Roll No. Total No. of Pages : 03

Total No. of Questions : 08

M.Tech. (ME) (Sem.–1st)

ADVANCE HEAT & MASS TRANSFER

Subject Code : MME-503

Paper ID : [E0403]

Time : 3 Hrs. Max. Marks : 100

INSTRUCTION TO CANDIDATES :

1. **Attempt any FIVE questions out of EIGHT questions.**
2. **Each question carry TWENTY marks.**

1. (a) Define thermal diffusivity and explain its significance in heat transfer. What is its dimension ? How does it differ from thermal conductivity ? 10

   (b) A 800 mm high and 1.5 m wide double pane window consists of two 4 mm thick layers of glass (K = 78 W/m-k) separated by a 10 mm wide stagnant air space (K = 0.026 W/m-k). Determine the rate of heat transfer through the window and the temperature of the inside surface, when the room is maintained at 20°C and the outside air is at – 10°C. Take the convective heat transfer coefficient on the inside and the outside surfaces of the window as 10 & 40 W/m^2-k respectively. 10

2. (a) Show that the temperature variation for heat transfer through conduction through a cylinder wall having uniform thermal conductivity is logarithmic. 10

   (b) An aluminium (K = 204 W/m-k) rod 20 mm in diameter and 200 m long protrudes from a wall which is maintained at 300°C. The end of the rod is insulated and the surface of the rod is exposed to air at 30°C. The convection heat transfer coefficient between the rod's surface and air is 10 W/m^2-k. Calculate the heat lost by rod. Also calculate the temperature of the rod at a distance of 100 mm from the wall. 10

3. (a) What are Heisler charts ? Explain the significan
   solving transient conduction problems.

   (b) An aluminium alloy plate of 400mm × 400mm
   is suddenly quenched into liquid oxygen at –
   fundamentals or deriving the necessary expressi
   required for the plate to reach a temperatur
   h = 20,000 kJ/m^2 – hr – °C, C_p = 800J/kg-k
   for aluminium may be taken as 214 W/m-k.

4. (a) Explain the physical significance of Nusselt
   number (Pr), Stanton number (Sf) and Grashoff

   (b) The resistance R experienced by a partially sub
   upon the velocity v, length of the body L. Vi
   density of fluid ρ and gravitational acceleration g
   expression for R.

5. (a) Explain how does heat transfer occur in a rect
   consisting of two isothermal parallel plates spa
   When does heat transfer essentially occur by co

   (b) What is modified Grashoff number ? Where do

   (c) Explain conette flow for laminar forced conve
   maximum temperature occur ?

6. (a) Enumerate the factors on which the rate of em
   body depend.

   (b) What is black body ? How does it differ from

   (c) Assuming the sun to be black body having a
   5800 K. Calculate :

   (i) Total emissive power.

   (ii) The wavelength at which the maximum spe

   (iii) Maximum value of $E_{b\lambda}$.

   (iv) The percentage of total emitted energy
   range of 0.35 μ to 0.76μ.

   (v) Total amount of radiant energy emitted by
   its distance can be assumed to be 1.391

7. (a) State & explain reciprocity theorem. 5

(b) For two infinite parallel grey planes exchanging radiant energy

$$F_{12} = \frac{1}{1/t_1 + 1/t_2 - 1}.$$ 5

(c) For a hemisphere furnace the flat floor is 700 K and has an emissivity of 0.5. The hemispherical roof is at 1000 K has emissivity of 0.25. Find the net radiative heat transfer from roof to floor. 10

8. (a) Explain equimolar counter diffusion. Does it have any counter part in heat transfer? 5

(b) Explain molecular diffusion through a stationary gas. Where does the stationary character of the stagnation gas imply ? 5

(c) Air at 20°C (ρ = 1.205 kg/m^3, V=15.06 × 10^{-6} m^2/s, D=4.166 × 10^{-5} m^2/s) flows over a tray (length = 320 mm, width = 420 mm) full of water with velocity of 2.8 m/s. The total pressure of moving air is 1 atm & the partial pressure of water present in the air 6.8 × 10^2 N/m^2. If the temperature on the water surface is 15°C, calculate the evaporation rate of water. Partial pressure at 15°C is 0.017 bar. 10