CBCS SCHEME

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BAU601

Sixth Semester B.E./B.Tech. Degree Examination, June/July 2025

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.
3. Use of Heat data hand books and thermodynamic data hand book is allowed.

		Module – 1	**M**	**L**	**C**
Q.1	**a.**	With an illustrative sketch explain the combined heat transfer mechanism.	**10**	**L2**	**CO2**
	b.	In an experiment, an electric current is passed through a 1 mm diameter wire of 100 mm length. The wire is submerged in liquid water and the current is increased while water starts boiling. Determine the power to be supplied to the wire to maintain a surface temperature of 120°C. Assume the heat transfer coefficient = 5 kW/m^2K and the water temperature is 90°C.	**10**	**L3**	**CO3**
		OR			
Q.2	**a.**	Derive an expression for one dimensional heat conduction equation without heat generation through a plane wall.	**10**	**L2**	**CO2**
	b.	A heat exchanger has a maximum temperature of wall at 810 K. Determine the maximum possible unit thermal resistance per m^2 area of the metallic wall separating the hot and cold gases. The hot gas temperature is 1200 K and the coolant temperature is 300 K. Assume the hot and cold side heat transfer coefficient are respectively 200 W/m^2 K and 400 W/m^2 K.	**10**	**L3**	**CO3**
		Module – 2			
Q.3	**a.**	Derive an expression for one dimensional fins equation without heat generation for fins of uniform cross section.	**10**	**L2**	**CO1,2**
	b.	One half of a long solid 25 mm diameter rod was inserted into a furnace while the other half was projecting into air at 27°C. After steady state had been reached, the temperature of two points 7.6 cm apart were measured and found to be 126°C and 91°C respectively. The heat transfer coefficient over the surface of the rod exposed to air was estimated to be 22.7 W/m^2 K. Determine the thermal conductivity of the rod.	**10**	**L3**	**CO3**
		OR			
Q.4	**a.**	Prove that the temperature T of the body of any time 't' during Newtonian heating or cooling is given by $\frac{\theta}{\theta^0} = e^{-B_i \cdot F_o}$. Where B_i = Biot number, F_o = Fourier number.	**10**	**L2**	**CO1,2**
	b.	A very thin glass walled 0.3 cm diameter mercury thermometer is placed in air where heat transfer coefficient is 57 N/m^2 K. Consider cylindrical thermometer bulb of mercury with K = 8.9 W/mK and α = 0.0166 m^2/h. Find the time required for the temperature change to reach half its final value.	**10**	**L3**	**CO3**

		Module – 3			
Q.5	**a.**	Using dimensional analysis demonstrate that for natural convection heat transfer $N_u = f(R_e, G_r)$ where N_u = Nusselt number, R_e = Reynolds number G_r = Grashoff number.	**10**	**L2**	**CO3**
	b.	A thin 20 cm diameter plate kept horizontally at 120°C in a large body of water at 80 °C. The plate convects heat from both top and bottom surfaces. Determine the heat input to the plate to maintain the temperature of 120 °C.	**10**	**L3**	**CO3**
		OR			
Q.6	**a.**	Define : i) Reynolds number ii) Prandtl number iii) Nusselt number iv) Stanton number. Write the relevant equations and their significance.	**10**	**L2**	**CO1,3**
	b.	Air at 20 °C is flowing over a hot plate which is 20 cm wide and 50 cm long. The plate is kept at 100 °C. Find the heat loss per hour from the plate if air is flowing parallel to 50 cm side with 2 m/s velocity. Take properties of air at 60 °C as $\gamma = 18.97 \times 10^{-6}$ m²/s, K = 0.025 W/m°C, $P_r = 0.7$. Take, $N_{u_m} = 0.664, R_e^{1/2}, P_r^{1/3}$.	**10**	**L3**	**CO3**
		Module – 4			
Q.7	**a.**	Derive an expression for effectiveness by NTU method for parallel flow heat exchangers.	**10**	**L3**	**CO3**
	b.	A shell and tube heat exchanger having two tube passes and a single shell pass to condense steam. Water flows at 15 Kg/s and was heated from 60 °C to 80 °C. The steam condenses at 140 °C and the overall heat transfer coefficient of heat exchanger is 820 W/m²K. Determine the length of the tubes required if there are 45 tubes of 27.5 mm outer diameter. Assume C_p = 4190 J/Kg.K for water 70 °C.	**10**	**L4**	**CO4**
		OR			
Q.8	**a.**	Air free saturated steam at T_v = 65°C condenses on the surface of horizontal tube with an OD of 25 mm, maintained at uniform wall temperature T_w = 35 °C. Determine the tube length L for a condensate flow of 6×10^3 Kg/s per tube.	**10**	**L3**	**CO3**
	b.	With the help of a typical experimental boiling curve, explain the different regimes of pool boiling.	**10**	**L4**	**CO4**
		Module – 5			
Q.9	**a.**	State and explain i) Stefan –Boltzman law ii) Kirchoff's law iii) Wein's displacement law of radiation.	**10**	**L2**	**CO2**

	b.	A flat black surface of area $A_1 = 1\ cm^2$ emits 1 $KW/m^2.sr$ in the normal direction. A small surface A_2 having same area as A_1 is placed at a distance of 0.5m subtending at an angle of 60°C normal to surface A_1 relative to A_1. Determine the solid angle subtended by A_2 and the rate at which A_2 is irradiated by A_1.	10	L3	CO4
		OR			
Q.10	a.	Obtain an expression for the rate of heat transfer when radiation shield is introduced between two parallel plates.	10	L2	CO2
	b.	A radiation shield is placed between two parallel plates one at 1000 K with emissivity 0.8 and the other at 300 K having emissivity 0.6. The shield has emissivity as 0.1 on the side facing hot plate and 0.3 on the side facing cold plate. Calculate the percentage reduction in radiation heat transfer due to the shield.	10	L3	CO4

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