Roll No. .....

1088

B. E. 6th Semester

Examination – December, 2011

HEAT & MASS TRANSFER

Paper : ME- 306-C

Time : Three hours] *[Maximum Marks : 100*

Before answering the questions, candidates should ensure that they have been supplied the correct and complete question paper. No complaint in this regard, will be entertained after examination.

Note : Attempt any *five* questions by selecting at least *two* from each part.

PART – A

1. (a) Sketch and Explain the combined heat transfer system. 10

(b) Explain the significance of heat transfer. 10

2. (a) Derive general three dimensional heat transfer equation in spherical coordinate system. 12

(b) Derive the expression for heat conduction through a plane wall. 8

3. (a) A carbon steel (K = 54W/m°C) rod with a cross section of an equilateral triangle (each side 5 mm) is 80 mm long. It is attached to a plane wall which is maintained at a temperature of 400°C. The surrounding environment is at 50°C and unit surface conductance is 90W/m²C. Compute heat dissipation by the rod. 10

(b) Define the term critical thickness of insulation and derive the expression of critical thickness of insulation for cylinder. 10

4. (a) What is meant by lumped capacity ? What are the physical dimensions necessary for a lumped unsteady state analysis to apply ? 8

(b) A metal plate of 4mm thickness (K=95.5W/m°C) is exposed to vapour at 100°C one side and cooling water at 25°C on opposite side. The heat transfer coefficients on either side are 14500W/m^2°C and 2250W/m^2°C respectively. Determine : 12

(i) The rate of heat transfer

(ii) The overall heat transfer

PART – B

5. Air at 20°C and at a pressure of 1 bar is flowing on a flat plate at a velocity of 3 m/sec. If the plate is 280 mm wide and at 56°C. Calculate the following quantities at x = 280 mm, given that properties of air at the bulk mean temperature (20 + 56/2) = 38°C are :

   Rho = 1.1374 Kg/m3, K = 0.0273 W/m°C, Cp = 1.005 KJ/KgK, Pr = 0.7 Nu = 16.768 $\times 10^{-6}$ m^2/sec 20

   (a) Boundary layer thickness

   (b) Local friction coefficient

   (c) Average friction coefficient

   (d) Shearing stress due to friction

   (e) Rate of heat transfer by convection.

6. (a) Calculate the shape factors for the following configuration : 10

      (i) A black body inside a black enclosure

      (ii) A tube with cross section of an equilateral triangle.

   (b) What is the Stefan's - Boltzmann law. Explain the concept of monochromatic emissive power, total emissive power and intensity of radiation. 10

7. A single pass counter flow concentric tube heat exchanger is used to cool engine oil (C = 2130 J/KgK) from 160 C with water available at 25°C as the cooling medium. The flow rate of cooling water through the inner tube of 0.5 m diameter is 7200 Kg/hr while the flow rate of oil through outer annulus with outside diameter 0.7 m is also 7200 Kg/hr. If the value of overall heat transfer coefficient is 250W/m²K. What will be the 20

(i) LMTD

(ii) Length of heat exchanger ?

Take specific heat of water as 4186 J/Kg K.

8. Distinguish between film condensation and drop wise condensation. Develop for laminar film condensation in a vertical plate an expression for the film thickness heat transfer coefficient and steam condensation rate in terms of relevant fluid properties temperature difference and the plate dimensions. 20