U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: V**

Branch: Chemical Engineering **Duration: 3 hrs.**

Course Code: 19CH5DCCED **Max Marks: 100**

Course: Chemical Equipment Design

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			UNIT - I	*CO*	*PO*	Marks
1	a)		With neat sketches explain the importance of various vessel components used in equipments	*CO1*	*PO 2*	**10**
	b)		Explain the three important classifications of process equipments?	*CO1*	*PO2*	**06**
	c)		Explain the operating conditions for pressure vessel	*CO1*	*PO2*	**04**
			OR			
2	a)		Explain the basic design considerations in chemical process equipment design with general design procedures	*CO3*	*PO3*	**10**
	b)		What are the factors satisfying the performance and reliability of the process equipments	*CO3*	*PO3*	**06**
	c)		Explain the importance of different pressure vessel codes	*CO3*	*PO3*	**04**
			UNIT - II			
3	a)		For a vessel of 1.5 m I.D., 2.0 m height, find the shell thickness and thickness of different types of heads/covers/closures for operating pressure is 14 bar. Operating Temperature is 500oC. Material of construction (MOC) carbon steel with allowable stress of 102 Mega Pascal's, Assume corrosion allowance – 2 mm and Joint efficiency = 1	*CO3*	*PO3*	**12**
	b)		Explain the static stress/loads in the process equipment design.	*CO3*	*PO3*	**08**
			OR			
4	a)		A cylindrical pressure vessel 2 m I.D is to operate at a pressure 4 kg/cm^2. The permissible stress of the material is 960 kg/cm^2. Weld joint efficiency is 85 %. Calculate the thickness required for the vessel. If this vessel is fabricated in spherical form, what	*CO3*	*PO3*	06

			maximum pressure will it be able to withstand?. Take design pressure 1.1 times the operating pressure.			
		b)	A cylindrical pressure vessel 1.8 m in diameter and 5 m in height is subjected to an internal pressure of 8 kg/cm^2. Corrosion allowance is 2 mm. If the vessel is fabricated as : Class B vessel with J-=0.85, Class C vessel with J = 0.5 and J = 0.7. What will be the minimum thickness of the vessel?. If a strip of suitable size is welded all along the longitudinal joint (J=1.0), what will be the thickness of the vessel and how much percentage saving in the material can be achieved? Take design pressure 1.1 times the operating pressure.	*CO3*	*PO3*	10
		c)	Write the formula used to calculate the weight of cylindrical shell, Elliptical and Hemispherical heads.	*CO4*	*PO3*	04
			UNIT - III			
	5	a)	With neat sketches write the different pressure vessel support.	*CO4*	*PO3*	08
		b)	Determine the thickness of the Flange for the following data: Diameter at gasket reaction load = G= 1220 mm. Design pressure, P = 0.33 N/mm^2, Permissible stress of flange materials, f = 95 N/mm^2, Minimum bolters load WM or WG= 4,24,00 N, Bolt or pitch circle diameter, C = 1310 mm, Corrosion allowance = 1mm.	*CO4*	*PO3*	12
			OR			
	6		A reaction vessel to process liquid components of the reaction mixture of 1500 liters with L/D ratio of 1.2 is to be designed with 1/3rd volume of the reactor as free space and Torispherical heads. The reactor operates at 8 kgf/cm^2 and is made of Al S. I. grade 316 stainless steel. It is jacketed for steam heating at a pressure of 1.4 kgf/cm^2 with MS. It has an agitator provided with turbine type impeller rotating at 300 rpm. For the purpose of agitator sizing, the reaction mixture may be having same properties as water. Calculate the diameter of tank, impeller and baffle thickness. Design the agitator shaft diameter and assess its power requirements. Data MOC = Al S. I. grade 316 SS, Pj = 1.4 kgf/cm^2 = 1.37 x 10^5 N/m^2, rpm = 300, assuming properties of water as ρ = 1000 kg/m^3, μ = 0.98x10^{-3} Pa s, assume allowable shear stress of material (f) as 9.5 kg/mm^2 = 93.19x10^6 N/m^2	*CO4*	*PO3*	**20**
			UNIT - IV			
	7		A cylindrical storage tank has diameter of 33 m and the tank height is 10 m. Liquid stored in the tank has a density of 810 kg/m^3. Material of construction is carbon steel having permissible stress 1300 kg/cm^2. Density of material used for fabrication is 7700 kg/m^3. The plate of size 3 m × 1.2 m in varying thickness are available, welded joint efficiency is 85%. Calculate the cylindrical shell thickness of the tank at different heights. Also estimate the	*CO3*	*PO3*	**20**

			total number of plates required for shell, bottom plate, annular ring and self-supporting roof. Find the bill of materials and calculate the weight of storage tank. Assume missing data if any.			
			OR			
	8		A storage tank is to be designed to store 2650 m3 of liquid, assume H/D =1.0. Steel plates of size 1.5 x 5.0 m, and a different thickness are available. 1. Design the shell coarse 2. Design the base, bottom plate and self-supporting sloping roof. 3. Estimate the bill of quantities and cost by considering Rs. 20,000/tonn Data: Liquid density = 1000 kg/m3, MS Plate density = 8000 kg/m3, Allowable stress of Mild Steel = 960 kgf/cm2, Weld Joint Efficiency (J) = 0.85 Corrosion allowance = 1 mm	*CO4*	*PO3*	**20**
			UNIT - V			
	9	a)	Estimate the optimum pipe diameter for carbon steel for water flowing at the rate 10 kg/sec at 20^0C using the carbon steel empirical equation and also check the velocity.	*CO5*	*PO4*	**04**
		b)	Tanker carrying toluene is unloaded using the ships pumps to an on shore storage tank. The pipeline is 225 mm ID & 900 m long. Miscellaneous losses due to fittings, valves etc. amounts to 600 equivalent pipe diameter. The maximum liquid level in the storage tank is 30m above the lowest level in the ship tank. The ship tank is N_2 blanketed and maintained at a pressure of 1.05bar. The storage tank has a floating roof which exerts a pressure of 1.1 bar on the liquid. The ship must unload 1000 tonnes in 5 hours. Estimate the power required by the pump. Take pump efficiency as 70%. Data: Density of the toluene = 874 kg/m^3, Viscosity = 0.62 X 10^{-3} Ns/m^2 and f= $0.04/(N_{Re})^{0.16}$	*CO5*	*PO4*	**16**
			OR			
	10	a)	What are the factors to be considered while selecting the optimum diameter? Discuss	*CO6*	*PO11*	**12**
		b)	Discuss what are the information to be provided in P and I diagram	*CO6*	*PO11*	**08**

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