GUJARAT TECHNOLOGICAL UNIVERSITY

BE 7 SEMESTER – OLD PAPER – S22 TO S26 – QUESTION BANK

Subject Name & Code: Mechanical Design of Process equipments - 3170514

Chapter 1: Introduction

Repeated Questions:

1. Materials and Mechanical Properties:

- **Q.** Define (i) Hardness (ii) Ductility (iii) Yield Stress (iv) Resilience (v) Toughness (vi) Creep (vii) Fatigue. **(SUMMER 2022 OR; WINTER 2022; SUMMER 2024; WINTER 2024; SUMMER 2025 - variations appear in multiple papers)**
- **Q.** Discuss the term: Poisson's Ratio, Modulus of elasticity and Power number. **(SUMMER 2024; WINTER 2024; SUMMER 2026 OR)**
- **Q.** Differentiate between fatigue and creep. **(SUMMER 2023; WINTER 2025)**

2. Design Parameters and Standards:

- **Q.** Describe in brief about design pressure & design temperature. **(SUMMER 2022; WINTER 2022; WINTER 2023)**
- **Q.** Give the full name of ASTM, ANSI, ASME, HTRI, TEMA, and API. **(WINTER 2022; WINTER 2023; SUMMER 2024; SUMMER 2025)**
- **Q.** What is design stress and factor of safety? Explain in brief. **(WINTER 2022 OR; WINTER 2024)**
- **Q.** What is pressure vessel? State the examples of pressure vessel. **(SUMMER 2022; SUMMER 2023)**

3. Testing and Fabrication:

- **Q.** Explain "Radiography test" for pressure vessel. **(SUMMER 2022; SUMMER 2023; WINTER 2023; WINTER 2024; SUMMER 2025; WINTER 2025; SUMMER 2026 OR)**
- **Q.** Enlist various types of fabrication techniques used in industries for the designing of equipment. Explain any one in detail. **(WINTER 2022; SUMMER 2024; WINTER 2024 OR)**

Other Important Questions:

1. Material Behaviour and Weld Joints:

- **Q.** Discuss stress vs strain curve. **(WINTER 2022)**
- **Q.** Define weld joint efficiency factor. **(WINTER 2023)**

Chapter 2: Design of Pressure vessel

Repeated Questions:

1. Classification, Heads and Gaskets:

- **Q.** Classify the unfired pressure vessel as per IS-2825. **(SUMMER 2022; WINTER 2022 OR; SUMMER 2023; SUMMER 2024 OR; WINTER 2024)**
- **Q.** State the applications of various types of heads used for pressure vessel design. **(SUMMER 2022; SUMMER 2023; WINTER 2023 OR; SUMMER 2024; SUMMER 2025)**
- **Q.** Discuss about mechanical design of Elliptical head / Torispherical head / Hemispherical head / Flat Heads / Conical Heads. **(WINTER 2022 OR; WINTER 2023; WINTER 2023 OR; SUMMER 2024 OR; WINTER 2024; WINTER 2024 OR; WINTER 2024 OR)**
- **Q.** Define Gasket, Gasket seating stress and Gasket factor. **(SUMMER 2022; WINTER 2022; SUMMER 2023; WINTER 2023; SUMMER 2024; WINTER 2024; WINTER 2024; SUMMER 2025)**

2. Shell Design under Internal and External Pressure:

- **Q.** Derive the equation for design stress to calculate the thickness of thin cylindrical shell under internal pressure. **(SUMMER 2022; SUMMER 2023; WINTER 2023; SUMMER 2025)**
- **Q.** Discuss about requirement of stiffening rings in pressure vessels / methods for shell subjected to external pressure. **(WINTER 2023 OR; WINTER 2023; SUMMER 2024 OR; WINTER 2025; WINTER 2025)**

3. Nozzles, Flanges and Supports:

- **Q.** State the purpose of providing reinforcement pad for nozzle. **(SUMMER 2022 OR; SUMMER 2023; WINTER 2025; WINTER 2025 OR; SUMMER 2026 OR)**
- **Q.** With neat sketch explain the different types of standard flanges used in industries / Flange facings. **(WINTER 2023; WINTER 2024; WINTER 2025)**
- **Q.** State the application of bracket, skirt and saddle support. Briefly discuss the design steps for bracket support. **(SUMMER 2022; SUMMER 2023; WINTER 2025)**

4. Nozzle Compensation (Numerical):

- **Q.** Examine the data given below to evaluate the requirement of compensation for the nozzle opening in a cylindrical shell. [Data truncated in source – refer to the original question paper] **(SUMMER 2024; WINTER 2024)**

Other Important Questions:

1. Shell under External Pressure (Numerical):

- **Q.** A low carbon steel cylindrical vessel having shell of 3 m outer diameter & 10 m length is to be designed for vacuum operation at 250°C [Data truncated in source – refer to the original question paper] **(SUMMER 2022)**
- **Q.** The material of both the vessel and stiffeners is Carbon Steel [Data truncated in source – refer to the original question paper]. Determine Allowable external pressure and stiffener ring requirements. **(SUMMER 2026)**

2. Nozzle Reinforcement (Numerical):

- **Q.** A nozzle having ID 400 mm is fabricated from S.S 316 plate [Data truncated in source – refer to the original question paper]. Calculate weight of reinforcement pad. **(WINTER 2023 OR)**
- **Q.** A nozzle having inside diameter 400 mm is fabricated from SA-516 Gr 70 plate [Data truncated in source – refer to the original question paper]. Check whether this nozzle requires reinforcement pad or not. **(SUMMER 2025)**

3. Jacketed Reactor (Numerical):

- **Q.** Find out the thickness of shell & jacket for the (i) reactor with plain jacket and (ii) reactor with channel jacket. **(WINTER 2025 OR)**

Chapter 3: Design of Reaction Vessel

Repeated Questions:

1. Jackets:

- **Q.** With neat sketch explain the various types of jackets and discuss the design of channel jacket and half coil jacket for reaction vessel. **(SUMMER 2022; WINTER 2022; SUMMER 2023; WINTER 2023 OR; SUMMER 2024; WINTER 2024; WINTER 2025)**

2. Agitators:

- **Q.** Name the various types of agitators and write their industrial applications / selection criteria. **(WINTER 2022; SUMMER 2023; SUMMER 2024; SUMMER 2025; WINTER 2025)**

3. Reactor Head (Numerical):

- **Q.** A Reactor of 800 mm inside diameter is covered with hemispherical head at the bottom [Data truncated in source – refer to the original question paper]. Find: (i) thickness of the head (ii) volume of head and (iii) weight of the fabricated head. **(WINTER 2022 OR; WINTER 2025)**

Other Important Questions:

1. Agitator Flow Patterns (Theory):

- **Q.** Discuss the flow pattern for axial flow and radial flow impellers also discuss importance of baffles. **(SUMMER 2024)**

2. Agitator Design (Numerical):

- **Q.** Determine (i) power required (ii) shaft diameter and (iii) critical speed for the turbine agitators operating in a reaction vessel [Data truncated in source – refer to the original question paper] **(SUMMER 2023 OR)**
- **Q.** Turbine agitators operating in a vessel of 1600 mm diameter is to be designed [Data truncated in source – refer to the original question paper]. Calculate powers required & suggest suitable motor HP, Calculate shaft diameter. **(WINTER 2024 OR)**

3. Reactor Shell and Head (Numerical):

- **Q.** Cylindrical reactor is having elliptical ends at the both ends [Data truncated in source – refer to the original question paper]. Design shell and bottom elliptical head of reactor. [Diagram required – refer to the original question paper] **(SUMMER 2025 OR)**

Chapter 4: Design of Storage Tank

Repeated Questions:

1. Venting and Roof Design:

- **Q.** Explain Normal and Emergency venting for storage vessel. **(SUMMER 2022 OR; WINTER 2022; SUMMER 2023 OR; SUMMER 2024 OR; WINTER 2024; SUMMER 2025; WINTER 2025 OR)**
- **Q.** Discuss external floating roof storage tank / With neat diagram discuss the different type of External floating roof tank. **(SUMMER 2022; WINTER 2022 OR; SUMMER 2023; SUMMER 2024 OR; WINTER 2024; WINTER 2025)**
- **Q.** Discuss the design steps for the conical roof with structural support. **(SUMMER 2022; WINTER 2022 OR; SUMMER 2024 OR; WINTER 2024 OR; SUMMER 2025 OR; WINTER 2025)**

2. Tank Accessories and Safety:

- **Q.** State the function of dyke wall in the storage tank. **(SUMMER 2022 OR; SUMMER 2024; SUMMER 2026)**
- **Q.** Briefly discuss about the wind girders for large open tanks. **(SUMMER 2022 OR; SUMMER 2023 OR; SUMMER 2024 OR)**
- **Q.** Discuss importance of sealing strips. **(WINTER 2022 OR; SUMMER 2024; WINTER 2024 OR)**

3. Shell Plate Design (Numerical):

- **Q.** Determine the total number of shell plates and plate thickness of a storage tank to store Phosphoric acid of 85% w/w [Data truncated in source – refer to the original question paper] **(SUMMER 2022 OR; WINTER 2022; SUMMER 2023 OR)**

Other Important Questions:

1. Storage Tank Design (Numerical):

- **Q.** Design a storage tank of benzene having 200 tonnes capacity [Data truncated in source – refer to the original question paper] **(SUMMER 2024)**
- **Q.** Fixed conical roof storage tank is fabricated from structural steel plate [Data truncated in source – refer to the original question paper]. find out the thickness of conical roof plate. **(SUMMER 2022 OR)**
- **Q.** Find different thickness of shell courses of closed storage tank [Data truncated in source – refer to the original question paper] **(SUMMER 2025)**

Chapter 5: Design of Shell & Tube Heat Exchangers

Repeated Questions:

1. Exchanger Components and Supports:

- **Q.** Explain the function of the following parts for the shell and tube heat exchanger: (i) Baffles (ii) Tie rods (iii) Spacers (iv) Expansion joint (v) Tube side pass partition (vi) Tube sheet (vii) Support. **(SUMMER 2022; WINTER 2023; WINTER 2023 OR; SUMMER 2026)**
- **Q.** Discuss the design procedure/steps for saddle support. **(WINTER 2022; WINTER 2023 OR; WINTER 2024 OR; SUMMER 2026; SUMMER 2026 OR)**

2. Thermal and Hydraulic Design:

- **Q.** Discuss the design steps for the calculation of tube side heat transfer coefficient and pressure drop. **(WINTER 2022; WINTER 2024)**

Other Important Questions:

1. Heat Exchanger Design Steps:

- **Q.** Discuss the design steps for the calculation of overall heat transfer coefficient in shell and tube heat exchangers. **(SUMMER 2024 OR)**
- **Q.** Discuss the general design steps for the shell and tube heat exchanger. **(SUMMER 2023)**
- **Q.** Discuss the mechanical design of tube and tube sheet under internal & external pressure for a shell and tube heat exchanger. **(WINTER 2025 OR)**

Chapter 6: Design of Distillation and Absorption Column

Repeated Questions:

1. Column Internals and Supports:

- **Q.** Name the various types of tray support with their industrial application. **(SUMMER 2022; WINTER 2022; SUMMER 2023; WINTER 2023; SUMMER 2024; WINTER 2025; SUMMER 2026)**
- **Q.** When skirt support is used for pressure vessel? State any two advantages of skirt support over bracket support / design steps for skirt support. **(WINTER 2022; SUMMER 2023; WINTER 2025; SUMMER 2026)**

2. Stresses in Column Shell:

- **Q.** State and explain the different types of stresses induced in the shell of distillation column with their design equations. **(SUMMER 2022; SUMMER 2023; SUMMER 2024; WINTER 2025; SUMMER 2026)**

Other Important Questions:

1. Column Types, Packings and Shell Thickness (Theory):

- **Q.** State various types of distillation column and explain its parts. **(WINTER 2023 OR)**
- **Q.** Write in details about the types of packings used in a packed column. **(WINTER 2023)**
- **Q.** Explain briefly: Determination of shell thicknesses at various heights for tray tower in case of internal pressure applied. **(WINTER 2024)**
- **Q.** Explain different types of supports used for a tall vertical tower / Discuss the shell thickness determination steps for a Distillation Column. **(SUMMER 2026 OR; SUMMER 2026 OR)**

2. Column Shell and Support Design (Numerical):

- **Q.** A vacuum distillation column is to operate under a top pressure of 50 mm Hg absolute [Data truncated in source – refer to the original question paper]. Check whether the support rings will act as an effective stiffening rings or not? **(SUMMER 2023 OR)**
- **Q.** A distillation column subjected to full vacuum is fabricated and installed [Data truncated in source – refer to the original question paper]. Analyze the various stresses induced in the column and determine the thickness of distillation column. **(SUMMER 2023 OR)**
- **Q.** Calculate the necessary shell thickness and stress analysis of a given fractionating column [Data truncated in source – refer to the original question paper] **(SUMMER 2024 OR)**
- **Q.** Determine the shell thickness and stress analysis for the fractionating column [Data truncated in source – refer to the original question paper] **(SUMMER 2022 OR)**
- **Q.** Shell I.D - 3500 mm, Working temperature - 180°C [Data truncated in source – refer to the original question paper]. Determine the thickness of distillation column. **(WINTER 2022 OR)**
- **Q.** Find the thickness of a straight cylindrical skirt support for distillation column based on following data [Data truncated in source – refer to the original question paper] **(WINTER 2024 OR)**
- **Q.** Calculate the thickness of shell plate for the entire distillation column, having following specifications [Data truncated in source – refer to the original question paper] **(SUMMER 2025 OR)**
- **Q.** Distillation is carried out in a packed tower under vacuum. Determine the thickness and weight of shell [Data truncated in source – refer to the original question paper] **(WINTER 2025 OR)**

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