# GUJARAT TECHNOLOGICAL UNIVERSITY

**Bachelor of Engineering**
**Subject Code: 3170514**
**Semester – VII**
**Subject Name: Mechanical Design of Process equipments**

**Type of course:** Open Elective

**Prerequisite:** The student should have basic understanding of Unit Operations of Chemical Engineering and mechanical properties associated with the material.

**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 | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 2 | 0 | 2 | 3 | 70 | 30 | 30 | 20 | 150 |

**Content:**

| Sr. No. | Contents | Total Hrs |
|---|---|---|
| 1 | **Introduction:** Design pressure and temperature, design and allowable stress, Static and rotary equipments, Different types of welding joints, joint efficiency and methods of fabrication of equipment, Radiography, Codes, standard and specification for pressure vessel, Mechanical properties of material. | 04 |
| 2 | **Design of Pressure vessel:** Mechanical design of shell and head subjected to internal and external pressure, Graphical & analytical method for shell and head subjected to external pressure, Shell design for external pressure with & without stiffening ring, Different types of Nozzles and design of reinforcement pad for nozzle by area for area method, Different types of flanges, flange facings, gaskets and their selection criteria, Design of bracket support. | 08 |
| 3 | **Design of Reaction Vessel:** Mechanical design of shell, head, Jacket, coil, agitator, nozzle, etc., Different types of agitators & their selection criteria, Determination of power required for agitation, shaft diameter, blade thickness, etc., Different types of jackets & their selection criteria, Selection between coil & jacket. | 05 |

| | | |
|---|---|---|
| **4** | **Design of Storage Tank:** Types of storage tanks, Capacity of storage tank, its diameter & height, Design of fixed roof storage tank, Design of structural supported conical roof as per API 620, Vent sizing for atmospheric and low pressure tanks. | **05** |
| **5** | **Design of Shell & Tube Heat Exchangers**: Function of various parts of shell & tube heat exchanger, Mechanical design of Shell, tube, tube sheet, head, channel shell, etc. of shell & tube heat exchanger, Mechanical design of saddle support. | **04** |
| **6** | **Design of Distillation and Absorption Column:** Mechanical design of shell, head, tray support for Vertical tall tower, Determination of shell thicknesses at various heights for tray tower & packed tower in case of internal & external pressure, Different types of tray support, Mechanical design of skirt support. | **06** |

**Suggested Specification table with Marks (Theory):**

| **Distribution of Theory Marks** | | | | | |
|---|---|---|---|---|---|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 07 | 21 | 21 | 07 | 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. Brownell L.E., Young E.H., "Process Equipment Design", Wiley Eastern, Delhi, 1977.
2. Thakore S.B., Shah D.A., "Illustrated Process Equipment Design", 4th Edition, Atul Prakashan, Ahmedabad, 2018.
3. Bhattacharyya B.C., "Introduction to Chemical Equipment Design: Mechanical Aspects", 5th Edition, CBS Publishers, New Delhi, 2008.
4. Perry R.H., "Chemical Engineers' Handbook", McGraw-Hill, 2009.
5. Joshi M.V., Mahajani V.V., "Process Equipment Design", 3rd Edition, MacMillan, Delhi, 1996.
6. Coulson J.M, Richardson J.F and Sinnott, R.K., "Coulson and Richardson's Chemical Engineering", Vol. 6, 4th Edition, Elesevier, New Delhi, 2006.
7. Dawande S.D., "Process Design of Equipments",Vol 1 & 2, Denett Publications, Nagpur, 2007.
8. Kern D.Q., "Process Heat Transfer", McGraw-Hill, New York, 1965.
9. Ludwig E., Chemical Process Equipment Design, 3rd Edition, Gulf Publications, 2002.

**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. | 20 |
| CO-2 | Build a bridge between theoretical and practical concepts used for designing the equipment in any process industry. | 35 |
| CO-3 | Create understanding of equipment design with mechanical concept. | 20 |
| CO-4 | Review the importance of design concepts in process industry. | 25 |

**List of Open Source Software/learning website:**

- Students can refer to the 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.

**Suggested List of Design Problems for practical/tutorials: (8 to 10 practicals are to be given)**

- Prediction/Estimation of various physical properties such as density, viscosity, surface tension, specific heat, thermal conductivity etc.
- Finding suitable material of construction for handling various chemicals.
- Design of shell for pressure vessel subjected to internal and external pressure.
- Design of heads for pressure vessel subjected to internal and external pressure.
- Design of nozzle for pressure vessel.
- Design of fixed roof and conical roof storage tank.
- Design of storage tank to store different acids and organic chemicals.
- Design of batch reaction vessel provided with agitator.
- Design of plain, channel and half coil jacket for reaction vessel.
- Design of shell and tube heat exchanger.
- Design of shell for distillation/absorption column under internal and external pressure.
- Design of tray support for the distillation column.
- Design of bracket and skirt support for vertical cylindrical vessel.
- Design of saddle support for horizontal cylindrical vessel.
- Sketches of equipment such as batch reaction vessel, tray column, packed tower, storage tank and shell and tube heat exchanger to be made in drawing sheet.