid moving devices: 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.	7
3	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 & Thermo syphon Reboilers, Tinker's flow model, Air cooled heat exchangers and air heaters, plate heat exchangers, etc.	14
4	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	14



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	distillation by Fenskey- 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.	
5	Process design of Reactors: Introduction, Different types of reactors, Batch Reactor, Advantages and disadvantages of batch reactors over continuous flow reactors, Continuous flow reactors, Advantages and disadvantages of PFR over MFR, Ideal MFR, Degree of completion of reaction, mixing for the different type of reaction systems, Bubble column reactor, various factors affecting performance of Bubble column reactor, process design of Bubble column reactor.	7

Suggested Specification table with Marks (Theory): (For BE only)

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)

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. M. S. Peters and K. D. Timmerhaus, Plant Design and Economics for Chemical Engineers, a. 4th ed., McGraw - Hill, New York, 1991.
4. Ludwig, E. E., Applied process design for chemical and petrochemical plants , volume 1,2 & 3, Third Edition, Butterworth- Heinemann, 1997
5. TEMA Standards.
6. Don W. Green, Robert H. Perry, Perry's Chemical Engineers' Handbook, 8th Edn., McGraw -Hill, New York, 2008
7. James R. Couper, James R. Fair & W. Roy Penney, Chemical Process Equipment - Selection and Design, 2nd Edn., Butterworth - Heinemann, 2010.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Build a bridge between theoretical and practical concepts used for designing the equipment in any process industry.	10%



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CO-2	Create understanding of equipment design.	10%
CO-3	Review the importance of design concepts in process industry	15%
CO-4	Interpret the basic fundamentals of process plant and equipment design	15%
CO-5	Build a skill to evaluate design parameters of equipment.	20%
CO-6	Solve various problem of designing of equipment.	30%

List of Experiments:

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

List of Open Source Software/learning website:

- Students can refer to video lectures available on the websites including NPTEL lecture series.
- MIT Open course lecture on Equipment design.
- Literature available for Process design of equipment in plant / industry. Literature available on internet