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

Autonomous Institute Affiliated to VTU

June / July 2024 Semester End Main Examinations

Programme: B.E. **Semester: V**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 16ME5DCFHT **Max Marks: 100**
Course: Fundamentals of 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. Heat and mass transfer data Hand book 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)	Explain briefly the following : i) Thermal conductivity, ii) Thermal diffusivity, iii) Thermal contact resistance, and iv) Fin efficiency	*CO1*	*PO1*	**08**
	b)	Write down the 3-D conduction equation in Cartesian coordinates and deduce it to any 3special cases**.**	*CO1*	*PO1*	**04**
	c)	The temperature distribution across a large concrete slab of 50 cm thick heated from one side as measured by thermocouples approximate to the relation $T = 60 - 50x + 12x^2 + 20x^3 - 15x^4$, where T is in °C and x is in meter, considering area of $5m^2$, Compute, (i) Heat entering and leaving the slab (ii) Heat energy stored in unit time, for concrete take k = 1.2 W/mK.	*CO2*	*PO2*	**08**
		OR			
2	a)	Define critical thickness of insulation and derive critical radius relation for a cylinder.	*CO2*	*PO1*	**08**
	b)	Derive the equations for lumped capacitance analysis and obtain the temperature distribution in terms of Biot and Fourier numbers.	*CO3*	*PO1*	**06**
	c)	A solid copper sphere of 10 cm diameter [ρ=8954 kg/m^3 ; C_p = 383J/kg K, k= 386 W/mK]. Initially at a uniform temperature t_i = 250ºC, is suddenly immersed in a well stirred fluid which is maintained at a uniform temperature ta = 50ºC. The heat transfer co-efficient between sphere and fluid is h = 200 W/m^{2}K. Determine the temperature of copper block at τ= 5 min after the immersion.	*CO3*	*PO2*	**06**
		UNIT - II			
3	a)	Define the following dimensionless numbers and give their physical significance. (i) Reynolds number, (ii) Nusselt number.(iii) Grashof Number, and (iv) Prandtl number	*CO4*	*PO2*	**10**
	b)	Assuming that a man can be represented by a cylinder 350mm in diameter and 1.65m high with a surface temperature of 28ºC. Calculate the heat he would lose while standing in a 30 km/h wind at 12 ºC.	*CO4*	*PO3*	**10**

			OR			
	4	a)	With a neat sketch derive the momentum equation for a flow over a two dimensional flat plate.	*CO4*	*PO1*	**08**
		b)	Explain clearly the concept of velocity and thermal boundary layers with appropriate sketches.	*CO4*	*PO2*	**06**
		c)	In a straight tube of 60 mm diameter, water is flowing at a velocity of 12 m/s. the tube surface temperature is maintained at 70 ºC and the flowing water is heated from the inlet temperature 15 ºC to an outlet temperature of 45 ºC. Calculate the following: (i) the heat transfer co-efficient from the tube surface to the water, (ii) The heat transferred, and (iii) The length of the tube.	*CO4*	*PO2*	**06**
			UNIT - III			
	5	a)	Draw the laminar and turbulent velocity boundary layer for vertical plate for natural convection for followings a) $T_w > T\infty$ b) $T_{w} < T\infty$	*CO4*	*PO3*	**06**
		b)	A 50 cm long fine wire of 0.02 mm diameter is maintained constant at 54°C by an electric current when exposed to air at 0°C. Find the electric power necessary to maintain the wire at 54°C.	*CO4*	*PO2*	**06**
		c)	A vertical cylinder 1.5 m high and 180 mm in diameter is maintained at 100°C in an atmospheric environment of 20°C. Calculate heat loss by free convection from the surface of the cylindr. Assume properties of air at mean temperature as , ρ= 1.06 kg/m^3, ν=18.6x10^{-6}, Cp= 1.004 kJ/Kg°C and k=0.1042 kJ/mh°C.	*CO4*	*PO2*	**08**
			UNIT - IV			
	6	a)	State and explain followings: i) Stefan Boltzmann's law, ii) Plane and Solid Angle iii) Radiation of black body as a function of wavelength and temperature, and iv) Radiation shield.	*CO5*	*PO1*	**10**
		b)	With figure explain distinct characteristics of black body radiation for $(E_\lambda)_b$ is a function of temperature and wavelength and also deduce the condition for the maximum monochromatic emissive power for the black body.	*CO5*	*PO2*	**10**
			UNIT - V			
	7	a)	Derive an expression for LMTD method for Counter flow heat exchanger.	*CO6*	*PO1*	**10**
		b)	In a certain double pipe heat exchanger hot water flows at a rate of 50000 kg/h and gets cooled from 95°C to 65°C. At the same time 50000 kg/h of cooling water at 30°C enters the heat exchangers. The flow conditions are such that overall heat transfer co-efficient remains constant at 2270 W/m^{2}K. Determine the heat transfer area required and effectiveness, assuming two streams are in parallel flow. Assume for the both streams C_p = 4.2 kJ/kgK	*CO6*	*PO3*	**10**

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