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BIME-034

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

Term-End Examination

December, 2017

00382

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.*

1. (a) What are the three 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. 7+7

2. (a) What is natural convection ? How does it differ from forced convection ? What forces cause natural convection currents ?

(b) A large window glass, 0·50 cm thick (k = 0·78 W/m-K) is exposed to warm air at 25°C over its inner surface, with convection coefficient of 15 W/m^2-K. The outside air is at – 15°C with convection coefficient of 50 W/m^2-K. Determine the heat transfer rate and temperature at the inner and outer surfaces of the glass. 7+7

3. (a) Define Laminar and Turbulent flows with examples. What is Reynolds number ?

(b) An exterior wall of a house consists of a 10·16 cm layer of common brick having thermal conductivity 0·7 W/m-K. It is followed by a 3·8 cm layer of gypsum plaster with thermal conductivity of 0·48 W/m-K. What thickness of loosely packed rockwool insulation (k = 0·065 W/m-K) should be added to reduce the heat loss through the wall by 80% ? 7+7

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

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

(b) A furnace wall is made of three layers. First layer is of insulation (k = 0·6 W/m-K), 12 cm thick. Its face is exposed to gases at 870°C with convection coefficient of 110 W/m^2-K. It is covered (backed) with a 10 cm thick layer of fire brick (k = 0·8 W/m-K) with a contact resistance of $2·6 \times 10^{-4}$ m^2-K/W between the first and the second layers. The third layer is a plate of 10 cm thickness (k = 4 W/m-K) with a contact resistance between second and third layers of $1·5 \times 10^{-4}$ m^2-K/W. The plate is exposed to air at 30°C with convection coefficient of 15 W/m^2-K. Determine the heat flow rate and overall heat transfer coefficient. 7+7

5. (a) What is Rayleigh number ? Why is the heat transfer coefficient for natural convection much less than that for forced convection ?

(b) What is a Black Body ? What are its properties ? Why does a cavity with a small hole behave as a black body ? 7+7

6. (a) Why does mass transfer take place ? State the modes of mass transfer with suitable examples.

(b) Define the following :

(i) Mass fraction

(ii) Mole fraction

(iii) Molar concentration

(iv) Mass flux

(v) Molar flux 7+7

7. (a) Give examples of industrial applications where mass transfer takes place.

(b) Write short notes on any ***two*** of the following :

(i) Biot Number

(ii) Solar Radiation

(iii) Heisler Chart

(iv) Logarithmic Mean Temperature Difference (LMTD) 7+7