Code : 021616

B.Tech 6th Semester Examination, 2017

Health Mass Transfer

Time : 3 hours *Full Marks : 70*

Instructions :

(i) *There are **Nine** Questions in this Paper.*

(ii) *Attempt **Five** questions in all.*

(iii) ***Question No. 1 is Compulsory.***

(iv) *The marks are indicated in the right-hand margin.*

1. Answer any SEVEN questions by writing True or False: 2×7=14

(a) Heat transfer takes place according to Second law of thermodynamics.

(b) Prandtl number is the ratio of thermal conductivity to electrical conductivity

(c) Up to the critical radius of insulation added insulation increases heat transfer

(d) Newton's law of cooling is related to convection mode of heat transfer

(e) The unit of Dynamic viscosity is m^2/s

(f) Nusselt number is a function of Grashoff number and Prandtl number for forced convection

(g) Thermal diffusivity of a substance is directly proportional to thermal conductivity

(h) long thick fins should be used

(i) For polished surfaces reflectivity is high

(j) Ice is very close to a Black body

2. Derive the general three dimensional heat conduction equation in Cylindrical co-ordinate system. From the general equation derive one dimensional steady state heat conduction equation for a homogeneous and isotropic material without internal heat generation. 14

3. A refrigerator has inside dimensions 60 cm × 45 cm base and 120 cm high. The composite wall is made of two 3 mm mild steel sheets (K=145 kJ/m hr°C) with 6 cm glass wool (K=0.188 kJ/m hr°C) insulation sandwiched between them. The average convective heat transfer coefficients at the interior and exterior wall are 40.8 and 52.3 kJ/m^2 hr °C respectively. The inside and outside temp. of air are 6.5°C and 25°C. Determine the rate at which heat must be removed from the refrigerator. Also determine the temperature at each contact surfaces. 14

4. (a) Derive the expression for temperature distribution at any section x of a plane wall with uniform heat generation when temperature of both sides are same. 10

(b) Define and explain the physical significance of Biot and Fourier Number. 4

5. A copper (K=396 W/m K) 0.25 cm in diameter protrudes from a wall at 95°C into ambient air at 25°C. The heat transfer coefficient is 10 W/m² K. Calculate the temperature at the end and heat loss if (a) the fin is infinitely long, (b) the fin is 2.5 cm long with and without insulated end. 14

6. Water at the rate of 4 kg/s is heated from 35 to 55°C in a shell and tube exchanger. On the shell side one pass is used with water as the heating fluid at the rate of 2 kg/s entering the exchanger at 95°C. The overall heat transfer coefficient is 1420W/m²K and the average water velocity in the 20 mm diameter tubes is 0.4 m/s. Because of space limitations the tube length must not be longer than 2.5m Calculate: 14

(i) the number of tube passes

(ii) the number of tubes per pass, and

(iii) the length of the tubes consistent with this restriction

Take correction factor = 0.88 if required

7. (a) Differentiate between free and forced convection. 2

(b) Air at 2 atm and 20°C is heated as it passes through a tube of 25 mm inside diameter with a velocity of 10 m/s. The temperature of the tube wall is maintained at 100°C. Calculate: 12

(i) the heat transfer per unit length of the tube

(ii) the bulk temperature change over a 3 m length of the tube.

Take for air : $\mu = 19.6 \times 10^{-6}$ kg/m s, $C_p = 1005$ J/kg K, K=0.0283 W/m K, Pr = 0.68

8. Air at 35°C and 1 atm flows at a velocity of 60 m/s over 14

(a) a flat plate 0.5 m long

(b) a sphere 5 cm in diameter

Calculate the mass transfer coefficient of water vapor in air. Neglect the concentration of water vapor in air. Take: diffusion coefficient of water vapor in air=0.256×10^{-4} m²/S, For air: $\mu = 2 \times 10^{-5}$ kg/m s, $C_p = 1.006$kJ/kg k, Pr = 0.706

9. (a) Explain the following terms: 4

(i) Black body

(ii) Gray Body

(iii) Monochromatic emissive power

(iv) Emissivity

(b) Derive the Stefan-Boltzmann law from Planck's law of thermal radiation. 10

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