U.S.N.										

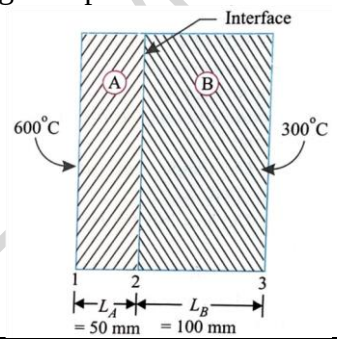
B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

August 2024 Semester End Main Examinations

Programme: B.E. **Semester: IV**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 23CH4PCHTR **Max Marks: 100**
Course: Process Heat Transfer

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

			CO	PO	Marks
		UNIT - I			
1	a)	Derive an expression for heat transfer through a hollow cylinder undergoing steady state heat conduction with uniform thermal conductivity.	*CO* 1	*PO2*	**10**
	b)	Find the steady state heat flux through the composite slab as shown in the figure and the interface temperature. Thermal conductivities of the two materials vary with temperature as given below: $k_A = 0.05(1 + 0.0065T)$ W/m°C, $k_B = 0.04(1 + 0.0076T)$ W/m°C where T is the average temperature of the slab in °C 	*CO1*	*PO2*	**10**
		UNIT - II			
2	a)	From the fundamentals, derive an expression for the temperature distribution and the heat transfer rate from a rectangular fin which is insulated at the tip.	*CO* 2	*PO2*	**12**
	b)	Calculate the critical radius of insulation for asbestos [K = 0.172 W/m. K] surrounding a pipe and exposed to the room temperature at 300 K with h = 2.8 W/m^2.K. Calculate the heat loss from 475 K, 60 mm diameter pipe when covered with the critical radius of insulation and without insulation.	*CO* 2	*PO2*	**08**
		OR			
3	a)	List the criteria for the selection of a good insulating material. List any three insulating materials.	*CO*1	*PO2*	**10**
	b)	What is critical insulation thickness? Derive an equation to determine the critical thickness of insulation of a cylinder.	*CO* 2	*PO2*	**10**

			UNIT - III			
	4	a)	Discuss in detail about heat transfer in film and drop wise condensation with the help of neat sketches.	***CO*** 3	***PO 3***	**10**
		b)	Derive the Nusselt's theory of laminar flow film condensation on a vertical plate to find an expression for film thickness.	***CO*** 3	***PO3***	**10**
			OR			
	5	a)	Explain the different regimes of boiling heat transfer phenomena with a neat sketch.	CO1	*PO2*	**10**
		b)	Discuss the concept of LMTD. Derive LMTD expression for counter-current heat exchangers. Enlist all the assumptions.	***CO*** 3	***PO3***	**10**
			UNIT - IV			
	6	a)	Write about the following i) Boiling point elevation ii) Capacity of an evaporator iii) Economy of an evaporator iv) Multiple-effect evaporators	***CO*** 3	***PO3***	**10**
		b)	An evaporator is operating at atmospheric pressure. It is desired to concentrate a feed from 5% solute to 20% solute [by weight] at a rate of 5000 kg/h. Dry saturated steam at a pressure corresponding to the saturation temperature of 399 K is used. The feed is at 298 K and the boiling point rise/elevation (BPR/BPE) is 5 K. The overall heat transfer coefficient is 2350 W/ (m^2 K). Calculate the economy of the evaporator and the area of the heat transfer to be provided, treating the solution as pure water and neglecting BPR. • The latent heat of condensation of steam at 399 K is 2185 kJ/(kg. K) • The Latent heat of vaporisation of/evaporation of water at 101.325 k Pa and 373 K = 2257 kJ/(kg. K) • Specific heat of feed= 4187 kJ/(kg. K)	***CO*** 3	***PO 3***	**10**
			UNIT - V			
	7	a)	Define the following terms i. Emissivity ii. Absorptivity iii. Transmissivity iv. Reflectivity	***CO*** 4	***PO2***	**10**
		b)	Liquid oxygen at atmospheric pressure (boiling point = 90 K) is stored in a spherical vessel of 300 mm outside diameter. The system is insulated by enclosing the container inside another concentric sphere of 500 mm inside diameter and the space between them is evacuated. Both the sphere surfaces are made of aluminium for which emissivity may be taken as 0.3. The temperature of the outer sphere is 313 K. i. Calculate the rate of heat flow due to radiation. ii. What will be the reduction in heat through if the polished aluminium with an emissivity of 0.05 is used for the container walls?	***CO*** 4	***PO2***	**10**

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