Roll No. .... **Total Pages : 04**

BT-5/D-18 **35126**

HEAT TRANSRER

ME-305N

Time : Three Hours] [Maximum Marks : 75

Note : Attempt *Five* questions in all, selecting at least *one* question from each Unit. Assume any missing data suitably.

Unit I

1. Derive the general heat conduction equation in cylindrical coordinates and use this to find the maximum temprature in a cylindrical rod for one dimensional steady heat conduction with uniform heat generation. **15**

2. Saturated steam at 110°C flows inside a copper pipe (thermal conductivity 450 W/m K) having an internal diameter of 10 cm and an external diameter of 12 cm. The surface resistance on the steam side is 12000 Wm^2K and that on the outside surface of pipe is 18 W/m^2K. Determine the heat loss from the pipe if it is located in space at 25°C. How this heat loss would be affected if the pipe is lagged with 5 cm thick insulation of thermal conductivity 0.22 W/mK ? **15**

Unit II

3. (a) Discuss the physical significance of Prandtl and Nusselt numbers. **7**

   (b) What do you understand by the hydrodynamic and thermal boundary layers ? Illustrate with reference to flow over a flat heated plate. **8**

4. Air at 20°C and at atmospheric pressure is flowing past a flat plate at 3 m/s velocity. The plate is haeted over its entire length to a uniform temperature of 60°C. Calculate the heat over transfer from the first 30 cm length of the plate. Use the following correlation Nu = 0.332 $Re^{0.5}$ $Pr^{0.33}$. Also make calculations for the drag force exerted on the first 30 cm length of plate. Use the analogy between fluid friction and heat transfer, $St\,Pr^{2/3} = \frac{\bar{C}_f}{2}$.

   The relevant thermo-physical properties of air are : k = 0.099 kJ/m-hr-deg, μ = 19.13 × 10^{-6} kg/ms, c_p = 1.00 kJ/kg-deg and ρ = 1.128 kg/km^3. **15**

Unit III

5. (a) Derive the expression of total emissive power using Plank's distribution law. **7**

(b) Assuming the sun to be a black body having a surface temperature of 5800 K, calculate :

(i) The total emissive power

(ii) The wavelength at which the maximum spectral intensity occurs

(iii) The value of maximum emissive power

(iv) The total amount of radiant energy emitted by the sun per unit time if its diameter can be assumed to be 1.391×10^9 m. **8**

6. (a) Define radiation shape factor and reciprocity theorem. **5**

(b) Two very large parallel plates with emissivities 0.5 exchange heat. Determine the percentage reduction in heat tranfer rate if a polished aluminium raciation shield (ε = 0.04) is placed in between the plates. **10**

Unit IV

7. (a) What is a fin ? Explain the terms effectiveness and efficiency as related to fins. **5**

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(b) A copper fin (k = 396 W/m K) 0.25 cm in diameter protrudes from a wall at 95°C into ambient air at 25°C The heat transfer coefficient by the tree convection is equal to 10 W/m^{2}K. Calculate the heat loss if :

(i) The fin in infinitely long

(ii) The fin is 2.5 cm long and the coefficient at the end is same as around the circumference. **10**

8. It is desired to use a double pipe counter current heat exchanger to cool 3 kg/s of oil (c_p = 2.1 kJ/kg K) from 120°C. Cooling water at 20°C enters the heat exchanger at a rate of 10 kg/s. The overall heat transfer coefficient of the heat exchanger is 600 W/m^2 K and the heat transfer area is 6 m^2. Calculate the exit temperature of oil and water. **15**

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