U.S.N.										

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

Autonomous Institute Affiliated to VTU

December 2023 Supplementary Examinations

Programme: B.E. **Semester: IV**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 22CH4PCHTR **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 allowed.

			UNIT - I	*CO*	*PO*	Marks
1	a)		What are the various modes of heat transfer? Define the laws governing them.	*CO 1*	*PO 1*	**6**
	b)		A composite wall of a furnace is made of 20 cm fire clay brick having k = 0.8 W/m^{o}C, followed by 15 cm of earth brick having k = 0.74 W/m^{o}C, followed by an outer layer of common brick 10 cm thick having k = 0.69 W/m^{o}C. The inner and outer surface temperatures are 1050^{o}C and 150^{o}C, respectively. Calculate – i. Heat loss per unit area ii. Temperature at the interface of different layers iii. Temperature at a point 15cm from the outer surface into the wall	*CO 1*	*PO 1*	**14**
			UNIT - II			
2	a)		An electrical cable of 10 mm dia is exposed to atmosphere which is 20^{o}C. The estimated surface temperature of the cable due to heat generation is 65^{o}C. Find the maximum percentage increase in heat dissipation when the wire is insulated with rubber having k = 0.155 W/mK. Assume, h=8.5W/m^{2}K. The maximum heat dissipation occurs when it is insulated up to the critical thickness of insulation.	*CO 4*	*PO 2*	**8**
	b)		Explain fin efficiency and fin effectiveness.	*CO 3*	*PO 2*	**4**
	c)		Derive an expression to find the heat loss through a fin of infinite length with neat sketch.	*CO 3*	*PO 2*	**8**
			OR			
3	a)		What is critical thickness of insulation? Derive an expression for critical thickness for a cylinder.	*CO 4*	*PO 2*	**10**
	b)		Steel bearings with k=50 W/m K, and α=1.3 x10^{-5} m^2/s are to be heat treated to a temperature of 650^{o}C and then quenched in oil which is at a temperature of 55^{o}C. The ball bearings have a diameter of 4 cm. The convective heat transfer co-efficient is 300 W/m^2 ^{o}C. Determine the time required for the bearing to remain in oil before temperature drops to 200^{o}C.	*CO 3*	*PO 2*	**10**

			UNIT - III			
	4	a)	What is overall heat transfer coefficient? Show how it is related to individual heat transfer coefficient for heat transfer through a pipe.	*CO 2*	*PO 2*	**8**
		b)	Explain the method of evaluating LMTD correction factor using the charts.	*CO 2*	*PO 2*	**4**
		c)	Find out the heat transfer area required for a co- current heat exchanger which is used to cool 6.93 kg/s of ethyl alcohol (specific heat is 3810 J/kg ^oC) from 65.6^oC to 39.4^oC using 6.3 kg/s of water available at 10^oC. Assume that the overall heat transfer co-efficient based on the outer tube is 568 W/m K. The outer diameter of the tube is 25.4 mm.	*CO 3*	*PO 2*	**8**
			OR			
	5	a)	Compare film wise and drop wise condensation with suitable examples.	*CO5*	*PO 3*	**4**
		b)	A steam condenser consists of 16 tubes arranged in square array. Water flows through tubes at 65°C while steam at 75°C condenses over the tubes. Length of the tubes = 120cm, dia of the tubes = 25mm. Find the rate of condensation if: i. Tubes are kept horizontal ii. Tubes are kept vertical Properties of water at 70°C: Latent heat of steam=2300kJ/kg ρ=977.8 kg/m^3, Cp=4.187 kJ/kg K, k=0.668 W/mK, ν=0.415x10^{-6} m^2/s	*CO5*	*PO 3*	**10**
		c)	Illustrate by sketch the different regimes of boiling heat transfer phenomena.	*CO 5*	*PO 3*	**06**
			UNIT - IV			
	6	a)	Explain capacity, economy, and boiling point elevation relevant to evaporation.	*CO 5*	*PO 3*	**4**
		b)	Discuss the various methods used for feeding the multiple evaporation systems.	*CO 5*	*PO 3*	**6**
		c)	A single effect evaporator is to be used to concentrate a food solution containing 15% by mass dissolved solids to 50% solids. The feed stream enters the evaporator at 291 K with a feed rate of 1.0 kg/s. Steam is available at a pressure of 2.4 bar, and an absolute pressure of 0.07 bar is maintained in the evaporator. Assuming that the properties of the solution are the same as those of water, and taking the overall heat transfer coefficient to be 2300 W/m^{2}K, calculate the rate of steam consumption and the necessary heat transfer surface area.	*CO 5*	*PO 3*	**10**

			UNIT - V			
	7	a)	Explain Plank's law, Kirchoff's law, and Wien's displacement law.	*CO 1*	*PO 3*	**6**
		b)	Find out heat transfer rate due to radiation between two infinitely long parallel planes. One plane has emissivity of 0.4 and is maintained at 200°C. Other plane has emissivity of 0.2 and is maintained at 30°C. If a radiation shield, $\varepsilon = 0.5$ is introduced between the two planes, find percentage reduction in heat transfer rate and steady state temperature of the shield.	*CO 2*	*PO3*	**14**

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