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BIME-034

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

00153

Term-End Examination

June, 2018

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.*

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1. (a) State the Fourier law of heat conduction and by using it, derive an expression for steady state heat conduction through a plane wall of thickness 'L' maintains its two surfaces of temperature T_1 and T_2 respectively. Thermal conductivity = K.

(b) Determine the heat transfer rate by convection over a surface of 1 m^2, if a surface at 100°C is exposed to a fluid at 40°C with convection coefficient of 25 W/m^2-K. 7+7

2. (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 $\dot{m}$ = Rate of mass flow of fluid,
μ = Viscosity of fluid.

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

(i) the overall heat transfer coefficient, and

(ii) the overall thermal resistance per m^2. 7+7

3. (a) What do you mean by critical radius of insulation ? Explain its concept with the help of material and surface resistance.

(b) A square plate heater (size 15 cm × 15 cm) is inserted between two slabs. Slab 'A' is 2 cm thick (k = 50 W/m-K) and Slab 'B' is 1 cm thick (k = 0·2 W/m-K). The outside heat transfer coefficient on both sides of 'A' and 'B' are 200 W/m^2-K and 50 W/m^2-K respectively. The temperature of surrounding air is 25°C. If the rating of the heater is 1 kW, find

(i) the maximum temperature in the system, and

(ii) the outer surface temperature of the two slabs. 7+7

4. (a) Show that the resistance offered by a hollow sphere of radii r_1, r_2 and constant thermal conductivity is given by

$$R_{sph} = \frac{r_2 - r_1}{4\pi r_1 r_2 k}.$$

(b) A steel tube (k = 45 W/m-K) of outside diameter 7·6 cm and thickness 1·3 cm is covered with an insulating material (k = 0·2 W/m-K) of thickness 2 cm. A hot gas at 330°C with convection coefficient of 200 W/m^2-K, is flowing inside the tube. The outer surface of the insulation is exposed to ambient air at 30°C, with convection coefficient of 50 W/m^2-K.

Calculate

(i) the heat loss to air from the 5 m long tube, and

(ii) the temperature drop due to thermal resistances of the hot gases, steel tube, the insulation layer and the outside air. 7+7

5. (a) Explain Fick's law of diffusion. What is mass diffusivity ?

(b) What are the different types of heat exchangers ? Explain any two. 7+7

6. (a) What is fouling of heat exchangers ? Describe the fouling processes and the factors affecting them.

(b) What are the types of condensation processes ? Briefly explain the dropwise condensation. 7+7

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

(a) Lewis Number

(b) Schmidt Number

(c) Shape Factor

(d) Thermal Boundary Layer

(e) Transient Heat Conduction

(f) Stefan-Boltzmann Law