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CBCS SCHEME

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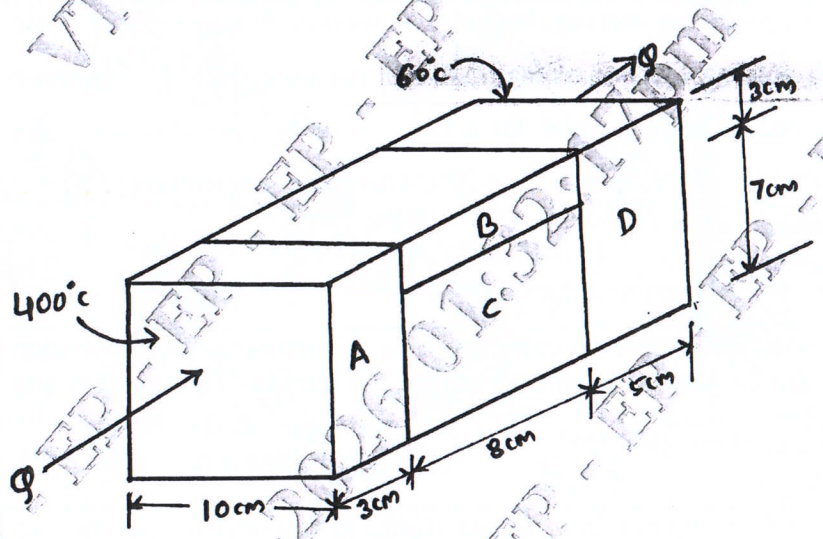
BME601

Sixth Semester B.E./B.Tech. Degree Examination, June/July 2026
Heat Transfer

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

		Module – 1	M	L	C
Q.1	a.	Explain the three types of boundary conditions in conduction heat transfer with examples.	6	L2	CO1
	b.	Write basic laws governing each mode of heat transfer along with mathematical expression.	6	L1	CO1
	c.	Find the heat flow rate through the composite wall shown in Fig Q1(c). Assume one dimensional conduction. Thermal conductivities of slabs A, B, C and D are 150, 30, 65 and 50 W/m°C respectively.  Fig Q1(c)	8	L4	CO1
		OR			
Q.2	a.	Derive an expression for the temperature distribution through the plane wall with uniform thermal conductivity. (Assume no energy generation)	6	L3	CO1
	b.	Explain the experimental procedure for determining overall heat transfer coefficient for a composite wall made up of three different materials with suitable sketch tabulation of reading and formulae.	6	L3	CO1

	c.	An iron plate of thickness L with thermal conductivity 'K' is subjected to a constant uniform heat flux q_0 W/m^2 at the boundary surface at X = 0. From the other boundary surface at X = L heat is dissipated by convection in to a fluid at temperature T_∞ with a heat transfer coefficient 'h'. Develop expression for the determination of the surface temperature T_1 and T_2 at the surface X = 0 and X = L respectively. Calculate surface temperature T_1 and T_2 for L = 2 cm, K = 20 W/m °C, $q_0 = 10^5$ W/m^2, T_∞ = 50°C, h = 500 W/m^2 °C	8	L4	CO1
		Module – 2			
Q.3	a.	With usual notations derive an expression for temperature distribution for Fin with insulated tip state the assumption made.	10	L3	CO3
	b.	Handle of a spoon has rectangular cross – section 5 mm × 2mm. Find length required so that its end temperature will not exceed 25° C even when spoon is dipped in boiling water for a long time. Assume long fin. Take K = 39 W/m°C, h = 10 W/m^2 °C, T_∞ = 20°C (Ambient temperature)	10	L4	CO3
		OR			
Q.4	a.	With usual notations derive an expression for the temperature distribution through a body for lumped parameter analysis in terms of Biot number and Fourier number.	10	L3	CO3
	b.	A 50 cm × 50 cm copper slab, 6 mm thick, at uniform temperature of 350°C, suddenly has its surface temperature lowered to 30 °C. Find the time at which the slab temperature becomes 100°C. Given : ρ = 9000 Kg/m^3, C_p = 0.38 kJ/Kg K, K = 370 W/mK, h = 100 W/m^2 K. Find out the rate of cooling after 60 seconds.	10	L4	CO3
		Module – 3			
Q.5	a.	Explain the finite difference formulation of one dimensional steady state conduction for a plane wall using energy balance approach.	10	L3	CO1

	b.	A large plate of thickness L = 4 cm having thermal conductivity K = 28 W/m°C in which heat is generated uniformly at a constant rate of $q_{gm} = 5 \times 10^6$ W/m^3. One end of the plate is maintained at 0 °C and other end is subjected to environment at T_∞ = 30°C, with heat transfer coefficient of h = 45 W/m^2 °C. Considering three nodes as two nodes at the boundary and one in the middle. Determine the surface temperature of the plate for steady state conditions using finite difference approach.	10	L4	CO1
		OR			
Q.6	a.	Explain the following : i) Stefan Boltzmann law ii) Kirchhoff's law iii) Wein's displacement law	6	L2	CO3
	b.	Explain the following : i) Absorptivity ii) Reflectivity iii) Transmissivity	6	L2	CO3
	c.	A long pipe 50 mm in diameter passes through a room and is exposed to air at 20°C. Pipe surface temperature is 93°C. Emissivity of the surface is 0.6. Calculate the net radiant heat loss per meter length of pipe.	8	L4	CO3
		Module – 4			
Q.7	a.	Explain with sketch development of velocity boundary layer and thermal boundary layer over a smooth flat plate.	10	L3	CO2
	b.	Dry air at atmospheric pressure and 20°C is flowing with a velocity of 3 m/s along the length of a long, flat plate 0.3 m wide maintained at 100°C. Calculate the following granitites at X = 0.3 m i) Boundary layer thickness ii) Local friction coefficient iii) Thickness of thermal boundary layer	10	L4	CO2
		OR			
Q.8	a.	Define the following Dimensionless parameters i) Nusselt number ii) Prandtl number iii) Reynold number iv) Stanton number v) Grashoff number	10	L1	CO2

	b.	Calculate the total heat loss from a human body, assuming as vertical cylinder, 30 cm in diameter and 175 cm in height stand in still air at 13°C. Take the skin temperature as 37°C and emissivity as 0.4.	10	L4	CO2
		Module – 5			
Q.9	a.	Explain the different regimes of boiling curves of water.	10	L4	CO4
	b.	Saturated steam at T_{sat} = 90°C (P = 70.14 KPa) condenses on the outer surface of a 1.5 m long 2.5 m outer diameter, vertical tube maintained at a uniform temperature T_∞ = 70 °C. Assume film condensation. Calculate : i) Local heat transfer coefficient at the bottom of tube ii) Average heat transfer coefficient over the entire length of the tube.	10	L3	CO4
		OR			
Q.10	a.	Derive an expression for Logarithmic Mean Temperature Difference (LMTD) for counter flow heat exchanger. State the assumption made.	10	L3	CO4
	b.	Engine oil is to be cooled from 80 °C to 50 °C by using a single pass counter flow concentric tube heat exchanger with cooling water available at 20 °C. Water flows inside a tube with an inner diameter of 2.5 cm at a rate of M_w = 0.08 Kg/s and oil flows through the annulus at a rate of M_{oil} = 0.16 Kg/s. The heat transfer coefficient for the water side and oil side are h_w = 1000 W/m^2 °C, h_{oil} = 80 W/m^2 °C. The fouling factor are F_w = 0.00018 m^2 °C/W and F_{oil} = 0.00018 m^2 °C/W, Tube wall resistance is negligible. Calculate the tube length required. C_w = 4180 J/Kg °C, C_{oil} = 2090 J/Kg °C	10	L4	CO4

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