Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER- VII EXAMINATION-SUMMER 2023

Subject Code: 3170514 Date: 30/06/2023

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 pressure vessel? State the examples of pressure vessel.	**03**
	(b)	Derive the equation for design stress to calculate the thickness of thin cylindrical shell under internal pressure.	**04**
	(c)	Sate and discuss the various types of gaskets used in industries.	**07**
Q.2	**(a)**	Differentiate between fatigue and creep.	**03**
	(b)	State the applications of various types of heads used for pressure vessel design.	**04**
	(c)	(i) Classify the unfired pressure vessel as per IS-2825. (ii) Explain "Radiography test" for pressure vessel.	**07**
		OR	
	(c)	A vacuum distillation column is to operate under a top pressure of 50 mm Hg absolute. The trays of distillation column are supported on periphery rings having 10 mm thickness and 75 mm width. The outer diameter of column is 1 m and the tray spacing is 0.5 m. Check whether the support rings will act as an effective stiffening rings or not? The material of construction is carbon steel and the maximum operating temperature is 50°C. If the shell thickness is 10 mm, check that the given shell thickness is sufficient or not. The modulus of elasticity at 50°C for carbon steel is 200×10^3 N/mm^2. Take corrosion allowance as 2 mm for carbon steel.	**07**
Q.3	**(a)**	State the advantages and limitations of bracket support.	**03**
	(b)	Name the various types of agitators and write their industrial applications.	**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		Determine (i) power required (ii) shaft diameter and (iii) critical speed for the turbine agitators operating in a reaction vessel of 1.6 m outside diameter with the following given data. Internal design pressure - 5 kgf/cm^2, agitator diameter - 500 mm, maximum agitator rpm - 200, viscosity of liquid - 600 cp, specific gravity of liquid - 1.2, over hang length of shaft - 1.2 m, No. of agitator blade - 6, elastic limit - 250 N/mm^2, permissible shear stress in shaft - 55 N/mm^2, modulus of elasticity - 19.5×10^5 kgf/cm^2. Power number - 8 for NRe < 1500, 6 for 1500 < NRe < 3000, 4.5 for 3000 < NRe < 4500, 3 for 4500 < NRe < 6000 and 2 for NRe > 6000.	**14**
Q.4	**(a)**	State the purpose of providing reinforcement pad for nozzle.	**03**
	(b)	With neat diagram discuss the different type of External floating roof tank.	**04**

(c) Discuss the general design steps for the shell and tube heat exchanger. **07**

OR

Q.4 **(a)** State the function of wind girders for large open tanks. **03**

(b) Explain the advantages and disadvantages of normal and emergency venting system for storage vessel. **04**

(c) Determine the total number of shell plates and plate thickness of a storage tank to store Phosphoric acid of 85% w/w for phosphoric acid plant having production capacity of 762.83 MT. Density of pure H_3PO_4 is 1834 kg/m^3. Allowable stress of Monel is 170 MPa and D/H is 1.5. Corrosion allowance is negligible. **07**

Q.5 **(a)** Name the various types of tray support with their industrial application. **03**

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

(c) Explain the various types of stresses induced in the shell of distillation column operated under internal design pressure. **07**

OR

Q.5 A distillation column subjected to full vacuum is fabricated and installed, having following specifications. **14**

Shell outer diameter (OD) - 2000 mm, Tangent to tangent length of shell - 35 m, Design temperature - 120^{o}C, Shell material - SA-283 Grade C, Type of shell plate joint - Double welded butt joint with 10% radiography, Height of skirt support - 4 m, Tray spacing – 0.3 m, No. of trays – 106, Top disengaging space – 1.2 m, Weight of liquid and tray – 120 kg/m^2, Weight of attachment (pipes, ladders & platform) – 150 kg/m, Wind pressure – 130 kgf/m^2, Insulation thickness – 100 mm, Density of insulation – 500 kg/m^3, Maximum allowable stress of shell plate material at design temperature – 605.22 kgf/cm^2, Modulus of elasticity – 2×10^6 kgf/cm^2, Poissons ratio – 0.3, Corrosion allowance – 2 mm, Specific gravity of shell and stiffener material – 7.865, Weight of top head – 315.55 kg, 38 number of stiffening ring, each with 8 mm thickness and 100 mm width are attached to the column. Neglect the stress created by eccentric and seismic load. Analyze the various stresses induced in the column and determine the thickness of distillation column.

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