

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

Subject Code: 3170514

Date: 05/06/2026

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) Define the terms: (i) Ductility (ii) Elasticity (iii) Creep. 03
 - (b) Write a short note on corrosion allowance and its importance in design. 04
 - (c) Define the two most important stresses generated in a thin cylindrical shell and discuss the classification of unfired pressure vessels as per IS-2825. 07

- Q.2**
- (a) Discuss the mechanical design of a Torispherical head. 03
 - (b) Describe in brief the concepts of 'Design Pressure' and 'Design Temperature.' 04
 - (c) Discuss the calculation of shell-side pressure drop for a shell and tube heat exchanger. 07

OR

- Q.2**
- (c) Discuss about different types of flange facings with neat figures. Mention the merits of each flange over others. 07

- Q.3**
- (a) State the industrial uses of Propeller, Paddle, and Turbine agitators. 03
 - (b) Define Gasket Seating Stress and Gasket Factor. 04
 - (c) A cylindrical vessel 14 ft ID and 0.3125 inch thickness has ring stiffeners located at 40 in spacing & it is subjected to an external pressure of 15 psi at a temperature of 700 °F. The material of both the vessel and stiffeners is Carbon Steel with a yield stress of 30,000 – 38,000 psi. Modulus elasticity of carbon steel is $170 \times 10^3 \text{ N/mm}^2$, $\mu = 0.3$. Determine : 07
 - (1) Allowable external pressure for a factor of safety of 3.
 - (2) If $P_{c\min} = 58 \text{ psi}$, the stiffener ring requirements for the vessel .

OR

- Q.3**
- (a) Discuss the purpose of providing a reinforcement pad for a nozzle. 03
 - (b) Discuss about the mechanical design of self-supporting roof for storage tanks. 04
 - (c) A Reactor (ID=800 mm) with hemispherical head at the bottom. Inside working pressure is 75 kgf/cm² gauge & working temperature is 70°C. Reactor is covered with plain jacket such that 75% length of shell & bottom hemispherical head are covered with jacket. Cooling water is circulated inside the jacket by pumping with a centrifugal pump having a shut off discharge pressure 6 kgf/cm²(g). The hemispherical head is fabricated from SA 516 Grade 70. (The maximum allowable stress at design temperature = 610 kgf/cm²). Modulus of Elasticity of plate material (E) = $193 \times 10^3 \text{ N/mm}^2$, $\mu = 0.3$, $\rho = 7830 \text{ Kg/m}^3$, Joint efficiency J = 0.85, Corrosion allowance= 3 mm, straight flange=120 mm. 07
Determine: (1) Thickness of the head (2) Weight of the fabricated hemispherical head.

- Q.4** (a) State the function of a dyke wall in a storage tank farm. **03**
(b) Discuss the design procedure and steps for a Saddle support. **04**
(c) Discuss the various types of stresses induced in the shell of a distillation column with their design equations. **07**

OR

- Q.4** (a) Explain 'Radiography Test' used for welding of pressure vessels. **03**
(b) Explain different types of supports used for a tall vertical tower. **04**
(c) Discuss the shell thickness determination steps for a Distillation Column. **07**

- Q.5** (a) Explain the function of: (i) Baffles (ii) Tie rods (iii) Spacers in heat exchangers. **03**
(b) Explain the various types of tray supports used in vertical tall towers. **04**
(c) Discuss the stepwise procedure for the design of a Skirt support. **07**

OR

- Q.5** (a) Discuss the terms: Poisson's Ratio and Moment of Inertia. **03**
(b) Briefly explain the methods for the design of a Reinforcement pad. **04**
(c) Explain the design procedure for Saddle Supports for a horizontal pressure vessel. **07**
