GUJARAT TECHNOLOGICAL UNIVERSITY

BE 7 SEMESTER – OLD PAPER – SUMMER 2022 TO SUMMER 2026 – QUESTION BANK

Subject Name & Code: Process Equipment Design - 3170502

Chapter 1: Process design of Piping and Pumps

Repeated Questions:

1. Pump Numericals (NPSH and Power Required):

- **Q.** Benzene/Hexane pumping numerical ($NPSH_A$ & Power required) [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks; SUMMER 2024, 7 Marks; SUMMER 2025, 7 Marks; SUMMER 2026, 7 Marks - same structure; fluid (Benzene/Hexane) and operating conditions vary slightly)**

2. NPSH:

- **Q.** NPSH definition and importance / $(NPSH)_A$ vs $(NPSH)_R$ **(SUMMER 2022, 3 Marks; WINTER 2022, 3 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 4 Marks; WINTER 2025, 3 Marks; SUMMER 2026, 4 Marks)**

3. Piping:

- **Q.** Equivalent length of pipes and joints **(WINTER 2022, 4 Marks; SUMMER 2023, 3 Marks; SUMMER 2026, 3 Marks)**

4. Orifice Meter:

- **Q.** Pressure taps in orifice meter [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 7 Marks)**

Other Important Questions:

1. Definitions and Piping Economics:

- **Q.** Define: 1. The capacity of pump 2. NPSH 3. Schedule number. **(SUMMER 2022, 3 Marks)**
- **Q.** Justify the effects of larger diameter pipe operating cost and fixed cost. **(SUMMER 2023, 4 Marks)**

2. Pump, Blower and Compressor Numericals:

- **Q.** A centrifugal pump draws benzene from an overhead tank. Operating vacuum in the tank is 700 Torr... Calculate the $(NPSH)_A$. [Data truncated in source – refer to the original question paper] **(SUMMER 2023, 7 Marks)**
- **Q.** Find out the power required for a turbo blower for the following duty... [Data truncated in source – refer to the original question paper] **(WINTER 2022, 7 Marks)**
- **Q.** It is proposed to pump 10000 kg/h of saturated toluene... how much liquid level in reboiler be maintained to give a net positive suction head of 2.4 m? Calculate the power required... [Data truncated in source – refer to the original question paper] **(WINTER 2023, 7 Marks)**
- **Q.** A three-stage reciprocating compressor is used to compress 306 Sm^3/h of methane... Calculate the power required... [Data truncated in source – refer to the original question paper] **(SUMMER 2022, 7 Marks OR)**

3. Flow Measurement (Rotameter and Orifice Meter):

- **Q.** A rotameter tube have an internal diameter of 40 mm at top and 25 mm at the bottom... Calculate the flow rate... [Data truncated in source – refer to the original question paper] **(WINTER 2023, 7 Marks)**
- **Q.** Calculate the differential pressure across orifice meter for the following data... [Data truncated in source – refer to the original question paper] **(SUMMER 2025, 7 Marks)**

- **Q.** 1. Discuss about five standard types of pressure taps for orifice meter. 2. State advantages and disadvantages of orifice meter over venturi meter. **(WINTER 2024, 7 Marks)**

Chapter 2: Process design of Heat Exchangers

Repeated Questions:

1. Shell and Tube Heat Exchanger – Design Features:

- **Q.** Effect of baffle cut and baffle spacing on heat transfer coefficient **(WINTER 2022, 3 Marks; SUMMER 2023, 4 Marks; SUMMER 2024, 3 Marks OR; WINTER 2024, 3 Marks)**
- **Q.** Criteria for fluid allocation in shell & tube heat exchanger **(WINTER 2022, 4 Marks; SUMMER 2023, 4 Marks; SUMMER 2024, 3 Marks; WINTER 2024, 3 Marks; SUMMER 2025, 3 Marks)**
- **Q.** Functions of parts in Shell & Tube HX (Baffles, Tie rods, Spacers, Pass partition plates, etc.) **(SUMMER 2022, 4 Marks; SUMMER 2023, 3 Marks; WINTER 2023, 7 Marks; WINTER 2024, 7 Marks OR; WINTER 2025, 3 Marks; WINTER 2025, 3 Marks OR; SUMMER 2026, 3 Marks)**
- **Q.** Merits and demerits of U-tube heat exchanger over fixed tube sheet / floating head **(WINTER 2024, 3 Marks OR; WINTER 2025, 4 Marks OR)**
- **Q.** Tinker's flow model with neat diagram [Diagram required – refer to the original question paper] **(SUMMER 2023, 7 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 4 Marks; SUMMER 2025, 4 Marks OR; SUMMER 2026, 4 Marks)**

2. Reboilers:

- **Q.** Kettle type reboiler design procedure / process design **(WINTER 2022, 7 Marks; WINTER 2024, 7 Marks OR; SUMMER 2025, 7 Marks; WINTER 2025, 7 Marks OR)**
- **Q.** Criteria of selection between kettle type reboiler and thermosyphon reboiler **(SUMMER 2022, 4 Marks OR; SUMMER 2023, 7 Marks OR; SUMMER 2025, 4 Marks; SUMMER 2026, 7 Marks OR)**
- **Q.** Vertical thermosyphon reboiler recirculation ratio trial and error conditions ($\Delta P_{av} \approx \Delta P_t$, $\Delta P_{av} > \Delta P_t$, etc.) **(SUMMER 2022, 4 Marks; SUMMER 2024, 7 Marks; WINTER 2024, 7 Marks; SUMMER 2025, 7 Marks OR)**

3. Types of Heat Exchangers and Heating/Cooling Media:

- **Q.** Merits and demerits of air cooled heat exchanger over water cooled heat exchanger **(WINTER 2024, 4 Marks; WINTER 2025, 4 Marks)**
- **Q.** Comparison between Plate Heat Exchanger (PHE) and Shell & Tube Heat Exchanger **(SUMMER 2022, 4 Marks; SUMMER 2024, 4 Marks; SUMMER 2025, 3 Marks OR)**
- **Q.** Heating and cooling media (Saturated steam vs hot oil, etc.) **(SUMMER 2023, 7 Marks; WINTER 2023, 4 Marks; WINTER 2024, 3 Marks; SUMMER 2025, 3 Marks)**

4. Numerical:

- **Q.** Lube-oil cooling water numerical (Flow rate & heat transfer coefficient) [Diagram required – refer to the original question paper] **(WINTER 2024, 7 Marks; WINTER 2025, 7 Marks)**

Other Important Questions:

1. Theory and Design Procedures (Shell and Tube Heat Exchanger):

- **Q.** Describe step wise procedure to calculate overall heat transfer coefficient in a shell and tube heat exchanger, employed to transfer the heat without phase change. **(WINTER 2025, 7 Marks)**
- **Q.** Write the general steps for the design of shell and tube heat exchanger. **(SUMMER 2026, 7 Marks)**
- **Q.** Why expansion joint is provided in fixed tube sheet heat exchanger? **(SUMMER 2023, 3 Marks)**
- **Q.** Give the full names for TEMA, ASME and BEM heat exchanger. **(WINTER 2023, 3 Marks)**
- **Q.** State the various types of shell and tube heat exchanger. Discuss their advantages over each other. **(WINTER 2023, 4 Marks OR)**
- **Q.** What is the significance of the temperature correction factor? How to calculate? **(SUMMER 2022, 3 Marks)**

2. Condensers (Theory):

- **Q.** Discuss step-wise design procedure for horizontal condenser (condensation taking on shell side). **(WINTER 2024, 7 Marks OR)**
- **Q.** Discuss criteria of selection between horizontal and vertical condenser. **(WINTER 2024, 4 Marks OR)**
- **Q.** Discuss the design procedure of condenser in details. **(WINTER 2023, 3 Marks OR)**

3. Numericals:

- **Q.** Consider a case where condensation is done with subcooling by cooling water entering at 32°C... Calculate the mass flow rates of cooling water... [Data truncated in source – refer to the original question paper] **(SUMMER 2023, 7 Marks OR)**
- **Q.** Methanol and Brackish Water numerical (Number of tubes and Shell Diameter). [Diagram required – refer to the original question paper] **(WINTER 2022, 7 Marks)**
- **Q.** Calculate tube side and shell side heat transfer coefficient for the design of a 1-2 shell-and-tube exchanger for the following duty... [Data truncated in source – refer to the original question paper] [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks)**
- **Q.** 10900 kg/h of pure saturated methyl ethyl ketone (MEK) vapour... Calculate required area of condenser... [Data truncated in source – refer to the original question paper] **(SUMMER 2025, 14 Marks)**

Chapter 3: Process design of Distillation Column

Repeated Questions:

1. Reflux Ratio, Vacuum Distillation and Operating Pressure:

- **Q.** Effect of reflux ratio on fixed, operating and total cost **(WINTER 2022, 3 Marks; WINTER 2024, 3 Marks; SUMMER 2025, 4 Marks; WINTER 2025, 4 Marks)**
- **Q.** Advantages and disadvantages of vacuum distillation **(WINTER 2022, 7 Marks; SUMMER 2023, 4 Marks; WINTER 2023, 4 Marks; SUMMER 2024, 4 Marks OR; WINTER 2025, 4 Marks; SUMMER 2026, 4 Marks OR)**
- **Q.** Selection / fixing of operating pressure in distillation column **(SUMMER 2023, 7 Marks; WINTER 2023, 4 Marks; WINTER 2024, 4 Marks; SUMMER 2025, 7 Marks)**

2. Flooding, Definitions and Key Components:

- **Q.** Jet flooding and downcomer flooding (Define/Differentiate) **(SUMMER 2024, 3 Marks; WINTER 2024, 7 Marks; SUMMER 2025, 4 Marks; WINTER 2025, 4 Marks OR)**
- **Q.** Definitions (Weeping, Entrainment, Flooding, Coning) **(WINTER 2023, 3 Marks; SUMMER 2024, 3 Marks; WINTER 2025, 3 Marks; SUMMER 2026, 3 Marks)**
- **Q.** Key components (Light key, Heavy key, Non-key) **(WINTER 2024, 3 Marks OR; WINTER 2025, 3 Marks; SUMMER 2026, 4 Marks)**

3. Short-cut Methods and Stage Calculations:

- **Q.** Minimum reflux ratio / FUG method numerical (Underwood equations) [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks; SUMMER 2024, 7 Marks; WINTER 2024, 7 Marks; SUMMER 2025, 14 Marks; WINTER 2025, 7 Marks; SUMMER 2026, 7 Marks OR)**
- **Q.** Discuss the design steps to calculate the number of theoretical stages in binary distillation column. **(SUMMER 2022, 7 Marks OR; WINTER 2024, 7 Marks OR)**

4. Tray Design:

- **Q.** Procedure to calculate tower diameter in a sieve tray distillation column **(SUMMER 2025, 7 Marks OR; WINTER 2025, 7 Marks OR)**
- **Q.** Procedure to calculate pressure drop in a sieve tray distillation column **(WINTER 2024, 7 Marks; WINTER 2025, 7 Marks)**
- **Q.** Selection / Comparison of trays **(SUMMER 2022, 4 Marks OR; WINTER 2023, 3 Marks; SUMMER 2024, 7 Marks OR)**
- **Q.** Downcomer design and types **(SUMMER 2022, 4 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 3 Marks)**

5. Tray Tower vs Packed Tower:

- **Q.** Selection criteria / Difference between tray tower and packed tower **(WINTER 2024, 4 Marks OR; WINTER 2025, 4 Marks; SUMMER 2026, 7 Marks)**

Other Important Questions:

1. Distillation Theory:

- **Q.** In a ABC private limited, management has decided to increase the production capacity of a existing plant... suggest ways to maintain the purity of top and bottom without altering physical dimensions of a column... [Data truncated in source – refer to the original question paper] **(WINTER 2025, 3 Marks)**
- **Q.** Mention the application of Hengstebeck and Geddes equation? Discuss the equation. **(SUMMER 2023, 3 Marks)**
- **Q.** Explain FUG method for multicomponent distillation. **(WINTER 2022, 4 Marks)**
- **Q.** Describe determination of optimum reflux ratio. **(WINTER 2022, 4 Marks)**

- **Q.** Discuss McCabe-Thiele method for calculation of number of trays in distillation column. **(SUMMER 2026, 7 Marks)**
- **Q.** Discuss the types of flooding in a distillation column. **(SUMMER 2022, 3 Marks OR)**

2. Tray Hardware and Packings:

- **Q.** Explain the function of weir in a sieve tray tower. Also suggest the effect of weir height on separation efficiency and pressure drop. **(WINTER 2025, 3 Marks OR)**
- **Q.** Discuss about the various packings used in a distillation column. **(SUMMER 2026, 3 Marks OR)**
- **Q.** State different types of weirs and downcomers of tray tower. **(SUMMER 2026, 3 Marks)**

3. Numerical:

- **Q.** Continuous rectifying column handles a mixture... Calculate (a) mass flows of distillate and waste liquor. (b) If a reflux ratio of 3.5 is employed, how many plates are required... [Data truncated in source – refer to the original question paper] [Diagram required – refer to the original question paper] **(WINTER 2022, 7 Marks)**

Chapter 4: Process design of Absorbers

Repeated Questions:

1. Packed Tower Internals:

- **Q.** Functions and types of liquid distributors, redistributors, packing supports, and hold-down plates **(SUMMER 2023, 3 Marks OR; WINTER 2023, 3 Marks; SUMMER 2024, 7 Marks; WINTER 2024, 3 Marks; SUMMER 2025, 3 Marks; WINTER 2025, 4 Marks OR; SUMMER 2026, 4 Marks)**
- **Q.** Random and Regular packing material [Diagram required – refer to the original question paper] **(WINTER 2022, 4 Marks; SUMMER 2023, 4 Marks OR; SUMMER 2024, 4 Marks OR)**

2. Selection of Absorbers:

- **Q.** Selection criteria for different types of absorbers/scrubbers (Packed tower, Spray tower, etc.) / Discuss the criteria of selection among the different types of the equipment used as absorbers or scrubbers. **(WINTER 2022, 7 Marks OR; SUMMER 2023, 7 Marks OR; WINTER 2023, 4 Marks; SUMMER 2024, 7 Marks; WINTER 2025, 4 Marks; SUMMER 2026, 7 Marks OR)**

3. Absorber Design:

- **Q.** Procedure for calculating minimum solvent rate / minimum amount of solvent **(WINTER 2022, 3 Marks; WINTER 2025, 7 Marks)**
- **Q.** Process design steps / procedure for packed tower absorber **(SUMMER 2022, 7 Marks; WINTER 2022, 7 Marks; SUMMER 2026, 7 Marks OR)**

Other Important Questions:

1. Packed Tower Theory:

- **Q.** What is channeling and discuss the ways to avoid channeling. **(SUMMER 2026, 3 Marks OR)**
- **Q.** Describe selection criteria for solvent in absorption column. **(SUMMER 2026, 4 Marks OR)**
- **Q.** What is the function of packing support? Explain in brief its types. **(SUMMER 2022, 3 Marks)**
- **Q.** Discuss the significance of following in a packed bed tower design: 1. Flooding velocity 2. Minimum wetting rate 3. The minimum amount of solvent required. **(SUMMER 2022, 7 Marks OR)**

2. Spray Tower:

- **Q.** State process design steps for vertical spray tower. **(WINTER 2022, 4 Marks OR)**

Chapter 5: Mechanical design of Pressure Vessel

Repeated Questions:

1. Design Parameters, Definitions and Materials:

- **Q.** Internal and External Design Pressure (Definitions / Differences) **(SUMMER 2023, 4 Marks; WINTER 2023, 3 Marks; SUMMER 2024, 3 Marks OR; WINTER 2024, 4 Marks; WINTER 2025, 3 Marks; SUMMER 2026, 3 Marks)**
- **Q.** Definitions (Design stress, Corrosion Allowance, Welding Joint efficiency factor, Design temperature) **(SUMMER 2022, 3 Marks OR; WINTER 2022, 3 Marks; SUMMER 2023, 3 Marks OR; SUMMER 2024, 3 Marks; WINTER 2024, 3 Marks OR)**
- **Q.** Selection of material of construction / Explain selection of material of construction. **(SUMMER 2022, 3 Marks OR; WINTER 2022, 3 Marks OR)**
- **Q.** Stress-strain curve / Explain about stress-strain curve with a neat figure. [Diagram required – refer to the original question paper] **(SUMMER 2025, 4 Marks OR; WINTER 2025, 3 Marks OR)**

2. Welding Joint Efficiency and Heads:

- **Q.** Radiography (NDT) for determination of welding joint efficiency **(SUMMER 2023, 4 Marks OR; WINTER 2023, 4 Marks; WINTER 2024, 4 Marks OR; SUMMER 2025, 3 Marks OR; WINTER 2025, 4 Marks; SUMMER 2026, 3 Marks OR)**
- **Q.** Types of heads/closures, selection criteria, and applications **(SUMMER 2022, 4 Marks OR; SUMMER 2023, 3 Marks; SUMMER 2023, 7 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 4 Marks OR; SUMMER 2025, 4 Marks; WINTER 2025, 7 Marks OR; SUMMER 2026, 4 Marks)**

3. Equipment Types and Agitators:

- **Q.** Static vs Rotary equipments **(WINTER 2023, 3 Marks OR; SUMMER 2024, 7 Marks OR; SUMMER 2026, 7 Marks)**
- **Q.** Types of agitators **(SUMMER 2024, 4 Marks; SUMMER 2026, 4 Marks OR)**

4. Design Procedures and Numerical:

- **Q.** Design steps for vertical cylindrical pressure vessel and head subjected to internal pressure **(SUMMER 2024, 7 Marks; SUMMER 2026, 7 Marks OR)**
- **Q.** Nozzle reinforcement pad numerical **(WINTER 2022, 7 Marks OR; SUMMER 2023, 7 Marks OR)**

Other Important Questions:

1. Theory:

- **Q.** Derive equation for longitudinal and circumferential stress and discuss design stress. **(WINTER 2022, 7 Marks)**
- **Q.** What is design pressure? Explain various methods to calculate the thickness of cylindrical pressure vessels. **(SUMMER 2022, 7 Marks OR)**
- **Q.** Discuss the various classes of Pressure vessels. **(WINTER 2023, 4 Marks OR)**
- **Q.** Discuss the use of jackets and coils in the industry. **(WINTER 2022, 4 Marks OR)**

2. External Pressure and Stiffener Rings:

- **Q.** A cylindrical vessel 14 ft ID and 0.3125 inch has ring stiffeners located at 40 in spacing... Determine the stiffener ring requirements... [Data truncated in source – refer to the original question paper] [Diagram required – refer to the original question paper] **(WINTER 2023, 7 Marks OR)**
- **Q.** Explain the graphical method to determine thickness of vessel subjected to external pressure with and without stiffening ring. **(SUMMER 2025, 7 Marks)**

****