No. of Printed Pages : 5

BME-027

B.Tech. MECHANICAL ENGINEERING (COMPUTER INTEGRATED MANUFACTURING)

00183

Term-End Examination

December, 2018

BME-027 : HEAT AND MASS TRANSFER

Time : 3 hours *Maximum Marks : 70*

Note : *Answer any **seven** questions. All questions carry equal marks. Use of scientific calculator is permitted.*

---

1. (a) What are the different modes of heat transfer ? Explain their potential for occurrence.

(b) The wall of a furnace is constructed from 15 cm thick fire brick having constant thermal conductivity of 1·6 W/mK. The two sides of the wall are maintained at 1400 K and 1100 K respectively. What is the rate of heat loss through the wall which is 50 cm × 3 m on a side? *5+5*

2. (a) Discuss the various regimes of pool boiling.

(b) A refrigerator stands in a room where air temperature is 21°C. The surface temperature on the outside of the refrigerator is 16°C. The sides are 30 mm thick and have an equivalent thermal conductivity of 0·10 W/mK. The heat transfer co-efficient on the outside is 10 W/m^{2}K. Assuming one-dimensional conduction through the sides, calculate the net heat flow rate and the inside surface temperature of the refrigerator. *5+5*

3. (a) What is a heat exchanger? Classify heat exchangers in three broad classes.

(b) Determine heat transfer rate through a spherical copper shell of thermal conductivity of 386 W/mK, inner radius of 20 mm and outer radius of 60 mm. The inner surface and outer surface temperatures are 200°C and 100°C respectively. *5+5*

4. (a) The temperature distribution in a plate of thickness 20 mm is given by

$$T\,(^\circ C) = 6x^2 + 10x + 4.$$

Assuming no heat generation in the plate, calculate heat flux on two sides of the plate. Also calculate rate of temperature change with respect to time, if k = 300 W/mK, $\rho = 580\ kg/m^3$, and C = 420 J/kg K.

(b) Calculate the heat transfer by radiation from the surface of a 60 mm dia spherical lamp (black body) at temperature of 80°C into an ambient at 20°C. *5+5*

5. Derive one-dimensional time dependent heat conduction equation with internal heat generation and variable thermal conductivity in the Cartesian coordinate system. *10*

6. A wall is constructed of several layers. The first layer consists of brick (k = 0·66 W/mK), 25 cm thick, the second layer 2·5 cm thick mortar (k = 0·7 W/mK), the third layer 10 cm thick limestone (k = 0·66 W/mK) and outer layer of 1·25 cm thick plaster (k = 0·7 W/mK). The heat transfer co-efficients on interior and exterior of the wall fluid layers are 5·8 W/m^2K and 11·6 W/m^2K, respectively.

Find

(i) Overall heat transfer coefficient

(ii) Overall thermal resistance per m^2

(iii) Rate of heat transfer per m^2, if the interior of the room is at 26°C while outside air is at –7°C. *10*

7. (a) Define fin effectiveness. When is the use of fins not justified ?

(b) Prove that the thermal resistance offered by a hollow long cylinder of constant thermal conductivity is given by

$$R_{cyl} = \frac{ln(r_2 / r_1)}{2\pi LK}.$$ *5+5*

8. Explain Fick's law of diffusion. What is mass diffusivity ? *10*

9. A tank contains a mixture of CO_2 and N_2 in the mole proportion of 0·2 and 0·8 at 1 bar and 290 K. It is connected by a duct of cross-sectional area 0·1 m^2, 0·5 m long to another tank (as shown in Figure 1) containing mixture of CO_2 and N_2 in the molar proportion of 0·8 and 0·2 respectively.

Calculate the diffusion rates of CO_2 and N_2. *10*

Assume diffusivity coefficient

$D_{AB} = 0{\cdot}17 \times 10^{-4}\ m^2/s$.

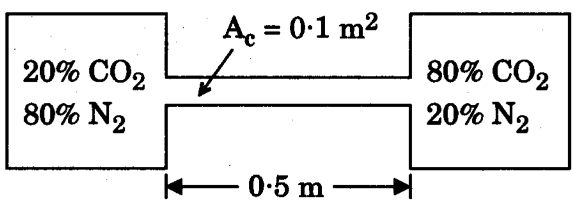

Figure 1

10. Define and explain the physical significance of any ***two*** of the following : *2×5=10*

(a) Schmidt number

(b) Lewis number

(c) Sherwood number