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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: IV**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 19CH4DCHTR **Max Marks: 100**
Course: Process Heat Transfer

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.
3. Use of steam tables is permitted.

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)	An inorganic liquid is heated in a bronze vessel to 115°C. After the desired temperature is reached, heating is stopped and the variation in temperature with time is noted. Analyze the modes of heat transfer in the above process and the law governing them in the above process.	CO1	PO 2	**08**
	b)	Explain the variation of thermal conductivity of a material with temperature.	CO1	PO2	**06**
	c)	A silver tube with 8 cm ID and 15 cm OD has an inner surface temperature of 200°C and outer surface temperature of 100°C. Determine the temperature halfway between the inner and outer surfaces.	CO1	PO2	**06**
		OR			
2	a)	Develop an expression for heat transfer by conduction through the composite cylindrical material consisting of three different materials assuming constant thermal conductivity.	CO1	PO2	**10**
	b)	A furnace wall consists of 20 cm of type 'A' brick and 10 cm of type 'B' brick and 0.6 cm metal plate. The inside of the type A brick is at 1150°C, outside temperature of metal is 30°C, an accurate heat balance of furnace has shown that the heat loss from the wall is 300 W/m^2. It is known that there may be a thin layer of air between the layers of the type A brick & type B, as well as type B brick & metal plate. To how many mm of type B are these air layers equivalent? The K values are 1.629 W/m K for the type A brick, 0.171 W/m K for type B, and 44.6 W/m K for metal plate.	CO1	PO2	**10**
		UNIT - II			
3	a)	Deduce an expression for critical radius of insulation for a spherical medium. State the assumptions made.	CO2	PO2	**10**

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		b)	Find the percentage reduction in heat loss from a spherical furnace when it is insulated. ID = 300 mm, OD = 500 mm, inside surface temperature T_i = 450° C, outside temperature T_o = 50°C, k for the furnace wall is 0.47 W/m.°C and k for insulation is 0.059 W/m°C. Insulation thickness = 25 mm, insulation outer temperature = 35°C.	*CO2*	*PO2*	**10**
			OR			
	4	a)	Compare fin efficiency and fin effectiveness, and explain how efficiency varies for different cases.	*CO2*	*PO2*	**08**
		b)	Develop an expression to find the temperature profile along the length of the fin when the tip of the fin is insulated.	*CO2*	*PO2*	**12**
			UNIT - III			
	5	a)	Derive the relation between overall and individual heat transfer coefficient considering the dirt factor.	*CO3*	*PO3*	**10**
		b)	Liquid 'A' is flowing at a rate of 1900 kg/hr inside the tubes in a heat exchanger and is to be cooled from 358 K to 318 K using water. Water flows outside tube at a rate of 13500 kg/hr and enters at 293 K.The film coefficient for liquid 'A' is 1700 W/m^{2}K. The wall resistance is negligible. The water side coefficients including the fouling factors are 11000 W/m^{2}K. i. What is the area required for counter current flow in a heat exchanger? ii. By what factors be the area increased if parallel flow were used to get more rapid cooling of Liquid 'A'? C_p of liquid 'A'= 0.88 kJ/kg°C C_p of water= 4.2 kJ/kg°C	*CO3*	*PO3*	**10**
			OR			
	6	a)	Analyze the various regimes in pool boiling of a saturated liquid.	*CO3*	*PO3*	**10**
		b)	Derive Nusselt equation stating all the assumptions made.	*CO3*	*PO3*	**10**
			UNIT - IV			
	7	a)	Describe the working of a single effect forced circulation evaporator.	*CO3*	*PO3*	**10**
		b)	A single effect evaporator operates at 10 kN/m^2. Assess the heat transfer area required to concentrate 6000 kg/hr of caustic soda solution from 12% to 45% solution. Saturated steam is available at 400 K. The overall heat transfer coefficient may be considered as 1.25 kW/m^{2}K. The feed enters the evaporator at 305 K. The Boiling point elevation is 3.5°F.The specific heat of feed and product are 3.768 kJ/kg and 3.14 kJ/kg, respectively. Data: Enthalpy of vapor =2376.108 kJ/kg ; Enthalpy of liquid= 221.08 kJ/kg	*CO3*	*PO3*	**10**
			OR			
	8	a)	Write a note on the following: (i) Performance of evaporator (ii) Evaporator capacity (iii) Economy of evaporator (iv) Multiple effect evaporators.	*CO3*	*PO3*	**10**

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		b)	Describe the utilization of Duhring's chart to determine the boiling point elevation with a suitable example and a neat sketch.	*CO3*	*PO3*	**10**
			UNIT - V			
	9	a)	Define radiation, and explain the laws of radiation.	*CO4*	*PO2*	**12**
		b)	Write a note on radiation shields and view factors.	*CO4*	*PO2*	**08**
			OR			
	10	a)	Derive the equation for rate of heat transfer for the radiation between the two infinite parallel planes.	*CO4*	*PO2*	**12**
		b)	Compute the loss of heat by radiation from a metal tube of 80 mm diameter and 5 m length at 503 K, if the tube is in an exceptionally large brick room which is at 303 K.	*CO4*	*PO2*	**08**

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