May - June - 2011

[3963] – 212

T.E. (Mechanical) (Semester – I) Examination, 2011
HEAT TRANSFER
(2008 Pattern) (New)

Time : 3 Hours   Max. Marks : 100

Instructions : *1) Answer **3** questions from Section **I** and **3** questions from Section **II**.*
*2) Answers to the **two** Sections should be written in **separate** books.*
*3) Neat diagrams must be drawn **wherever** necessary.*
*4) Black figures to the **right** indicate **full** marks.*
*5) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is **allowed**.*
*6) Assume suitable data, **if** necessary.*

SECTION – I

Unit – I

1. a) Identify the mode(s) of heat transfer in the following :
   i) Heat transfer from a room heater
   ii) Hot plate exposed to atmosphere
   iii) Heat loss from thermos flask
   iv) Coding of Activa scooter engine
   v) Heat loss from automobile radiator
   vi) Heat transfer of sun energy to your classroom. **6**

   b) A steel pipe (K = 50 W/mk) of ID 100 mm and OD 110 mm is to be covered with two layers of insulations, each having a thickness of 50 mm. The thermal conductivity of first insulation is 0.06 W/m°C and that of the second is 0.12 W/mK. Calculate the loss of heat per meter length of pipe and the interface temperature between the two layers of insulations, when the temperature of the inside tube surface is 250°C and that of the outside surface of the insulation is 50°C.

   If the order of insulations is reversed, find the change in heat loss and comment on the result from insulation point of view. **10**

OR

2. a) Derive the expression for Logarithmic Mean Area (LMA) for hollow cylinder as;

$$A_m = \frac{A_o - A_i}{ln(A_o / A_i)}$$; where A_m is LMA, A_o outer surface area and A_i inner surface area of the cylinder. **8**

P.T.O.

b) Calculate the rate of heat loss for a red brick wall of length 5 m, height 4 m and thickness 25 cm. Temperature of the inner surface is 110°C and that of the outer surface is 40°C. Thermal conductivity of the red brick is 0.7 W/mK. Also, calculate the temperature at an interior point of the wall (in the thickness), 20 cm away from the inner surface of the wall. **8**

Unit – II

3. a) Prove that critical radius of insulation for cylinder is k/h and that for sphere is 2k/h; where k is conductivity of insulation and h is heat transfer coefficient between insulation and surroundings. Use standard notations. **8**

b) A hollow sphere of inside radius 30 mm and outside radius 50 mm is electrically heated at its inner surface at a constant rate of 10^5 W/m^2. The outer surface is exposed to a fluid at 30°C with heat transfer coefficient of 170 W/m^{2}K. Thermal conductivity of the sphere material is 20 W/mK. Calculate the inner and outer surface temperatures. **8**

OR

4. a) The inside and outside surfaces of a hollow sphere $a \le r \le b$ at $r = a$ and $r = b$ are maintained at temperatures T_1 and T_2 respectively. The thermal conductivity of the sphere material varies with temperature as :

$k(T) = k_0(1 + \alpha T + \beta T^2)$. Prove that the total heat flow rate Q. through the sphere is given as :

$$Q = \frac{4\pi k_0 ab}{(b-a)}(T_1 - T_2)\left[1 + \frac{\alpha}{2}(T_1 + T_2) + \frac{\beta}{3}(T_1^2 + T_1T_2 + T_2)^2\right].$$ **8**

b) Nichrome wire, having a resistivity of $100\,\mu\Omega - \text{cm}$, is to be used as a heating element in a 10 kW heater. The wire surface temperature should not exceed 1220°C. Take surrounding air temperature as 20°C. Convective heat transfer coefficient on 1.15 kW/m^{2}K and thermal conductivity of Nichrome as 17 W/mK. Find out what diameter of Nichrome wire is necessary for 1 m long heater. **8**

Unit – III

5. a) Derive the expressions for heat transfer rate Q and temperature distribution for a short fin using standard notations. **9**

b) In an experiment to determine the thermal conductivity of a very long solid rod of 2.5 cm diameter, its one end is placed in a furnace and rod is projecting into a room with ambient air at 22°C. After steady-state conditions are achieved, the temperatures at two points 10 cm apart, are found to be 110°C and 85°C respectively. Convective heat transfer coefficient between the rod surface and the surrounding air is 28.4 W/m^{2}K. Determine the thermal conductivity of the rod material. **9**

OR