Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII (NEW) EXAMINATION – WINTER 2021

Subject Code:3170514 Date:27/12/2021

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)**	State different types of gasket used in chemical industries.	**03**
	(b)	Discuss the following: (i) internal design pressure (ii) external design pressure (iii) design temperature (iv) Allowable stress	**04**
	(c)	Explain the function of the following parts for the shell and tube heat exchanger. (i) Baffles (ii) Tie rods (iii) Spacers (iv) Expansion joint (v) Tube side pass partition (vi) Tube sheet (vii) Support.	**07**
Q.2	**(a)**	Give full form of TEMA, ASME and HTRI.	**03**
	(b)	Define weld joint efficiency factor. Explain radiography test.	**04**
	(c)	Discuss the different types of standard flanges with a neat sketch.	**07**
		OR	
	(c)	Define the terms: Stress, Strain, Ductility, Rigidity, Elasticity, Creep, Resilience	**07**
Q.3	**(a)**	Discuss about mechanical design of Hemispherical head.	**03**
	(b)	Describe various types of jackets and their selection criteria.	**04**
	(c)	Write a short note on Tray supports used for distillation column.	**07**
		OR	
Q.3	**(a)**	Explain Normal and Emergency venting for storage vessel.	**03**
	(b)	Discuss about design of Elliptical head.	**04**
	(c)	Discuss about different types of agitators and their selection criteria.	**07**
Q.4	**(a)**	Discuss analytical method for thickness calculation of shell subject to external pressure.	**03**
	(b)	Derive the equation for longitudinal and circumferential stresses generated due to operating pressure in cylindrical vessel.	**04**
	(c)	Discuss rafter selection, girder selection and column selection steps used for design of column supported conical roof.	**07**
		OR	
Q.4	**(a)**	Write a short note on safety valves.	**03**
	(b)	Discuss significance of stiffening ring in pressure vessel design.	**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 & size of roof curb angle. Storage tank can be classified as ‘Class A Tank’. Given Data:- Tank diameter = 7m Tank height = 5m	**07**

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 = $2x10^6$ 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

Q.5 **(a)** Discuss floating roof storage tank. **03**

(b) Discuss the term: Poisson's Ratio and Moment of Inertia. **04**

(c) A cylindrical vessel 14 ft.ID and 0.3125 inch has ring stiffeners located at 40 in spacing and it is subjected to an external pressure of 15 psi at a temperature of 700 ^oF. The MOC is carbon steel with yield stress of 30,000-38,000 psi. Modulus elasticity of carbon steel is 170×10^3 N/mm^2. **07**

i) Is t_s = 0.3125 inch adequate for a design with factor of safety of 4?

ii) What is the allowable external pressure for a factor of safety of 3?

iii) What is the thickness for same ID vessel based on a factor of safety 3?

iv) Determine the stiffener ring requirements for the vessel in (C).

OR

Q.5 Design a skirt support for distillation column based on following data. **14**

Diameter of column = 2500 mm
Height of distillation column = 40 m
Maximum weight of vessel, its attachments and contents = 300,000 kg
Type of skirt support = straight cylindrical
Diameter of skirt = 2500 mm
Height of skirt = 5 m
Wind pressure at the top of column = 128.5 kgf/m^2
Material used for skirt support = IS 800, Structural steel
Allowable tensile stress of material = 1400 kgf/cm^2
Allowable compressive stress of material = 666 kgf/ cm^2
Allowable bending stress of material = 1575 kgf/ cm^2
Allowable compressive stress of concrete = 35 kgf/ cm^2
Seismic coefficient = 0.08
Minimum weight of empty vessel = 250,000 kg
Allowable tensile stress of bolt material = 1020.7 kgf/ cm^2
Bolt material = SA 193 Gr B 8 t
Weight of skirt = 10700 kg

****

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.

****