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15ME63

Sixth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Heat Transfer

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer FIVE full questions, choosing one full question from each module.***
2. ***Use of heat transfer data hand book and steam tables are permitted.***

Module-1

1 a. Explain three modes of heat transfer with their basic laws. **(06 Marks)**

b. The inner wall of the furnace is made of fire brick of thickness 115 mm and the outer wall is made of red brick of thickness 230 mm. The temperature of the inside furnace is 685°C and the temperature of outside surface of red brick is 121°C under steady state condition to reduce the heat loss a layer of Magnesia insulation of thickness 50 mm is added on the outer surface of red brick after steady state condition is reached. The various temperature are measured as flame side of furnace 712°C junction between the fire brick and red brick is 655°C, junction between the red brick and Magnesia is 490°C outer surface Magnesia temperature is 77°C. Calculate the heat loss in first and second cases and find the percentage of heat loss reduction. Assume thermal conductivity of Magnesia is 0.085 W/m°C. **(10 Marks)**

OR

2 a. State the assumptions and derive general 3-dimensional heat conduction equation in Cartesian co-ordinates. **(08 Marks)**

b. A hollow sphere is made up of steel having thermal conductivity of 45 W/m°C. It is heated by means of a coil of resistance 100 Ω which carries a current of 5 amps. The coil is located inside a hallow space at the centre. The outer surface area of sphere is 0.2 m^2 and its mass 32 kg assuming density of the sphere material to be 8 gm/cc. Calculate the temperature difference between the inner and outer surface. **(08 Marks)**

Module-2

3 a. Derive an expression for the temperature distribution and heat flow for a pinfin, when the tip of the fin is insulated. **(08 Marks)**

b. A thin rod of copper K = 100 W/m°C, 12.5 mm in diameter spans between two parallel plates 150 mm apart. Air flows over the rod providing a heat transfer co-efficient of 50 W/m^2°C. The surface temperature of the plate exceeds the air by 40°C. Determine (i) The excess temperature at the centre of the rod over that of air and (ii) Heat lost from the rod in watts. **(08 Marks)**

OR

4 a. Show that the temperature distribution under lumped analysis is given by,

$$\frac{T - T_\infty}{T_i - T_\infty} = e^{-BiFo}$$

Where T_i = Initial temperature

T_∞ = Ambient temperature **(08 Marks)**

b. A 15 mm diameter mild steel sphere (K = 42 W/m°C) is exposed to coding air flow at 20°C resulting in the convective co-efficient $h = 120$ W/m^2°C. Determine the following:

(i) Time required to cool the sphere from 550°C to 90°C.
(ii) Instantaneous heat transfer rate for 2 mins after start of cooling.
(iii) Total energy transferred from the sphere during first 2 mins.

Take for mild steel S = 7850 kg/m^3, C_P = 475 J/kg°C, α = 0.045 m^2/hr **(08 Marks)**

Module-3

5 a. Explain three types of boundary conditions applied in Finite difference representations. **(09 Marks)**

b. Consider steady-state heat conduction in a square region of side 2b, in which energy is generated at a constant rate of g w/m^3. The boundary conditions for the problem are shown in Fig. Q5 (b). Write the finite difference equations for nodes 1, 3 and 5 in this Fig. Q5 (b) **(07 Marks)**

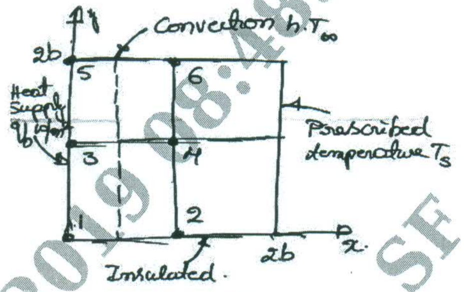

Fig. Q5 (b)

OR

6 a. State and explain : (i) Kirchoff's law (ii) Plank's law (iii) Wein's displacement law (iv) Lambert's cosine law. **(08 Marks)**

b. Two large parallel plots with emissivity 0.5 each are maintained at different temperatures and are exchanging heat only by radiation. Two equally large radiation shields with surface emissivity 0.05 are introduced in parallel to the plates. Find the percentage reduction in net radiative heat transfer. **(08 Marks)**

Module-4

7 a. With a diagram, explain velocity boundary layer and thermal boundary layer. **(08 Marks)**

b. Lubricating oil at a temperature of 60˚C enters a 1 cm diameter tube with a velocity 3.5 m/s. The tube surface is maintained at 30˚C. Calculate the tube length required to cool the oil to 45˚C. Assume that the oil has the following average properties for the temperature range of this problem S = 865 kg/m^3, K = 0.14 W/m˚K, C_P = 1.78 kJ/kgK and $\gamma = 9 \times 10^{-6}$ m^2/s. **(08 Marks)**

OR

8 a. Explain the significance of, (i) Reynold's number (ii) Prandtl number (iii) Nusselt number (iv) Stanton number. **(08 Marks)**

b. Calculate the convection heat loss from a radiator 0.5 m wide and 1 m high maintained at a temperature of 84˚C in a room at 20˚C. Treat the radiator as a vertical plate. **(08 Marks)**

Module-5

9 a. With assumptions, determine LMTD for counter flow heat exchanger. **(08 Marks)**

b. A parallel flow heat exchanger uses 1500 kg/hr of cold water entering at 25˚C to cool 600 kg/hr of hot water entering at 70˚C. The exit temperature on the hot side is required to be 50˚C. Neglecting the effects of fouling make calculations for the area of heat exchanger. It may be assumed that the individual heat transform co-efficient on both sides are 1600 W/m^{2}K. Use LMTD and NTU approaches. **(08 Marks)**

OR

10 a. With a neat sketch, explain the different regimes of pool boiling. **(08 Marks)**

b. A vertical square plate 300m × 300m is exposed to steam at atmospheric pressure. The plate temperature is 98˚C. Calculate the heat transfer and the mass of steam condensed per hour. **(08 Marks)**

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