

GUJARAT TECHNOLOGICAL UNIVERSITY

CHEMICAL ENGINEERING (30) ADVANCED EQUIPMENT DESIGN SUBJECT CODE: 2713010 SEMESTER: I

Type of course: Chemical Engineering (ELECTIVE I)

Prerequisite: The student should have basic understanding of Mechanical and Process Design aspects of Process Equipment Design

Rationale: Equipment design involves modifications and additions to existing plants or creating design layouts of plant / equipments. It also involves use of design correlations, design codes, standards; recommended practices, properties of materials, design softwares, etc. 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 softwares 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)	PA (V)		PA (I)			
					ESE	OEP	PA	RP		
3	2	2	5	70	30	20	10	20	0	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	A brief review of MOC, design considerations, fabrication techniques, codes and standards for design of pressure vessels and storage tanks, Estimation of physical properties and phase equilibrium data.	4	8
2	Design of piping, pumps and flow meters for compressible fluids, non-Newtonian Fluids, two phase gas-liquid, gas-solid (pneumatic conveying), liquid-solid (hydro-transport) and liquid-liquid flows.	10	19
3	Design of shell and tube heat exchangers, condensers (contact and surface type) and reboilers (kettle and thermosyphon type).	10	19
4	Design of air-cooled, plate type and spiral heat exchangers,	5	8
5	Design of multi-component separation (by simplified methods) columns: sieve tray, bubble cap, valve and packed type.	10	19
6	Testing of equipment for safe operation. Design of pressure / vacuum relief devices for pressure vessels and storage tanks. Design of flares.	10	19
7	Design of Phase separators viz. cyclone separators, electrostatic precipitator and bag filters etc...	5	8

Reference Books:

1. Ray Sinnott, Gavin Towler, Chemical Engineering Design - Principles, Practice and Economics of Plant and Process Design, Butterworth-Heinemann, 2008
2. Brownell and Young, Process Vessel Design, Wiley Eastern, 1977.
3. M. S. Peters and K. D. Timmerhaus, *Plant Design and Economics for Chemical Engineers*, 4th ed., McGraw-Hill, New York, 1991,

- Ludwig, E. E., Applied process design for chemical and petrochemical plants , volume 1,2 & 3, Third Edition, Butterworth-Heinemann,1997
- TEMA Standards.
- Don W. Green, Robert H. Perry, Perry's Chemical Engineers' Handbook, 8th Edn., McGraw-Hill, New York, 2008
- James R. Couper, James R. Fair & W. Roy Penney, Chemical Process Equipment- Selection and Design, 2nd Edn., Butterworth-Heinemann, 2010

Course Outcome:

After learning the course the students should be able to:

- design process equipment and modify the design of existing equipment to new process conditions or new required capacity
- create understanding of equipment design.
- review the importance and relevance of design concepts in process industry.
- build a bridge between theoretical and practical concepts used for designing the equipment in any process industry.

List of Experiments:

- Prediction of Physical properties.
- Estimation of various design parameters for various equipments from handbook.
- Solution of various problem used in the designing of equipments.
- Sketches of various equipments.

Open Ended Projects:

The practical work at masters must be largely consisting of open ended projects. In each case a sample set may be provided and the faculty member may be empowered to select appropriate problems for practical work. At the end of semester before submission of marks of PA and term work, the faculty member will upload the three best problems done by the students during the practical hours.

After performance of practicals (minimum 5 Practical) remaining time should be allotted to open-ended projects / study reports / latest outcomes in technology study:

- In the beginning of the academic term, faculties will have to allot their students at least one Open-ended Project / Study Report / Latest outcome in technology.
- Literature survey including patents and research papers of fundamental process
 - Design based small project **or**
 - Study report based on latest scientific development **or**
 - Technology study report/ modeling/ simulation/collection report **or**
 - Computer based simulation/ web based application/ analysis presentations of basic concept field which may help them in chemical engineering.
- These can be done in a group containing maximum **three** students in each.
- Faculties should cultivate problem based project to enhance the basic mental and technical level of students.
- Evaluation should be done on **approach of the student on his/her efforts** (not on completion) to study the design module of given task.
- In the semester student should perform **minimum 5** set of experiments and complete **one small open ended dedicated project** based on engineering applications.

Open Ended Projects field:

Students are free to select any area of science and technology based on chemical engineering design and its applications to define Projects.

Some suggested projects are listed below:

- Carry out detailed design (process as well as mechanical design) of any equipment with the help of softwares available.
- Preparation of report of analysis on scientific development in design methodology.

Major Equipments:

- Working / Non-working models of various equipments like Shell & Tube heat exchanger, distillation column, pumps, cyclone separator, etc...

List of Open Source Software/learning website:

- 1) Literature available for Process and Mechanical design of equipment in plant / industry.
- 2) NPTEL
- 3) MIT Open course lecture on Equipment design.

SPECIAL NOTE:

⇒ **It is strongly recommended that to examine the students proficiency in the use of design correlations and estimation of properties required for design, the open book examination be conducted in this subject. Perry's Chemical Engineers' Handbook is allowed in the examination in many institutions for this design course. The use of this Handbook during the examination of this paper is strongly recommended.**