Heat Transfer (ME-3O5E)

Time : Three Hours **Maximum Marks : 100**

Note :- Attempt any FIVE questions.

1. (a). Derive the heat conduction equation for an anisotropic medium having three dimensional heat conduction along with internal heat generation. (12)

(b). A spherical shell of inner radius 5 cm and outer radius 10 cm has its inner and outer surfaces maintained at 10O°C and 30°C respectively. Obtain the steady-state temperature variation in the shell if the conduction is radial and there are no heat sources or sinks. Also find the steady-state heat flux at the inner and outer surfaces. Take K = 105 W/mK. (8)

2. (a) Obtain from first principles an expression for the steady-state heat transfer rate from a fin of circular cross-section rosing heat by convection from its tip. State the assumptions made. (12)

(b). An aluminium (K = 2OO W/mK) fin is in the form of a plate. 3 mm thick and 150 mm long. The ambient air is at 30°C with a heat transfer coefficient of 67 W /^{m2K}. How much heat is dissipated per meter width if the fin base is at 100°C?

3. A double pipe heat exchanger is to be used to cool water from 22°C to 6°C using brine entering at 2°C and leaving at 3°C. The overall heat transfer coefficient is 500 W/m^{2}C. Calculate the heat transfer area for a design heat load of 10 kW for both parallel-flow and counter flow arrangements. (20)

tip. State the assumptions made.

4. (a). Define the terms 'Total Emissive Power' and Intensity of Radiation. Derive a relation between them, clearly stating the assumptions made. (15)

(b). The filament of an electric bulb is maintained at a temperature of 2900 K and may be realized as a black body. Determine the wavelength at which the monochromatic emissive power is maximum, for radiation emitted by the filament. (5)

5. (a). Derive the relation N_{μ} = CPr^{m}Rc^n for forced convection heat transfer using dimensional analysis. (8)

(bl Define Grashoff Number. Explain its significance. Differentiate between hydrodynamic and thermal boundary layers. (12)

6. Air with a free stream temperature of 10°C and free stream velocity of 15 m/s flows parallel to a flat plate, 1.5 m long which is held at a temperature of 90°C. Calculate the heat transfer rate from one side of the plate. What is the drag force experienced by the plate? Use the following property values:

At 50°C.

Density of air, ρ = 1.088 kg/m^3, v = 18.65 x 10^{-6} m^2/s

K = 0.0281 W/m°C, Pr = 0.703. (20)

7. A cylindrical wire of 6 mm diameter if heated by a current passing through it. 100 W of heat is dissipated per meter length of the wire. The wire is covered by an insulation of outer diameter 12 mm. The material of the insulation has a thermal conductivity of 0.4 w/m°C. The outer surface of the insulation is exposed to a gas at 3O°C. The temperature of the outer surface of the insulation is measured to be 6O°C. Determine the temperature variation in the wire and the maximum temperature in the wire. (20)

Take K = 15 W/m°C for the wire material.

8. Write short notes on any TWO of the following topics:

(a) Critical Insulation Radius

(b) Reynolds Analogy

(c) Shape Factor. (2xI0=20)