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

Autonomous Institute Affiliated to VTU

October 2024 Supplementary Examinations

Programme: B.E. | **Semester: VI**
Branch: Mechanical Engineering | **Duration: 3 hrs.**
Course Code: 22ME6PCHTR | **Max Marks: 100**
Course: 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. The Heat Mass Transfer Date hand book and steam tables are 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)	Explain the three modes of heat transfer with appropriate basic rate equations.	*CO1*	*PO1*	**06**
	b)	Derive an expression for general three-dimensional heat conduction equation in Cartesian coordinates and reduce it to Laplace equation.	*CO1*	*PO1*	**08**
	c)	A hallow cylinder 5 cm ID and 10 cm OD has an inner surface temperature of 200°C and an outer surface temperature 100°C. Determine the temperature of the point half way between the inner and the outer surfaces. If the thermal conductivity of the cylinder material of 70 W/m°C, determine the heat flow through the cylinder per meter length.	*CO2*	*PO2*	**06**
		OR			
2	a)	Derive expression for temperature distribution and heat dissipation in a straight fin for a rectangular profile for short fin insulated at the tip.	*CO1*	*PO1*	**10**
	b)	Write the relation for Fourier and Biot number relations and explain their physical significance.	*CO3*	*PO1*	**04**
	c)	A 120 mm diameter apple (ρ=990 kg/m^3; cp=4170 J/kg°C; k=0.58 W/m°C) approximately spherical in shape is taken from a 25°C environment and placed in a refrigerator where temperature is 6°C and average convective heat transfer coefficient over the surface of the apple is 12.8 W/m^2°C. Determine the temperature at the center of the apple after the period of 2 hours.	*CO3*	*PO2*	**06**
		UNIT - II			
3	a)	Define the terms 'Boundary layer thickness' and 'Displacement thickness'.	*CO4*	*PO1*	**04**
	b)	Derive the expression for boundary layer thickness, and local	*CO4*	*PO1*	**10**

			skin friction coefficient following Blasius method for the laminar flow over a flat plate			
		c)	A plate of length 750 mm and width 250 mm has been placed longitudinally in a stream of cruid oil which flows with a velocity of 5 m/s. If the oil has a specific gravity of 0.8 and kinematic viscosity of 1 stoke, calculate: i) Boundary layer thickness at middle of plate, ii) shear stress at the middle of the plate, and iii) Friction drag on one side of the plate.	*CO4*	*PO2*	**06**
			OR			
	4	a)	Air at 27°C is moving at 0.3 m/sec across a 100 W electric bulb at 127°C. If the bulb is approximated by a 10 cm diameter and 1 m high cylinder, estimate the heat transfer rate and percentage of power lost due to convection.	*CO4*	*PO2*	**10**
		b)	Water at 25°C flows across a horizontal copper tube 1.5 cm OD with a velocity of 2 m/s. Calculate the heat transfer rate per unit length if the wall temperature is maintained at 75°C. For this case use the following correlation for the calculation of film coefficient. $$\overline{Nu_D} = 0.3 + \frac{0.62\, {Re_D}^{1/2} Pr^{1/3}}{\left[1 + \left(\frac{0.40}{Pr}\right)^{2/3}\right]^{1/4}} \left[1 + \left(\frac{Re_D}{282000}\right)^{1/2}\right]$$ Given properties of water: ρ=988 kg/m^3, k=0.648 W/m°C, $\mu=549.2\times10^{-6}$ N-s/m^2, Cp=4.174 kJ/kg°C	*CO4*	*PO2*	**10**
			UNIT - III			
	5	a)	Derive the momentum equation for free convection flow over a vertical flat plate.	*CO4*	*PO1*	**10**
		b)	A sheet metal air duct carries air-conditioned air at an average temperature of 10°C. The duct size is 320 mm× 200 mm and length of the duct exposed to surrounding air at 30°C is 15 m long. Find the heat gained by the air in the duct. Assume 200 mm side is vertical and top surface of the duct is insulated. Take the following properties of the air at mean temperature of 20°C: C_p=100 J/kg°C; ρ=1.204 kg/m^3; $\mu=18.2\times10^{-6}$ N-s/m^2; $\vartheta = 15.1 \times 10^{-6}$ m^2/s; k=0.256 W/m K and Pr=0.71.	*CO4*	*PO2*	**10**
			UNIT - IV			
	6	a)	Write the differences for the below mentioned terms: i) A black body and grey body, ii) Specular and diffuse surface, and iii) Absorptivity and emissivity.	*CO6*	*PO1*	**06**
		b)	State and prove Kirchhoff's law of radiation.	*CO6*	*PO1*	**06**
		c)	A square room 3m × 3 m, has a floor heated to 27^0 C and has a ceiling ay 10^0 C. The walls are assumed to be perfect insulated. The height of the room is 2.5 m. The emissivity of all the surfaces is 0.8. Determine the following: i) Net heat exchange	*CO6*	*PO2*	**08**

			between the floor and the ceiling; ii) Wall temperature. Assume ceiling to floor shape factor as 0.25			
			UNIT - V			
	7	a)	Discuss: i) Fouling factor, and ii) NTU method	*CO5*	*PO1*	**04**
		b)	Derive an expression for effectiveness of parallel-flow heat exchanger in terms of N and C. Where N is NTU and C is Capacity ratio.	*CO5*	*PO2*	**08**
		c)	The following data is given for counter-flow heat exchanger: m_h=1 kg/sec m_c=0.25 kg/sec C_{ph}=1.045 kJ/kg ^oC C_{pc}=4.18 kJ/kg ^oC t_{h1}=1000^oC t_{c2}=850^oC; U=88.5 W/m^2 ^oC; A=10 m^2 Calculate t_{h2} and t_{c1}. Subscript 'h' and 'c' stands for cold and hot fluid respectively.	*CO5*	*PO2*	**08**

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