CBCS

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Sixth Semester B.E. Degree (CBCS) Examination
Heat transfer -Model Question Paper – 2

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing one full question from each module.
Use of heat transfer data hand book permitted.

Important Note: 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written e.g, 38+2 = 40, will be treated as malpractice.

		MODULE – I	
1	a	Derive an expression for general three dimensional heat conduction equation for general three dimensional heat conduction equation in cylindrical coordinate.	(08Marks)
	b	A composite cylindrical wall is composed of two materials of thermal conductivity KA and KB. A thin electric resistance heater for which interfacial contact resistances are negligible separates the two materials. Liquid pumped through the inner tube is at temperature Ti with the inside surface heat transfer coefficient hi. The outer surface of the composite wall is exposed to an ambient at a uniform temperature To with a surface heat transfer coefficient ho. Under steady state conditions a uniform heat flux of qh is dissipated by the heater. I. Sketch the equivalent thermal circuit for the composite wall and express all thermal resistances in terms of the relevant variables. II. Obtain an expression that may be used to determine the temperature of the heater	(08Marks)
		OR	
2	a	A furnace wall is made of composite wall of total thickness 550mm. The inside layer is made of refractory material (K = 2.3W/mK) and outside layer is made of an insulating material (K = 0.2W/m-K). The mean temperature of the glass inside the furnace is 900°C and interface temperature is 520°C. The heat transfer coefficient between the gases and the inner surface is taken as 230W/m2-°C and between the outside surface and atmosphere as 46 W/m2-°C. Taking air temperature as 30°C, calculate (i) required thickness of each layer, (ii) the rate of heat loss per square meter area.	(08Marks)
	b	A hollow sphere of pure iron contains a liquid mixture which releases 8000 watts .inside diameter of the sphere is 120mm and outside diameter of the sphere is 240mm. Steady state conditions prevail and outside surface temperature of the sphere is 600C. Determine the temperature at a location 30mm from the outside surface of the sphere. Assume material of sphere has a thermal conductivity of 75W/mk and the heat released by chemical mixture is constant.	(08Marks)
		MODULE – II	
3	a	Define critical thickness of insulation. A 3mm diameter and 5m long electric wire is tightly wrapped with a 2mm thick plastic cover whose thermal conductivity is k = 0.15W/m-K. Electrical measurements indicate that a current of 10A passes through the wire and there is a voltage drop of 8V along the wire. If the insulated wire is exposed to a medium at T_∞ = 30°C with a heat transfer coefficient of h = 12W/m²-K, determine the temperature at the interface of the wire and the plastic cover in steady operation. Also determine whether doubling the thickness of the cover will increase or decrease this	(08 Marks)

		interface temperature.	
	b	Derive an expression for the temperature distribution and rate of heat transfer from a fin of uniform Cross section. Neglect the heat transfer from the fin.	(08 Marks)
		OR	
4	a	Derive an expression for instantaneous temperature and heat transfer rate for a body subjected to heating or cooling in terms of Biot and Fourier number.	(08 Marks)
	b	A hot cylinder ingot of 50mm and 200mm long is taken out from the furnace at 800°C and dipped in water till its temperature falls to 500°C. Then it is directly exposed to air till its temperature falls to 100°C. Find the total time required for the ingot to reach the temperature from 800°C to 100°C. Take the following for ingot: k = 60W/m-°C, C = 200J/m-°C, ρ = 800kg/m³, heat transfer coefficient in water = 200W/m²-°C, heat transfer coefficient in air = 20W/m²-°C, Temperature of air or water = 30°C.	(08 Marks)
		MODULE – III	
5	a	Consider three consecutive nodes n-1, n,n+1 in a plane wall. Using finite difference form of the first derivative at the midpoints , show that the finite difference form of the second derivative can be expressed as $$\frac{T_{n-1} - 2T_n + T_{n+1}}{\Delta x^2}$$	(06 Marks)
	b	For one dimensional steady state heat conduction problem obtain the finite difference formulation when one end is subjected to prescribed temperature and the other end is subjected constant heat flux.	(12 Marks)
		OR	
6	a	Define the following: 1) Black body and opaque body 2)Stefan Boltzman Law 3) Wein's displacement law 4) Plank's Law	(08 Marks)
	b	Calculate the net radiant heat exchange per unit area for two parallel plates at temperatures of 427^0C and 27^0C respectively. ε (hot plate) is 0.9 and ε (cold plate) is 0.6. A polished aluminum shield is placed between them, find the percentage reduction in heat transfer. ε (Shield) is 0.4	(08 Marks)
		MODULE – IV	
7	a	What do you mean by hydrodynamic and thermal boundary layer? Explain with a neat sketch.	(08 Marks)
	b	Air at 40^0C flows over a thin plate with a velocity of 3m/sec. the plate is 2m long and 1m wide. Estimate the boundary layer thickness at the trailing edge of the plate and the total drag force experienced by the plate.	(08 Marks)
		OR	
8	a		(08 Marks)
	b	A 6m long section of an 8cm diameter horizontal hot water pipe passes through a large room whose temperature is maintained is 20°C. If the outer surface temperature of the pipe is 70°C, determine the rate of heat loss from the pipe by natural convection. If the emissivity of the pipe is 1.0, determine the rate of heat loss by radiation. Also determine total heat loss and percentage of heat loss by natural convection. Properties of air at film temperature are: ν = 17.50×10^{-6} m²/s, k = 0.02699W/m-K, Pr = 0.7241m, β = 1/318.	(08 Marks)
		MODULE – V	
9	a	Obtain an expression for the effectiveness of a counter flow heat exchanger in terms of NTU and the capacity ratio C	(08 Marks)
	b	8000kg/hr of air at 100^0C is cooled by passing it through a single pass cross flow heat exchanger. To what temperature is the air cooled, if water entering at 15^0C flows through the tubes un mixed at the rate of 7500 kg/hr. Take U = 500 KJ/hr	(08 Marks)

		m^2 , A= $20m^2$, Cp of air – 1 kJ/kg ^0C , Cp of water – 4.2 kJ/kg^0C	
		OR	
10	**a**	With the help of typical experimental boiling curve explain the different regimes of pool boiling	(06 Marks)
	b	Air free saturated steam at a temperature of 65^0C (p =25.03 kPa) condenses on a vertical outer surface of a 3m long vertical tube maintained at a uniform temperature of 35^0C. Assuming film condensation, calculate the average heat transfer coefficient over the entire length of the surface and the rate of condensate flow.	(10 Marks)