

Total No. of Questions :12]

SEAT No. :

**P1130**

[Total No. of Pages :3

**[4659] - 355**

**B.E. (Biotechnology)**

**BIOPROCESS EQUIPMENT DESIGN (415465)**

**(2008 Pattern) (Semester-I)**

*Time : 3 Hours]*

*[Max. Marks : 100*

*Instructions to the candidates:*

- 1) *Answers to the two sections should be written in separate answer books.*
- 2) *Answer Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6 from Section I and Q.7 or Q.8, Q.9 or Q.10, Q.11 or Q.12 from Section II.*
- 3) *Neat diagrams must be drawn wherever necessary.*
- 4) *Figures to the right side indicate full marks.*
- 5) *Use of calculator is allowed.*
- 6) *Assume suitable data, if necessary.*

**SECTION-I**

- Q1)** a) Draw and explain Stress strain curve for **[8]**  
i) Ductile material and ii) Brittle material.  
b) Explain Maximum distortion energy and Maximum shear stress theory. **[8]**

OR

- Q2)** a) Describe the general design procedure for process equipment. **[4]**  
b) Define and explain Design Stress, Polar Moment of Inertia, and Young's Modulus. **[12]**

- Q3)** a) Describe the design of plain head, shallow head and hemispherical head with neat sketches. **[12]**  
b) A vessel having 1.59 m outside diameter is to operate at a pressure of 5 Kg/cm<sup>2</sup>. The permissible stress of the material used for fabrication is 1021 Kg/cm<sup>2</sup>. Welded joint efficiency is 85%. Calculate the thickness required for a cylindrical vessel and Spherical vessel? Which vessel should be selected for operation? Operating pressure is 5Kg/cm<sup>2</sup>. **[6]**

OR

**P.T.O.**

- Q4)** a) The inside diameter of cylinder is 25cm and subjected to an internal pressure of 600kg/cm<sup>2</sup>. Allowable tensile stress of the material is 1400 Kg/cm<sup>2</sup>. What should be the minimum thickness of the vessel? [9]
- b) A high pressure vessel is to be operated at 100MN/m<sup>2</sup>. The inside diameter of vessel is 30.5cm. Steel having yield stress 466MN/m<sup>2</sup> is selected for fabrication. Estimate the wall thickness required by maximum shear stress theory with a factor of safety 1. [9]
- Q5)** a) Give classification and selection criteria of agitators. [8]
- b) Explain various types of jackets with neat sketches. [8]

OR

- Q6)** A toluene is continuously nitrated to mononitrotoluene in a cast iron vessel, 1 meter in diameter, fitted with propeller agitator 0.3 m diameter, rotating at 2.5 Hz. The temperature is maintained at 310 K by circulating 0.5 kg/sec cooling water through a stainless steel coil 25 mm outer diameter and 22 mm inner diameter in the form helix 0.8 m in diameter. The conditions are such that the reacting material may be considered to have some physical properties as 75% H<sub>2</sub>SO<sub>4</sub>. If the mean water temperature is 290 K, what is the overall heat transfer co-efficient for desired heat transfer co-efficient. [16]

**Properties of water**

$K = 0.59 \text{ W/mk}$

$C_p = 4180 \text{ J/kg.K}$

$\mu = 1.08 \times 10^{-3} \text{ NS/m}^2$

$\rho = 998 \text{ kg/m}^3$

**Properties of 75% H<sub>2</sub>SO<sub>4</sub>**

$K = 0.40 \text{ W/mk}$

$C_p = 1880 \text{ J/kg.K}$

$\mu = 6.5 \times 10^{-3} \text{ NS/m}^2 \text{ at } 310\text{K}$

$\rho = 1666 \text{ kg/m}^3$

$\mu_s = 8.6 \times 10^{-3} \text{ NS/m}^2$

Thermal conductivity of stainless steel is 15.9 W/mk. Dirt resistance at inside and outside surface are 0.0002 & 0.0004 m<sup>2</sup>K/w.

**SECTION-II**

- Q7)** 12000 kg/hr of water available at 93°C is to be cooled to 50°C in a shell and tube heat exchanger. This heat is to be utilized for preheating of water from 15°C to 45°C, Cold water is to be circulated through the tubes, while hot water on shell side. Tubes of inside diameter 20 mm are to be used and the maximum velocity through the tubes should not be more than 0.5 m/sec. Due to space limitations the tube length is to be restricted to 3.2m. Overall heat transfer coefficient for the heat exchanger is 1450 w/m<sup>2</sup>K. Fouling resistance and metal wall resistance may be neglected. Suggest a suitable design for the shell and tube heat exchanger. [16]

OR

- Q8)** a) What are the different types of heat exchanger? Discuss about Codes and Standards for heat exchanger. [8]  
b) Explain the procedure with equations to calculate the tube side heat transfer coefficient and pressure drop. [8]

- Q9)** a) Explain the optimum sieve plate performance diagram. [8]  
b) Discuss various feed arrangements to be considered for distillation column along with neat sketches. [8]

OR

- Q10)** a) Write short note on AIChE method for calculation of plate efficiency. [8]  
b) Define Murphree plate, Overall plate (column) efficiency. [8]

- Q11)** a) State the advantages of high performance thin layer chromatography. [6]  
b) State the need of downstream processing in biological processes. [8]  
c) Write short note on Tangential Flow Filtration (TFF). [4]

OR

- Q12)** a) Write short notes on: [9]  
i) Filter integrating testing  
ii) Commissioning and validation of filter  
b) Describe downstream processing operation used in fermentation process. [9]

