Printed Pages—4 **TME505**

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

PAPER ID : 4078 **Roll No.** | | | | | | | | | | |

B.Tech.

(SEM. V) ODD SEMESTER THEORY EXAMINATION 2012-13

HEAT AND MASS TRANSFER

Time : 3 Hours *Total Marks : 100*

Note : *Attempt **all** problems. Each problem carry equal marks.*

1. Attempt any **TWO** : **(10×2=20)**

   (a) A steel pipe of 100 mm bore and 7 mm wall thickness, carrying steam of 260 C, is insulated with 40 mm of glass wool covering, this covering is turn insulated with 60 mm of asbestos felt. The atmospheric temperature is 30 C. The heat transfer coefficients for the inside and outside surfaces are 550 and 15 W/mK respectively, and the thermal conductivities of steel, glass wool and asbestos felt are 50, 0.09 and 0.07 W/mk respectively. Calculate :

   (i) Rate of heat loss per unit length of pipe.

   (ii) Temperatures at each X-section of the pipe.

   (b) Derive the expression for temperature distribution in a straight fin of rectangular profile assuming insulated end and the heat loss from the edge of the fin. Mention the advantages of using fin.

   (c) Derive 3-dimensional heat transfer equation in Cartesian coordinate system.

2. Attempt any **TWO** : **(10×2=20)**

(a) (i) Explain the significance of fin effectiveness and fin efficiency.

(ii) What are Fourier and Biot numbers ? What is the physical significance of these numbers ?

(b) A fin of circular x-section, diameter 2.5 cm is placed in a furnace with large portion of it projecting in 10 cm apart are found to be 110 C and 85 C. The convective heat transfer coefficient between the fin surface and the surrounding air is 28.4 W/sq.mK. Determine the thermal conductivity of fin material.

(c) A cylindrical stainless steel ingot 15 cm in diameter and 40 cm long passes through a heat treatment furnace which is 6 m in length. The temperature of the furnace gas is 1280 C. The initial ingot temperature is 100 C. The combined radiant and convective heat transfer coefficient is 100 W/sq.mK. Calculate the maximum speed with which the ingot moves through the furnace if it must attain 850 C temperature. Take K_{steel} = 45 W/mK, $\alpha = 0.46 \times 10^{-5}$.

3. Attempt any **TWO** : **(10×2=20)**

(a) Discuss the analogy of heat and mass transfer. Define and explain Nusselt number, Prandtl number and Reynolds number.

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

(c) Air at 34 C is flowing over a flat plate maintained at 120 C with a free stream velocity of 5 m /s. The plate is 10 m long and 1 m wide. Calculate the local heat transfer coefficient at 0.5 m and 5 m from the leading edge of the plate. Also determine the heat transferred from the first 50 cm of the plate to air.

For air take :

Pr = 0.697, $\gamma = 20.76 \times 10^{-6}$ sq.m/s, K = 0.3 W/m.K.

4. Attempt any **TWO** : **(10×2=20)**

(a) Explain the following :

(i) Gray body

(ii) Diffuse emitter

(iii) Emissivity

(iv) The greenhouse effect.

(b) Two concentric spheres of diameter 0.8 m and 1.2 m are separated by an air space and have surface temperatures of 227 C and 127 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 $\varepsilon = 0.5$ and $\varepsilon = 0.05$.

(c) A 20 cm diameter spherical ball at 800 K is suspended in the air. Assuming that the ball closely approximates a black body, determine :

(i) The total blackbody emissive power

(ii) The total amount of radiation emitted by the ball in 5 min.

5. Attempt any **TWO** : **(10×2=20)**

(a) 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.K

C_p(ethylene glycol) = 2650 J/kg.K.

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

(b) Explain physical mechanism of condensation. Also discuss convective boiling inside a tube.

(c) Write short notes on the following :

(i) Filmwise condensation

(ii) Flick's law of diffusion.