This question paper contains 4 printed pages.]

Your Roll No. .....

8465 **A**

B.Tech. (M)/IV

Paper EME–402—HEAT TRANSFER

Time : 3 Hours *Maximum Marks : 70*

(Write your Roll No. on the top immediately on receipt of this question paper.)

*Attempt any **five** questions.*

Assume missing data suitably, if any.

Use of Heat Transfer Data Book is permitted.

1. (a) The temperatures on two sides of a plane wall are T_1 and T_2, and thermal conductivity of wall material is prescribed by the relation $K = K_0 e^{(-x/2)}$ where K_0 is constant and L is the wall thickness. Derive an expression for temperature distribution in the wall.

   (b) Calculate the rate of heat flow / m^2 through a furance wall consisting of 200 mm thick inner layer of chrome brick (1.25 w/mk) a centre layer of Kaolin brick (0.08 w/mk) 1.00 mm thick and an outer layer of masonry brick (0.6w/mk) thick. The unit surface conductance at the inner surface is 80 w/m^2 k and

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outer surface temperature is 80°C. The temperature of the gases inside the furnace is 1680°C. What temperature prevail at the inner and outer surfaces of the centre layer? 5,9

2. (a) A steam pipe of 220 mm outer dia is carrying steam at 300°C. It is insulated with a material having thermal conductivity K 0.06 (1 + 0.0018 T) where K is w/m°C and T is m°C. If the insulation thickness is 50 mm and the temp of the outer surface is 50°C determine (i) the heat flow /m length of the pipe and (ii) temp at mid thickness.

(b) Explain the Geometric mean area as applied to hollow sphere. 10,4

3. (a) Two rods A and B of the same length and diameter protrude from a surface at 120°C and are exposed to air at 25°C. The temperatures measured at the end of the rods are 50°C and 75°C. If the thermal conductivity of material A is 20 w/mk, determine the thermal conductivity of material B. Assume the condition of bin insulated at the tip.

(b) A 2 cm thick steel plate (k = 50 w/mk) has uniform heat generation of $40 \times 10^{+6}$ w/m^3. The temp at one surface of the plate is 160°C and that at the outer is 100°C. Workout temp distribution across the plate, value and position of maximum temp in the plate. 7,7

4. (a) What are Heisler charts? Explain their significance in solving transient conduction problems.

(b) A cylindrical ingot, (k = 65 w/mk) 25 mm radius and 250 mm height initially at 850°C is dipped in water at 25°C with connective heat transfer co-efficient of 2.5 w/m^2 k and temp drops to 400°C. Subsequently the ingot is kept exposed to air at 25°C with connective heat transfer co-efficient of 30 w/m^2k till it attains a temp of 80°C. Determine total time required for the ingot to reach the temp from 85°C to 80°C. Take C_p = 250 J/kgt and P = 820 kg/m^3. 4, 10

5. (a) Two parallel rectangular surfaces 1m × 2m are opposite to each other at a distance of 4m. The surfaces are black. and at 1000°C and 200°C. Calculate heat exchange by radiation between the two surfaces.

(b) Determine the net radiant heat exchange / m^2 area for two infinite parallel plates held at temp of 800 k and 500k respectively. Take $\xi_1 = 0.6$ and $\xi_2 = 0.4$. What should be the emissivity of a polished Al shield placed between them if the heat flow is to be reduced to 40% of its original value? Determine temp of field also. 5, 9

6. (a) Define Nusselt, Reynolds and Prondh numbers. Explain their significance in connective heat transfer.

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(b) Air at 10°C flows over a flat plate 1 m wide and 1.5 m long. The plate is maintained at 90°C and dissipates 3.75 Kw of energy. Determine the connective heat transfer co-efficient and the velocity at which air flows over the plate.

7. (a) Determine the heat transfer rate by free connection between a horizontal wire and air at 25°C. The surface of the wire is at 95°C and its dia is 2.5 mm. Use Nusselt relation $Nu = 1.18 (GrPr)^{1/8}$.

(b) Water is boiled at the rate or 30 kg / hr in a copper pan 30 cm in dia at atm pr. Estimate the temp of the bottom surface of the pan assuming nucleate boiling conditions. 7, 7

8. (a) Is it better to arrange for the flow in a HX to be parallel or counter flow? Explain.

(b) In a counter flow Hx oil / (Cp = 3 KJ / Kgk) at the rate of 1400 Kg / hr is cooled from 100°C to 30°C by water that enters the exchanger at 20°C at the rate of 1300 kg / hr. Determine the heat exchanger area for an overall heat transfer co-efficient of 3975 KJ/m^2 hK. Also derive a relationship between oil and water temperatures at any section of the heat exchanger. 3, 11