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

Autonomous Institute Affiliated to VTU

June 2025 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.

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)		Derive the generalized heat conduction equation with internal heat generation in Cartesian co-ordinate system.	*CO1*	*PO1*	**10**
	b)		Explain the modes of heat transfer with suitable example of each.	*CO1*	*PO1*	**06**
	c)		A long hollow cylinder (k = 50 W/m.K) has an inner radius of 10 cm, and outer radius of 20 cm. The inner surface is heated uniformly at constant rate of 1.16×10^5 W/m^2 and outer surface is maintained at 30°C. Calculate the temperature of inner surface.	*CO1*	*PO1*	**04**
			OR			
2	a)		A 240 mm steam pipe, 210 meters long is covered with 50 mm of high temperature insulation (k=0.0925 W/m K) and 40 mm of low temperature insulation (k=0.062 W/m K). The inner and outer surface temperature are measured are 390^0 C and 40^0 C. Calculate the total heat loss per hour, heat loss per m^2 of the pipe, temperature between 2 insulation layers.	*CO1*	*PO1*	**06**
	b)		A square plate heater (15 cm x 15 cm) is inserted between two slabs. Slab 'A' is 2 cm thick (k=50 W/m K) and slab 'B' is 1 cm thick (k=0.2 W/m K). The outer heat transfer coefficient on side 'A' and side 'B' are 200 W/m^2 K and 50 W/m^2 K respectively. The temperature of the surroundings is 25^0C. If rating of the heater is 1 kW. Determine maximum temperature of the system and outer surface temperature of two slabs.	*CO1*	*PO1*	**06**
	c)		An egg with mean diameter as 40 mm initially at 20^0 C is placed in boiling water and found to be boiled as per consumer taste. For how long should it take for similar egg to get boiled at the same state for the same person if the egg has taken from a refrigerator at 5^0C. Use k=10 W/m K; density=1200 kg/m^3; C=2 kJ/kg K; h=100 W/m^2 K)	*CO1*	*PO1*	**08**

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			UNIT - II			
	3	a)	Explain thermal boundary layer formation with appropriate relations over a flat plate.	*CO1*	*PO1*	**06**
		b)	Differentiate between free and forced convection kind of heat transfer.	*CO1*	*PO1*	**04**
		c)	Define and obtain the formulations for, i) Biot number, ii) Fourier number, iii) Grashoff number, iv) Nusselt number, and v) Prandtl number.	*CO1*	*PO1*	**10**
			OR			
	4	a)	Explain velocity boundary layer formation with appropriate relations over a flat plate.	*CO1*	*PO2*	**08**
		b)	Derive integral momentum equation for hydrodynamic boundary layer over a flat plate.	*CO1*	*PO2*	**12**
			UNIT - III			
	5	a)	Differentiate between laminar and turbulent flow.	*CO2*	*PO2*	**06**
		b)	Assuming a man as a cylinder with 350 mm diameter and 1.65 m height at a surface temperature of 28^0C. Calculate the heat he would lose standing in wind at 30 km per hour at 12^0C.	*CO2*	*PO2*	**06**
		c)	Air at 20^0C and at a pressure of 1 bar id flowing over a flat plate at a velocity of 3 m/s. If the plate is 280 mm wide and at 56^0C, calculate following quantities at x=280 mm. Use density=1.13 kg/m^3; k=0.027 W/m K; C_p=1.005 kJ/kg K; Pr=0.70, kinematic viscosity=16.768 x10^{-6} m^2/s. i) Boundary layer thickness; ii) Local friction coefficient iii) Average friction coefficient; iv) Shearing due to friction v) Thickness of boundary layer; vi) Average convective heat transfer coefficient; vii) Rate of heat transfer by convection	*CO2*	*PO2*	**08**
			OR			
	6	a)	What is hydraulic diameter in case if internal flows. Justify with two different examples.	*CO2*	*PO2*	**06**
		b)	When 0.6 kg of water per minute is passed through a tube of 2 cm diameter, it is found to be heated from 20^oC to 60^oC. the heating is achieved by condensing steam on the surface of the tube and subsequently the surface temperature of the tube is maintained at 90^o C. Determine the length of the tube required for fully developed flow.	*CO2*	*PO2*	**06**
		c)	Air at 25^o C flows past a flat plate at 2.5 m/s. the plate measures 600 mm x 300 mm and is maintained at a uniform temperature at 95^oC. Calculate the heat loss from the plate, if the air flows parallel to the 600 mm side. How would this heat loss be affected if the flow of air is made parallel to the 300 mm side?	*CO2*	*PO2*	**08**

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			UNIT - IV			
	7	a)	Explain black body, grey body, and white body for radiation heat transfer.	*CO2*	*PO2*	**06**
		b)	What is view factor in radiation. Quantify with an example of two infinitely long directly opposed parallel plates.	*CO2*	*PO2*	**06**
		c)	Two large plates are maintained at a temperature of 900 K and 500 K respectively. Each plate has area of 6 m^2. Compare the net heat exchange between the plates for the following cases. (i) Both plates are black; (ii) Plates have an emissivity of 0.5.	*CO2*	*PO2*	**08**
			OR			
	8	a)	Explain absorptivity, reflectivity, and transmissivity for radiation heat transfer.	*CO2*	*PO2*	**06**
		b)	Explain emissivity, monochromatic emissivity, and intensity of radiation.	*CO2*	*PO2*	**06**
		c)	Find out heat transfer rate due to radiation between two infinitely long parallel planes. One plane has emissivity of 0.4 and is maintained at 200°C. Other plane has emissivity of 0.2 and is maintained at 30°C. If a radiation shield (ε=0.5) is introduced between the two planes, find percentage reduction in heat transfer rate and steady state temp of the shield.	*CO2*	*PO2*	**08**
			UNIT - V			
	9	a)	Derive the log-mean temperature difference (LMTD) equation for counter flow heat exchanger.	*CO2*	*PO2*	**10**
		b)	Hot exhaust gases, which enter a finned-tube, cross-flow heat exchanger at 300°C and leave at 100°C, are used to heat pressurized water at a flow rate of 1 kg/s from 35 to 125°C. The exhaust gas specific heat is approximately 1000 J/kg. K, and the overall heat transfer coefficient based on the gas-side surface area is U_h = 100 W/m^2. K. Determine the required gas-side surface area using the NTU method.	*CO2*	*PO2*	**10**
			OR			
	10	a)	Derive the log-mean temperature difference (LMTD) equation for parallel flow heat exchanger.	*CO2*	*PO2*	**10**
		b)	A counterflow, concentric tube heat exchanger is used to cool the lubricating oil for a large industrial gas turbine engine. The flow rate of cooling water through the inner tube (Di = 25 mm) is 0.2 kg/s, while the flow rate of oil through the outer annulus (Do = 45 mm) is 0.1 kg/s. The oil and water enter at temperatures of 100 and 30°C, respectively. How long must the tube be made if the outlet temperature of the oil is to be 60°C?	*CO2*	*PO2*	**10**

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