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BIME-034

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

Term-End Examination

00906

June, 2016

BIME-034 : HEAT AND MASS TRANSFER

Time : 3 hours *Maximum Marks : 70*

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

1. (a) State Fourier law of heat conduction and by using it derive an expression for steady state heat conduction through a plane wall of thickness L that maintains its two surfaces at temperatures T_1 and T_2 respectively.

(b) The wall of a furnace is constructed from 15 cm thick fire brick having constant thermal conductivity of 1·6 W/(m.K). 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 ? 7+7

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

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

where :

r_1 = inner radius

r_2 = outer radius

L = length of cylinder

K = thermal conductivity of material

(b) A furnace wall is made up of three layers, one of brick, one of insulating brick and one of red brick. The inner and outer surfaces are at 870°C and 40°C respectively. The respective thermal conductivities of the layers are 1·17 W/(m.K), 0·139 W/(m.K) and 0·875 W/(m.K) respectively and thicknesses are 22 cm, 7·5 cm and 11 cm. Assuming close bonding of the layers at their interfaces, find out the rate of heat loss per square metre per hour. *7+7*

3. (a) Explain the concept of black body and grey body in radiation terminology.

(b) Define Fick's first law and second law of diffusion. Describe the various mechanisms of mass transfer. 7+7

4. (a) Distinguish between natural and forced convection heat transfer.

(b) Derive an expression of overall heat transfer co-efficient based on outer surface area. 7+7

5. (a) What is meant by thermal resistance ? Explain the electrical analogy for solving heat transfer problems.

(b) Classify the heat exchangers according to the flow direction of fluid and give few examples of each in actual field of application. 7+7

6. (a) Prove that the shape factor of a cylindrical cavity of diameter D and height H with respect to itself is $F_{1\to1} = \frac{4H}{4H+D}$.

(b) The sun emits maximum radiation at wavelength of $\lambda = 0{\cdot}52$ micron. Assuming the sun as a black body, find the surface temperature of the sun and emissive power at that temperature. 7+7

7. Write short notes on any ***four*** of the following : $4 \times 3\frac{1}{2} = 14$

(a) Steady State Heat Conduction

(b) Fin Efficiency

(c) Wien's Displacement Law

(d) Laminar Flow

(e) Green House Effect

(f) Lumped Heat Capacity System