Code: R7310306

R7

B.Tech III Year I Semester (R07) Supplementary Examinations, May 2013

HEAT TRANSFER

(Mechanical Engineering)

Time: 3 hours Max Marks: 80

Answer any FIVE questions

All questions carry equal marks

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1 (a) State Fourier's law of heat conduction and derive a general equation for heat conduction in three-dimensional spherical coordinates.

(b) One side of a plane wall is maintained at 100°C, while the other side is exposed to a convection environment having T = 10°C and h = 10 W/m^2 °C. The wall has k = 1.6 W/m°C and is 40 cm thick. Calculate the heat transfer rate through the wall.

2 (a) A composite slab consists of 250 mm fire clay brick (k = 1.09 W/m.K) inside, 100 mm fired earth brick (0.26 W/m.K) and outer layer of common brick (0.6 W/m.K) of thickness 50 mm. If inside surface is at 1200 ºC and outside surface is at 100 ºC. Find:

(i) Heat flux.

(ii) The temperature of the junctions and

(iii) The temperature at 200 mm from the outer surface of the wall.

(b) Explain the concept of electrical analogy. How is it useful in solving heat transfer problems?

3 (a) Define Biot number and Fourier number. Explain the significance of each.

(b) A brick (24 x 10 x 8) is heated to a uniform temperature of 400^oC and allowed to cool in air at a temperature of 25^0C. Calculate the temperature at the center of the brick after 100 min. have elapsed. H = 10 W/m^2 K, K = 1.0 W/m^2.K, α = 3.33 × 10^{-3} m^2/hr.

4 (a) Explain the physical significance of Reynolds number, Prandtl number and Nusselt number.

(b) Air at 15^0C and at a pressure of 1 atm is flowing along a flat plate at a velocity of 4.75 km/s of the plate is 1 m wide and at 70^0C. Find the following at a distance of 1 m from the leading edge:

(i) Hydrodynamic boundary layer thickness.

(ii) Average friction factor.

(iii) Thermal boundary layer thickness and

(iv) Local heat transfer coefficient.

5 A hot plate 25 cm in height and 100 cm wide at 100^0C is exposed to the air at 20^0C. Find the following:

(a) Boundary layer thickness at 10 cm from leading edge.

(b) Local heat transfer coefficient at 10 cm from leading edge.

(c) Average heat transfer coefficient for the whole surface of the plate.

(d) Heat flow from the plate.

(e) Rise in temperature of the air passing through the boundary.

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6 (a) What do you mean by sub-cooled boiling?

(b) The outer surface of a vertical cylinder drum of 350 mm diameter is exposed to saturated steam at 2.0 bar for condensation. If the surface temperature of the drum is maintained at 80^0C, calculate:
(i) the length of the drum and
(ii) the thickness of the condensate layer to condense 70 kg/h of steam.

7 (a) Why the counter flow is better than the parallel flow heat exchanger?

(b) Water enters a counters flow, double pipe heat exchange at 15^0C, flowing at the rate of 1300 kg/h. It is heated by oil (C_p = 2000 J/kg.K) flowing at the rate of 550 kg/h from an inlet temperature of 94^0C. For an area of 1 m^2 and an overall heat transfer coefficient of 1075 W/m^2.K, determine the total heat transfer and the outlet temperature of water and oil.

8 (a) What is the Stefan-Boltzmann law? Explain the concept of total emissive power.

(b) A 2.54 cm outside diameter tube is used to transport a cryogenic liquid at -196^0C from a plant to an adjacent unit. The tube is enclosed in an evacuated concentric pipe of 52.5 mm ID having a wall temperature of -3^0C. A thin walled radiation shield is placed midway in the annular region between the tube and the pipe. Calculate the rate gain by the liquid per meter length of the tube. The following emissivity data are available: tube wall = 0.05; pipe wall = 0.1; inner surface of the radiation shield = 0.02; outer surface of the radiation shield = 0.03.

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