Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII (NEW) EXAMINATION – SUMMER 2022

Subject Code:3170514 Date:06/06/2022

Subject Name:Mechanical Design of Process equipments

Time:02:30 PM TO 05:00 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 do you mean by pressure vessel? Define design pressure and temperature.	**03**
	(b)	Explain "Radiography test" for pressure vessel.	**04**
	(c)	What is gasket? Define gasket seating stress and discuss the various types of gaskets used in industries.	**07**
Q.2	**(a)**	Classify the unfired pressure vessel as per IS – 2825.	**03**
	(b)	Derive the equation for design stress to calculate the thickness of thin cylindrical shell under internal pressure.	**04**
	(c)	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^{o}C. Shell thickness is 14 mm. Shell will be fabricated from carbon steel plate. Modulus of elasticity of plate material and poisson ratio is 19.5×10^5 kgf/cm^2 and 0.3 respectively. (i) What is the maximum allowable vacuum permitted in the vessel based on the given shell thickness without stiffener? (ii) Calculate the number of equally spaced circumferential stiffeners for full vacuum. Moment of inertia for the stiffening ring is 650 cm^4. Take 1.5 mm corrosion allowance.	**07**
		OR	
	(c)	Define (i) Elasticity (ii) Fatigue (iii) Creep (iv) Resilience (v) Toughness (vi) Longitudinal stress (vii) circumferential stress.	**07**
Q.3	**(a)**	State the applications of various types of heads used for pressure vessel design.	**03**
	(b)	With neat sketch explain the uses of various types of jackets for reaction vessel.	**04**
	(c)	State the application of bracket, skirt and saddle support. Briefly discuss the design steps for bracket support.	**07**
		OR	
Q.3	**(a)**	State the purpose of providing reinforcement pad for nozzle.	**03**
	(b)	State the various types of agitators. Discuss the design aspects of any one agitator in details.	**04**
	(c)	Determine the thickness of base plate and gusset plate of bracket support for the reaction vessel with the following data. Diameter of the vessel – 1.5 m, Height of vessel – 1.8 m, Weight of vessel with contents – 7.5 tonns, Vessel clearance from foundation – 1 m, Height of bracket from foundation – 2 m, Bolt circle diameter -1.65 m, Size of base plate for bracket - 14 cm × 15 cm, Space between gusset plate – 12.5 cm, Height of gusset plate – 120 cm, Permissible bending stress for the material - 1600 kgf/cm^2. The vessel is kept for indoor application.	**07**
Q.4	**(a)**	State the function of dyke wall in the storage tank.	**03**
	(b)	With neat diagram discuss about the type of External floating roof tank.	**04**
	(c)	Discuss the design steps for the conical roof with structural support.	**07**

OR

Q.4 **(a)** What is normal and emergency venting for storage vessel? **03**

(b) Briefly discuss about the wind girders for large open tanks. **04**

(c) Fixed conical roof storage tank is fabricated from structural steel plate (IS–2062). Based on the given following data find out the thickness of conical roof plate. Storage tank can be classified as 'Class A Tank'. Tank diameter – 7 m, Tank height – 5 m, Slope of conical roof – 1 in 6 (or 1/6), Superimposed live load on roof – 125 kgf/m^2, Modulus of elasticity of Plate material – 2×10^6 kgf/cm^2, Density of Plate material – 7800 kg/m^3, Poisson's ratio – 0.3, Thickness of topmost shell course – 10 mm, CA –1.5. **07**

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

(b) Explain in detail the function of various parts of shell & tube heat exchanger. **04**

(c) State and explain the different types of stresses induced in the shell of distillation column with their design equations. **07**

OR

Q.5 Determine the shell thickness and stress analysis for the fractionating column having following specifications. **14**

Shell I.D - 3500 mm, Working temperature – 180^{o}C, Working pressure – 2 N/mm^2 (gauge), Design temperature – 200^{o}C, Top disengagement space – 200 mm, Base chamber height – 3200 mm, Sp. Gravity of material – 7.7, Permissible tensile stress – 95 N/mm^2, Insulation density – 7700 N/m^3, Corrosion allowance – 3 mm, Poisson ratio – 0.32, Modulus of elasticity – 1.93×10^5 N/mm^2 Insulation thickness – 140 mm, Head type – Eliptical, Weight of head – 2800 N, Weight of pipe, ladders, platform etc. – 1600 N/m^2, Wind pressure - 1600 N/m^2, Weight of liquid and tray – 900 N/m^2, Seismic load and eccentricity are negligible, No. of trays – 60, Tray spacing – 0.7 m.

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