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BIME-034

B.Tech. – VIEP – MECHANICAL ENGINEERING (BTMEVI)

Term-End Examination

June, 2017

00654

BIME-034 : HEAT AND MASS TRANSFER

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt any **seven** questions. All questions carry equal marks. Use of scientific calculator is permitted. Assume missing data, if any, suitably.*

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

(b) Determine the heat flow across a plane wall of 10 cm thickness with a thermal conductivity of 8·5 W/m-K. When the surface temperatures are steady and at 200°C and 50°C, the wall area is 2 m^2. Also find the temperature gradient in flow direction. *5+5*

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

$$R_{cyl} = \frac{ln\left(\frac{r_2}{r_1}\right)}{2\pi LK}$$

where r_1 = inner radius,

r_2 = outer radius,

L = length of cylinder,

K = thermal conductivity of material.

(b) Two black bodies exchanging heat by radiation are maintained at 1500°C and 150°C respectively. Calculate the radiation heat flux due to radiation between them.

Take $\sigma = 5{\cdot}67 \times 10^{-8}$ W/m^2 K^4. *5+5*

3. A thermopane window consists of two 5 mm thick glass (K = 0·78 W/mK) sheets separated by 10 mm stagnant air gap (K = 0·025 W/mK). The convection heat transfer coefficient for inner and outside air are 10 W/m^2 K and 50 W/m^2 K, respectively. Determine the rate of heat loss per m^2 of the glass surface for a temperature difference of 60°C between the inside and outside air. *10*

4. Define the following terms (any ***five***) : *5×2=10*

(a) Mass fraction

(b) Mole fraction

(c) Molar concentration

(d) Mass flux

(e) Molar flux

(f) Lewis number

(g) Sherwood number

5. How is thermal performance of a fin measured ? Under what situations does the fin efficiency become 100% ? *10*

6. (a) Show that the Reynolds number for flow through a tube of diameter D can be expressed as

$$R_e = \frac{4\,\dot{m}}{\pi D \mu}$$

where $\dot{m}$ = mass flow rate,

μ = coefficient of viscosity.

(b) Explain the mechanism of convection heat transfer. *5+5*

7. A flat square electrical heater of 0·5 m × 0·5 m is placed vertically in still air at 20°C. The heat generated is 1200 W/m^2. Determine the value of natural convection coefficient and average temperature of the plate. *10*

8. Discuss the modes of condensation. Why is dropwise condensation preferred ? What are the practical difficulties in retaining dropwise condensation on a surface ? *10*

9. (a) What is a black body ? What are its properties ? Why does a cavity with a small hole behave as a black body ?

   (b) Explain Kirchhoff's law. *5+5*

10. (a) What are heat exchangers ? Where are they used ?

    (b) State the modes of mass transfer with suitable examples. *5+5*