

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.

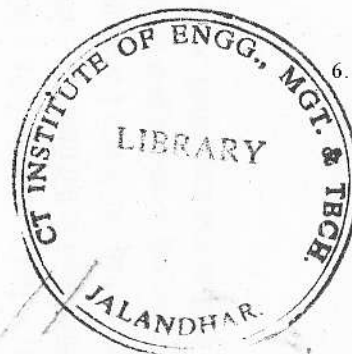
Max. Marks : 100

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 ($K = 78 \text{ W/m-k}$) separated by a 10 mm wide stagnant air space ($K = 0.026 \text{ W/m-k}$). 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 & $40 \text{ W/m}^2\text{-k}$ 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 ($K = 204 \text{ W/m-k}$) rod 20 mm in diameter and 200 mm 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 $10 \text{ W/m}^2\text{-k}$. 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 significance of solving transient conduction problems.
(b) An aluminium alloy plate of $400\text{mm} \times 400\text{mm}$ is suddenly quenched into liquid oxygen at -183°C . Explain the fundamentals or deriving the necessary expression for the plate to reach a temperature of -183°C . The heat transfer coefficient $h = 20,000 \text{ kJ/m}^2 - \text{hr} - ^\circ\text{C}$, $C_p = 800 \text{ J/kg-k}$ 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 number (Gr).
(b) The resistance R experienced by a partially submerged body upon the velocity v , length of the body L , viscosity of fluid μ and gravitational acceleration g . Derive an expression for R .
5. (a) Explain how does heat transfer occur in a rectangular duct consisting of two isothermal parallel plates spaced $2L$ apart. When does heat transfer essentially occur by conduction?
(b) What is modified Grashoff number? Where does it occur?
(c) Explain convection flow for laminar forced convection. Where does maximum temperature occur?
6. (a) Enumerate the factors on which the rate of evaporation of a liquid body depend.
(b) What is black body? How does it differ from grey body?
(c) Assuming the sun to be black body having a temperature of 5800 K . Calculate :
(i) Total emissive power.
(ii) The wavelength at which the maximum spectral emissive power occurs.
(iii) Maximum value of $E_{b\lambda}$.
(iv) The percentage of total emitted energy in the wavelength range of 0.35μ to 0.76μ .
(v) Total amount of radiant energy emitted by the sun in the wavelength range of 0.35μ to 0.76μ at its distance can be assumed to be $1.391 \times 10^{26} \text{ J}$.



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

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

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

(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 ($\rho = 1.205 \text{ kg/m}^3$, $V=15.06 \times 10^{-6} \text{ m}^2/\text{s}$, $D=4.166 \times 10^{-5} \text{ m}^2/\text{s}$) 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 $6.8 \times 10^2 \text{ N/m}^2$. 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