Model Question Paper-1 with effect from 2022-23 (CBCS Scheme)

USN

Sixth Semester B.E. Degree Examination

HEAT TRANSFER

TIME: 03 Hours **Max. Marks: 100**

Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.
02. M: Marks, L: Blooms Level, C: Course outcomes
03. Use of Heat Transfer Data Hand Book, Thermodynamics Data Hand Book and Steam Tables are permitted.
04. Assume missing data suitably

		Module-1	M	L	C
Q.01	a	Explain the different modes of heat transfer with examples	6	L2	CO1
	b	Explain the concept of thermal contact resistance	4	L2	CO1
	c	A composite slab made of three layers 15 cm, 10 cm and 12 cm thickness. The first layer is of material with k=2.5 W/mK, and occupies 60% of area and the rest is of k=1.45 W/mK. The second layer is made of material 12.5 W/mK for 50% area and remaining is of material with k=18.5 W/mK. The third layer is of single material with k=0.76 W/mK. The slab is exposed to warm air at 26°C and cold air is -20°C on the outer side. The convective coefficients are 15 and 20 W/m^{2}K on the inside and outside respectively. Estimate heat flow and interface temperatures.	10	L3	CO1
		OR			
Q.02	a	Derive the expression for critical radius of insulation of cylinder	6	L3	CO1
	b	Explain the experimental method of determining the thermal conductivity of a metal rod.	6	L2	CO1
	c	A 1 mm diameter electric wire is covered with 2 mm thick layer of insulation (k=0.5 W/mK). Air surrounding the wire at 25°C and h=25 W/m^{2}K, the wire temperature is 100°C. Find: (i) The rate of heat dissipation forms the wire per unit length with and without insulation. (ii) The critical radius of insulation (iii) The maximum value of heat dissipation.	8	L3	CO1
		Module-2			
Q.03	a	Derive an expression for the temperature distribution for a long fin of uniform cross section with insulated tip.	10	L3	CO2
	b	A copper fin (k=396 W/mK) 0.25 cm in diameter protrudes from a wall at 95°C into ambient air at 25°C. The heat transfer coefficient by free convection is equal to 10 W/m^{2}K. Find the heat loss if (a) the fin is infinitely long, (b) the fin is 2.5 cm long and the coefficient at the end is the same as around the	10	L3	CO2

		circumference			
OR					
Q.04	**a**	Define Biot number and Fourier number and explain their significance in transient heat conduction	**08**	**L2**	**CO2**
	b	An ordinary egg can be approximately as sphere of 5 cm diameter. The initial temperature of egg is 5°C before it is dropped into 95°C water with convective heat transfer coefficient of 1200 W/m^2 °C/. Assume the egg properties to be same as that of water and evaluate the time required for the centre of egg to attain a temperature of 70°C.	**12**	**L3**	**CO2**
Module-3					
Q.05	**a**	Explain the finite difference formulation of differential equation of 1-D steady heat conduction	**10**	**L2**	**CO3**
	b	What are the limitations of analytical solution used in the engineering problem? Discuss the advantages of numerical method over analytical method.	**10**	**L2**	**CO3**
OR					
Q.06	**a**	Write a brief note on the concept of black body	**4**	**L2**	**CO3**
	b	State and explain (i) Kirchhoff's Law (ii) Planks law (iii) Stefan-Boltzmann law	**6**	**L2**	**CO3**
	c	A long steel rod 20 mm in diameter is to be heated from 427°C to 538°C. It is placed concentrically in a long cylinder furnace which has an inside diameter of 160 mm. the inner surface of the furnace is at a temperature of 1093°C and has an emissivity of 0.85. If the surface of the rod has an emissivity of 0.6, estimate the time required for the heating operation. Take the density of steel as 7800 kg/m^3 and its specific heat is 0.67 kJ/kg K	**6**	**L3**	**CO3**
Module - 4					
Q. 07	**a**	Explain the development of boundary layer over a flat plate with different zones	**10**	**L3**	**CO4**
	b	Atmospheric air at 100°C enters a 0.04 m diameter, 2m long tube with a velocity of 9 m/s. A 1 kW electric heater wound on the outer surface of the tube provide a uniform heat flux to the tube. Find (i). the mass flow rate of air. (ii). Exit temperature of air. (iii). The temperature of the tube at outlet	**10**	**L2**	**CO4**
OR					

Q.08	**a**	Define the following non dimensional numbers and explain their significance: (i) Reynolds number (ii) Prandtl number (iii) Nusselt number (iv) Grashoff's number (v) Stanton number	**10**	**L2**	**CO4**
	b	A sheet metal air duct carries air-conditioned air at an average temperature of 10°C. the duct size is 320 mm x 200 mm and length of the duct exposed to the surrounding air at 30°C is 15 m long. Find the heat gain by the air in the duct. Assume 200 mm side is vertical and top surface of the duct is insulated. Use the following properties. $Nu = 0.6(Gr.Pr)^{0.25}$ for vertical properties $Nu = 0.27\ (Gr.Pr)^{0.25}$ for horizontal surface Take the properties of the air at mean temperature of (30+10)/2= 20°C as given below; $Cp = 100\ J/kg\ K$; $\rho = 1.204\ kg/m^3$, $\mu = 18.2 \times 10^{-6}\ N - s^2/m$, $\nu = 15.1 \times 10^{-6} m^2/s$ $k = 0.256\ W/mK$, $Pr = 0.71$	**10**	**L3**	**CO4**
Module-5					
Q.09	**a**	Discuss the regimes of pool boiling curve	**10**	**L2**	**CO5**
	b	The outer surface of a vertical cylinder drum of 350 mm diameter is exposed to saturated steam at 20 bar for condensation. If the surface temperature of the drum is maintained at 80°C, calculate (i) the length of the drum and (ii) the thickness of the condensate layer to condense 70 kg/h of steam	**10**	**L3**	**CO5**
OR					
Q.10	**a**	Derive the equations for LMTD for a parallel flow heat exchangers	**10**	**L3**	**CO5**
	b	A 4 kg/s product stream from a distillation column is to be cooled by a 3 kg/s water stream in a counter flow heat exchanger. The hot and cold stream inlet temperatures are 400 K and 300 K respectively and the area of the exchangers is 30 m^2. If the overall heat transfer coefficient is estimated to be 820 W/m^2K, determine the product stream outlet temperature if its specific heat is 2500 J/kg K and the coolant outlet temperature	**10**	**L3**	**CO5**