U.S.N.										

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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: VI**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 22CH6PCPED **Max Marks: 100**
Course: Process Equipment Design

Instructions:
1. Answer Unit I and Unit IV are compulsory. Answer any ONE full question from choosing Unit II and Unit III.
2. Missing data, if any, may be suitably assumed & stated.
3. Perry's Chemical Engineers Handbook, IS 4503 and IS 2825 Unfired Pressure Vessel Codebooks are permitted to use.

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.

				CO	*PO*	Marks
			UNIT – I			
1	a)	Classify the chemical equipment based on common features which require similar design features.		*CO* 3	*PO4*	**06**
	b)	What is torispherical head? Write the equation used to calculate the thickness of torispherical head.		*CO* 3	*PO4*	**06**
	c)	Explain the general design procedure of process equipment used in chemical industry.		*CO* 3	*PO4*	**08**
			UNIT – II			
2		Design a one shell side pass and two tube side pass shell and tube heat exchanger to cool 1,00,000 kg/h of methyl alcohol from 95ºC to 40ºC, using water which flows through the tubes with the temperature rise from 25º to 40ºC. The tube data are 20 mm OD, 16 mm ID, 4.88 m long (effective length) cupronickel tubes are to be arranged in 1.25 triangular pitch. Design the exchanger and estimate it's the pressure drop. Data: • Conductivity of metal; k_w is 50 W/m^2 ºC • Allowable stress for the material is 11.7 kg$_f$/cm^2. • Baffles: 20% cut baffles are to be spaced • Fouling coefficient for methyl alcohol and water are 5000 and 3000 W/m^2 ºC respectively. • Overall coefficient is 600 W/m^2 ºC.			
	a)	Determine the shell side and tube side fluid properties at average temperature.		*CO* 1	*PO2*	**05**
	b)	Determine overall heat transfer coefficient from individual heat transfer coefficient.		*CO* 2	*PO4*	**20**
	c)	Determine the pressure drops at shell side and tube side.		*CO* 2	*PO4*	**10**
	d)	Carry out the mechanical design of the heat exchanger.		*CO* 2	*PO4*	**15**
	f)	Draw a neat front sectional view of STHE. Name at least 10 parts.		*CO* 4	*PO2*	**10**

			UNIT - III			
	3		A liquid mixture of benzene toluene is being distilled in a fractionating column at 101.3 k Pa pressure. A sub-cooled liquid feed of 100 kmole/h with composition of 45 mole% benzene (A) and 55 mole% toluene (B) and enters at 327.6 K. A distillate containing 95 mole% benzene and 5 mole% toluene and a bottoms containing 10 mole% benzene and 90 mole% toluene are to be obtained. The amount of liquid is fed back to the column at the top is 4 times the distillate product. Design the distillation column. Data: • The average heat capacity of the feed is 159 kJ/kg mole. K • The average latent heat 32,099 kJ/kg moles. The equilibrium data:			
		a	Calculate the rate of distillate and bottom product in kg moles per hour.	CO2	*PO4*	**10**
		b	Determine the number of theoretical stages at the operating reflux.	CO2	*PO4*	**20**
		c	Estimate the minimum number of theoretical stages required at total reflux.	CO2	*PO4*	**05**
		d	Establish the plate specifications and bubble cap design.	CO2	*PO4*	**15**
		e	Draw schematic diagram of bubble cap distillation column.	CO4	*PO2*	**10**
			UNIT – IV			
	4	a	A pressure vessel with internal diameter 1200 mm, made up of stainless steel. Vessel operated with internal pressure of 3 kg/cm^2. Permissible stress at 150°C is 13 kg/mm^2. Flanged and dished type of head is fixed to both side of vessel. Estimate the shell thickness and head thickness of the pressure vessel based on the internal pressure Data: • External diameter and crown radius of head is 1200 mm. • Knuckle radius of head is 72 mm. • Material of head is stainless steel.	CO3	*PO4*	**10**
		b	Pressure vessel of internal diameter 1.5 m operates at 0.05 kg/mm^2. The vessel must be provided with a nozzle 10 cm internal diameter. The nozzle is welded to the shell wall and does not project inside the vessel. Permissible stress of the material is 10.20 kg/mm^2. Corrosion allowance is 1 mm and welded joint efficiency is 85%. Estimate the reinforcement required for the nozzle.	*CO3*	*PO4*	**10**

Temperature (K)	353	358	363	367	373	378	384
x_A	1	0.780	0.580	0.450	0.258	0.13	0
y_A	1	0.900	0.777	0.657	0.456	0.261	0

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