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: 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)	Derive an equation for steady state heat transfer through a composite wall, without heat generation and with constant thermal conductivity.	CO 2	PO 2	08
	b)	A furnace is constructed with thickness of 225 mm fire brick 120 mm of insulating brick and 225 mm of building brick. The inside temperature is 1200 K and outside temperature is 330 K. Find the heat loss per unit area and the temperature at the wall interface. Data: Thermal conductivity for fire brick is 1.4 W/mK Thermal conductivity for insulating brick is 0.2 W/mK Thermal conductivity for building brick is 0.7 W/mK	CO 3	PO 2	08
	c)	It is necessary to insulate a flat surface so that the rate of heat loss per unit area of the surface does not exceed 450 W/m^2. The temperature difference across the insulating layer is 400 K. Evaluate the thickness of insulation if i. The insulation is made up of asbestos cement having thermal conductivity of. 0.11 W/mK. ii. The insulation is made up of fire clay having a thermal conductivity of 0.84 W/mK.	CO 3	PO 2	04
		UNIT - II			
2	a)	Derive an expression for temperature profile and efficiency of an infinitely long rectangular fin.	CO 4	PO 2	12
	b)	One thousand spheres made of copper of diameter 3 mm are annealed in the annealing furnace. Initial temperature of the sphere is 20°C. Temperature of annealing furnace is 400°C. Given data: h = 30 kcal/m^2 h°C; C_p = 0.8 kcal/kg °C. Compute the time required for the spheres to reach a temperature of 300°C.	CO 3	PO 2	08
		OR			

	3	a)	Drive an equation for critical radius of insulation for spherical vessel insulated with a material of thermal conductivity K, state all assumptions	*CO 4*	*PO 2*	**10**
		b)	A steam pipe, 40 mm outside diameter is to be insulated by two layers of insulation, each 20 mm thick. The material A-1 has conductivity K, and material A-2 has conductivity 3 K. Assuming that the inner and outer surface temperatures of the composite insulation to be fixed, find which arrangement would give less heat loss rate, A-1 near pipe surface and A-2 as the outer layer or vice versa also calculate the percentage reduction in heat loss.	*CO5*	*PO 3*	**10**
			UNIT - III			
	4	a)	Derive an expression for overall heat transfer coefficient by stating all assumptions. Define fouling and write expression for overall heat transfer coefficient including fouling.	*CO5*	*PO 3*	**10**
		b)	Illustrate briefly the following i. Pool boiling ii. Dropwise and film wise condensation	*CO5*	*PO 3*	**10**
			OR			
	5	a)	Drive the expression of logarithmic mean temperature for counter flow heat exchanger, stating all the assumptions.	*CO 5*	*PO 3*	**08**
		b)	Derive Nusselt's equation for film wise condensation stating all the assumptions.	*CO 5*	*PO3*	**12**
			UNIT - IV			
	6	a)	Illustrate the working of natural circulation evaporators with neat labelled diagrams.	*CO 5*	*PO3*	**10**
		b)	An evaporator is operating at atmospheric pressure. It is desired to concentrate feed from 5% solute to 20% solute by weight at a rate of 5000 kg/h. Dry saturated steam at a pressure corresponding to saturation temperature of 399 K is used. The feed is at 290 K and boiling point elevation is 5 K. Overall heat transfer coefficient is 2350 W/m^2K. Compute the capacity, economy of evaporator and area of heat transfer to be provided. Data: Treating solution to be pure water and neglecting Boiling point. Latent heat of condensation of steam at 399 K is 2185 kJ/kg and latent heat of evaporation of water at atmospheric pressure and 373 K is 2257 kJ/kg. Specific heat of feed is 4.187 kJ/kgK.	*CO 5*	*PO3*	**10**
			UNIT - V			
	7	a)	Briefly elaborate on i. Wien's displacement law ii. Plank's law iii. Kirchhoff's law of radiation	*CO 1*	*PO1*	**10**
		b)	Two large plane surface A and B situated at 2.5 mm apart in air. Surface A has an emissivity of 0.16 and it is at temperature of 400 K. Surface B has an emissivity of 0.08 and surface temperature is 350 K. Compute the heat transfer rate by radiation between two surfaces. Given: $\sigma = 5.62 \times 10^{-8}$ W/m^2K^4	*CO 3*	*PO2*	**10**

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