(c) Consider a diffuse circular disk of diameter D and area A_j and a plane diffuse surface of area $A_i << A_j$. The surfaces are parallel and A_i is located at a distance L from the centre of A_j. Obtain the following expression for the view factor

$$F_{ij} = \frac{D^2}{D^2 + 4L^2}$$

5 Answer any **two** of the following : **10×2=20**

(a) Discuss various modes of pool boiling with the help of pool boiling curve. List various regimes of forced boiling insides a tube.

(b) Discuss the significance of the following :
(i) Fouling factor
(ii) Schmidt number and Sherwood number
(iii) Impermeable surface.

(c) A concentric tube heat exchanger uses water, which is available at 15°C, to cool ethylene glycol from 100°C to 60°C. The water and glycol flow rates are same at 5 kg/s. Determine the effectiveness of heat exchanger.

Take: $C_p(water) = 4178\ J/kg \cdot K$

$C_p(ethylene\ glycol) = 2650\ J/kg \cdot K$

Can you comment, whether the heat exchanger is working in parallel flow or counter flow modes of operation ?

* 4 0 7 8 / 5 7 0 0 *

Printed Pages : 4 **TME-505**

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 4078 Roll No.

B. Tech.

(SEM. V) EXAMINATION, 2008-09

HEAT & MASS TRANSFER

Time : 3 Hours] *[Total Marks : 100*

Note :
*(i) Attempt **all five** questions.*
(ii) Use of Heisler charts is allowed.
(iii) Use the data and expressions provided in the question paper.
(iv) Assume missing data suitably, if any.

1 Attempt any **four** of the following : **5×4=20**

(a) Derive an expression for overall heat transfer coefficient for a plane wall.

(b) Derive an expression for maximum temperature within a plane wall subjected to one dimensional conduction with uniform heat generation, in terms of surface temperature.

(c) Derive an expression for critical radius of insulation for cylindrical body. Give practical example to explain the concept of critical radius.

(d) A plane wall of area 5 m^2 and thickness 10 cm is subjected to one dimensional heat conduction. Find the heat transfer rate if the surfaces of wall are at 400°C and 100°C and the conductivity of wall varies as follows :

$$K = 0.5\,(1 + 0.0065\,t)$$

where K is in W/m.K and t is in °C.

(e) What do you understand by "Contact Resistance" ? How can it be reduced ?

(f) Derive an expression for thermal resistance of spherical body.

2 Answer any **two** of the following : **10×2=20**

(a) A large metal plate 10 cm thick is initially maintained at a temperature of 500°C. It is suddenly exposed to a surrounding at 140°C with a heat transfer coefficient of 570 W/m^2.K. At a later instant its center plane reaches a temperature of 356°C. Find the temperature of a plane at a distance of 2.5 cm from the mid plane at the same instant. Take :

$$K = 170\ W/m \cdot K,\ \alpha = 4.78 \times 10^{-5}\ m^2/s,$$

(b) Derive the following expression for transient conduction

$$\theta/\theta_i = \exp\left[-B_i \cdot F_0\right]$$

(c) A brass rod $(K = 133\ W/m \cdot K)$ 100 mm long and 5 mm in diameter extends horizontally from a casting at 200°C. The rod is in air at $T_\infty = 20^\circ C$ and $h = 30\ W/m^2 \cdot K$. What is the rate of heat transfer to air and temperature of the free end of the rod ?

3 Attempt any **two** of the following : **10×2=20**

(a) Outer surface of a 12.5 mm radius tube is maintained at 100°C. Water at 20°C with a flow rate of 1 kg/s enters the tube. Find the length of tube, if water leaves at 80°C. Take for water

(i) At 50°C : $P_r = 3.56$, $C_p = 4181\ J/kg \cdot K$,

$\mu = 5.48 \times 10^{-4}\ N \cdot s/m^2$,

$K = 0.643\ W/m \cdot K$

(ii) At 100°C : $\mu = 2.79 \times 10^{-4}\ N \cdot s/m^2$

for fully developed turbulent pipe flow.

$$Nu_\phi = 0.027\ Re_D^{4/5}\ Pr^{1/3}\ (\mu/\mu s)^{0.14}$$

(b) (i) Discuss the analogy of heat and mass transfer.

(ii) Define and explain : Nusselt number, Prandtl number and Reynold number.

(c) Explain the physical mechanism of free convection with the help of example and neat sketch. Discuss the significance of various dimensionless numbers to natural convection.

4 Attempt any **two** of the following : **10**

(a) Explain the following :

(i) Gray body

(ii) Diffuse emitter

(iii) Emissivity

(b) Two concentric spheres of diameter $D_1 = 0.8\ m$ and $D_2 = 1.2\ m$ are separated by an air space and have surface temperatures of $T_1 = 127^\circ C$ and $T_2 = 27^\circ C$. Find the net rate of radiation exchange between the spheres

(i) If the surfaces are black

(ii) If the surfaces are diffuse and gray with $\epsilon_1 = 0.5$ and $\epsilon_2 = 0.05$.