Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–VII EXAMINATION – WINTER 2025

Subject Code:3170514 Date:28-11-2025

Subject Name:Mechanical Design of Process equipments

Time:10:30 AM TO 01:00 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)**	What is stiffening rings? When can it be used in pressure vessel design?	**03**
	(b)	Write a technical note on "Radiography test" for pressure vessel.	**04**
	(c)	What is flange joint? With neat sketch explain the different types of standard flanges used in industries.	**07**
Q.2	**(a)**	Differentiate between fatigue and creep.	**03**
	(b)	Name the methods used to calculate the shell thickness under external pressure and discuss any one of them with necessary equations and design steps.	**04**
	(c)	A Reactor (ID = 800 mm) with hemispherical head at the bottom. Inside working pressure is 75 kgf/cm^2 (g) & working temperature is 70 ^{0}C. Reactor is covered with plain jacket such that 75% length of shell & bottom hemispherical head is covered with jacket. Cooling water is circulated inside the jacket by pumping with a centrifugal pump having a shut off discharge pressure 6.0 kgf/cm^2(g). The hemispherical head is fabricated from SA-516 Grade 70. The maximum allowable stress at design temperature is 610 kgf/cm^2. Modulus of Elasticity of plate material (E) = 193 × 10^3 N/mm^2. Poisson's ratio (μ) = 0.3, ρ = 7.83 g/cm^3, Joint efficiency (J) = 0.85. Take 3 mm corrosion allowance. Find: (i) Thickness of the head and (ii) weight of the fabricated head.	**07**
		OR	
	(c)	Find out the thickness of shell & jacket for the (i) reactor with plain jacket and (ii) reactor with channel jacket. The data are given as follow. 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 for shell - 4 Kgf/cm^2, Internal design pressure for jacket - 3 Kgf/cm^2, Design temperature for shell and jacket - 150 C, Material of shell - SA 316 Gr 70, Maximum allowable stress at design temperature - 980 Kgf/cm^2, Modulus of elasticity - 19 × 10^5 kgf/cm^2, Poisson's ratio - 0.3, Joint efficiency - 0.85. Take corrosion allowance as 1.5 to 3 mm.	**07**
Q.3	**(a)**	State the uses of propeller, paddle and turbine agitator.	**03**
	(b)	Discuss the purpose of providing reinforcement pad for nozzle.	**04**
	(c)	With neat sketch explain the various types of jackets and discuss the design of channel jacket and half coil jacket for reaction vessel.	**07**

OR

Q.3 Design a bracket support for reaction vessel based on given data. Brackets are welded with outside surface of the reactor shell. OD of reactor shell = 1052.7 mm, Thickness of the shell = 6.35 mm, Height of the vessel = 2.1524 m, Clearance from vessel bottom to foundation = 0.75 m, Weight of vessel with contents = 3918.9 kg, Wind pressure = 100 kgf/m^2, No of brackets = 4, Diameter of bolt circle = 1202.7 mm, Size of base plate for bracket = 150 mm x 150 mm, Height of the C channel from foundation = 2.0264 m, Size of C channel = 150 mm x 75 mm, Area of cross section = 20.88 cm^2, Modulus of section = 19.4 cm^3, Radius of gyration = 2.21 cm, MOC for support = IS 800, Max. allowable tensile stress = 1400 kgf/cm^2, Max. allowable compressive stress = 1233 kgf/cm^2, Max. allowable bending stress = 1575 kgf/cm^2 **14**

Q.4 **(a)** State the industrial applications of different types of storage tanks. **03**

(b) Why permanent vent is provided in storage tank? State the advantages and disadvantages of external roof tank over internal floating roof tank. **04**

(c) Discuss the design steps for the selection of rafter, girder and column used for column supported conical roof. **07**

OR

Q.4 **(a)** State the purpose of providing reinforcement pad for nozzle. **03**

(b) Discuss about normal and emergency venting system for storage vessel. **04**

(c) Discuss the mechanical design of tube and tube sheet under internal & external pressure for a shell and tube heat exchanger. **07**

Q.5 **(a)** Name the various types of stresses induced in the shell of distillation column. **03**

(b) When skirt support is used for pressure vessel? State any two advantages of skirt support over bracket support. **04**

(c) What is tray support? Write a short note on different types of tray supports used for distillation column. **07**

OR

Q.5 Distillation is carried out in a packed tower under vacuum. Determine the thickness and weight of shell based on the following given data. **14**

Shell ID = 1500 mm, Length of Shell - 15 m, External design pressure - 101.325 kPa, Design temperature - 200^oC, Shell and head material - SA 240 GrS type 304, Type of Shell Plate join - Double welded butt joint with 10% radiography, Nos. of packing sections - 5, Height of each packing section - 2.5 m, Top disengaging space - 1.2 m, Type of Packing - 25 mm S.S. pall rings, Weight of Packing per m^3 - 480 kg, % void space - 94%, Density of liquid - 1100 kg/m^3, Weight of attachment (pipes, ladders & platform) - 150 kg/m, Wind pressure - 981 N/m^2, Insulation thickness - 50 mm, Density of insulation - 500 kg/m^3, Density of SA 240 GrS type 304 - 7800 kg/m^3, Maximum allowable stress of shell or head plate material - 104.12 N/mm^2 (tensile), Modulus of elasticity of plate material - 2×10^5 N/mm^2, Poissions ratio of plate material - 0.3, Neglect the stress created by eccentric load and seismic load.

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