Seat No./Enrollment No.: _____

GUJARAT TECHNOLOGICAL UNIVERSITY
BACHELOR OF ENGINEERING – SEMESTER 7 – EXAMINATION – SUMMER 2026

Subject Code: 2170502 **Date: 03/06/2026**

Subject Name: Process Equipment Design -II

Time: 02:30 PM TO 05:30 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1	**(a)**	Define: (i) Internal design pressure (ii) External design pressure (iii) Design temperature.	**03**
	(b)	Classify pressure vessels as per IS 2825 and explain the significance of design stress and joint efficiency.	**04**
	(c)	Discuss the general steps in designing a cylindrical shell for internal pressure including selection of corrosion allowance, testing and code requirements.	**07**
Q.2	**(a)**	Define: (i) Fatigue (ii) Creep. Explain why these properties are important in pressure vessel design.	**03**
	(b)	Explain the area-for-area method for sizing nozzle reinforcement pads with a neat sketch.	**04**
	(c)	A nozzle is welded to a cylindrical shell of a pressure vessel. State the data required and outline the complete design procedure to check adequacy of reinforcement using the area-replacement method.	**07**
		OR	
	(c)	With neat sketches, discuss the different types of standard flanges and flange facings used in process vessels, highlighting their selection criteria.	**07**
Q.3	**(a)**	Explain the classification of storage tanks as per IS 803 and define a Class A storage tank.	**03**
	(b)	**List the design steps for a self-supporting conical roof for a large diameter storage tank.**	**04**

(c) A storage tank (Class-A) is having following data: **07**
Tank Diameter: 30 m Tank height: 18 m
Sp. Gr. of liquid: 1.18
Conical roof slope: permissible 1 in. 5
Superimposed load - 125 kg/m2
Material – carbon steel (structural)
Permissible stress : 980 kgf/cm2
Density of plate material : 7800 kg/m3
Modulus of elasticity: 2 x 106 kg/cm2
Standard plate size = 1.8 m width x 6.3 m length
Design the shell and bottom. Verify that self-supporting conical roof can work for this storage tank or not
Conical roof slope: permissible 1 in. 5

OR

Q.3 **(a)** State the functions of floating roofs in storage tanks and list different types of floating roofs. **03**

(b) Explain the design steps and precautions for shell and bottom plates for a fixed-roof tank storing a corrosive liquid, considering corrosion allowance and fabrication aspects. **04**

(c) Describe the complete design procedure for a column-supported conical roof, including selection of columns, rafters, girders and roof curb angle. **07**

Q.4 **(a)** Define: (i) Gasket seating stress (ii) Gasket factor. State why correct gasket selection is critical in reaction vessel design. **03**

(b) Classify agitators and discuss the selection criteria for choosing a suitable agitator for liquid–liquid mixing. **04**

(c) A flat-blade turbine agitator with six blades is installed in a baffled tank. Describe the stepwise procedure to determine power requirement, shaft diameter and blade thickness for safe operation under given fluid properties. **07**

OR

Q.4 **(a)** List the different types of jackets used on reaction vessels and mention two advantages of a half-coil jacket over a plain jacket. **03**

(b) Explain the mechanical design of jackets and coils for an exothermic stirred reactor. **04**

(c) Find out the thickness of shell of the reactor & thickness of jacket for the following three available options: **07**

i) Reactor with plain jacket

ii) Reactor with channel jacket

iii) Reactor with half coil jacket.

iii) Reactor with half coil jacket.

Given data:

Inside diameter of shell = 1500 mm, Inside diameter of jacket = 1600 mm, Shell length = 1500 mm, diameter of half coil = 75 mm, Width of channel jacket = 75 mm, Internal design pressure of shell = 4 kgf/cm^2, Internal design pressure of jacket = 3 kgf/cm^2, Design temperature of both shell & jacket = 150 ^{0}C, maximum allowable stress at design temperature = 980 kgf/cm^2, Modulus of elasticity E = 19 × 10^5 kgf/cm^2, Poisson's ratio μ = 0.3, Joint efficiency J = 0.85.

Q.5 **(a)** Write a short note on saddle supports, indicating when they are preferred over other support types. **03**

(b) Explain the design criteria for skirt supports for tall distillation columns, including allowable stresses and load combinations. **04**

(c) A tray distillation column operates at elevated temperature and pressure. Outline the procedure for determining shell thickness at various heights considering internal pressure, dead load and wind load. **07**

OR

Q.5 **(a)** Define: (i) Seismic coefficient (ii) Wind pressure as used in the mechanical design of vertical columns. **03**

(b) Explain the design procedure for bracket supports for a vertical cylindrical vessel installed outdoors. **04**

(c) Discuss the design steps for skirt and base plate including anchor bolts for a tall column subject to combined dead load and wind load, and comment on possible failure modes. **07**

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