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: Aerospace Engineering **Duration: 3 hrs.**
Course Code: 22AS4PCHMT **Max Marks: 100**
Course: Heat & Mass 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 Heat transfer data handbook 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)		Discuss the modes of heat transfer.	*CO1*	*PO1*	**06**
	b)		Derive 3-D conduction equation in Cartesian coordinates.	*CO1*	*PO*	**10**
	c)		The inner surfaces of a plane brick wall are at 60°C and the outer surface is at 35°C.Calculate the rate of heat transfer per m^2 of surface area of the wall, which is 220 mm thick. The thermal conductivity of brick is 0.51 W/m°C.	*CO1*	*PO1*	**04**
			OR			
2	a)		To measure the effective thermal conductivity of an opaque honeycomb material for an aircraft wall. A spherical shell of inner radius 26 cm and outer radius 34 cm was constructed and a 100W electric bulb placed in the center. At steady state, the temperature of the inner and outer surfaces were measured to be 339 and 311 K respectively. What is the effective conductivity of the material?	*CO2*	*PO2*	**05**
	b)		Explain (i) Critical radius of insulation (ii) Heat transfer in extended surfaces	*CO1*	*PO1*	**08**
	c)		Calculate the critical radius of insulation for asbestos (k=0.172W/m K) surrounding a pipe and exposed to room air at 300K. Calculate the heat loss from a 475K, 60 mm diameter pipe when covered with the critical radius of insulation and without insulation.	*CO*	*PO*	**07**
			UNIT - II			
3	a)		What is transient heat conduction? Derive an expression for lumped parameter analysis in terms of Biot number and Fourier number.	*CO2*	*PO2*	**10**

		b)	A 15 mm diameter mild steel sphere (k=42 W/m°C) is exposed to cooling air flow at 20°C resulting in a convective heat transfer coefficient h = 120 W/m^2°C. Determine the following i) Time required to cool the air from 550°C to 90°C ii) Instantaneous heat transfer rate 2 minutes after the start of cooling iii) Total energy transferred from the sphere during first 2 minutes. For mild steel take ρ = 7850 kg/m^3 C_p = 475 J/kg°C h = 120 W/m^2°C	*CO2*	*PO2*	**10**
			UNIT - III			
	4	a)	Explain free and forced convection.	*CO1*	*PO1*	**4**
		b)	Explain Reynolds number, Grashoff's number and Prandtl number. Discuss their significance	*CO1*	*PO1*	**8**
		c)	Air at 20°C is flowing over the flat plate which is 200 mm wide and 500 mm long. The plate is maintained at 100°C. Find the heat loss per hour from the plate if the air is flowing parallel to 500 mm side with 2 m/s velocity. What will be effect of heat transfer if the flow is parallel to 500 mm side?	*CO2*	*PO2*	**8**
			OR			
	5	a)	Discuss the Hydrodynamic and Thermal boundary layer.	*CO2*	*PO1*	**10**
		b)	A vertical cylinder 1.5 m high and 180 mm diameter is maintained at 100°C in an atmospheric environment at 20°C. Calculate the heat loss by natural convection from the surface of the cylinder. Assume properties of air at mean temperature as take ρ =1.06 kg/m^3, υ =18.97 x 10^{-6} m^2/s C_p = 1.004 kJ/kg°C, k = 0.1042kJ/mh°C	*CO3*	*PO2*	**10**
			UNIT - IV			
	6	a)	Define Stefan-Boltzmann law, Kirchhoff's law, Plank's law, Wein's displacement law and Lambert's cosine law	*CO1*	*PO1*	**10**
		b)	Calculate the net radiant heat exchange per m^2 area for two large parallel plates at temperatures 427°C and 27°C respectively ε (hot plate) = 0.9, ε (cold plate) = 0.6 If the polished aluminum shield is placed between them. Find the percentage reduction in heat transfer ε (shield) = 0.4.	*CO3*	*PO2*	**10**
			UNIT - V			
	7	a)	Explain Boiling regimes with neat diagram.	*CO4*	*PO1*	**06**
		b)	In a gas turbine power plant, heat is transferred in a plate-fin heat exchanger from the hot gases leaving the turbine to the air leaving the compressor. The air flow rate is 5000 kg/h and the flow rate of hot gases is 5075 kg/h. Take C_p on both sides as 1050 J/kg K. Hot fluid inlet = 450°C, cold fluid inlet = 170°C,	*CO3*	*PO2*	**08**

			overall heat transfer coefficient = 52 W/m^2K, Area = $50m^2$. Flow arrangement is single pass cross flow, both fluids unmixed. Calculate the outlet temperature and heat transfer rate.			
		c)	The flow rates of hot and cold water streams running through a parallel flow heat exchanger are 0.2 m/s and 0.5 m/s respectively. The inlet temperatures of hot and cold sides are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer coefficients on both sides are 650 W/m^2 °C. Calculate the area of the heat exchanger.	*CO3*	*PO2*	**06**

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