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A – 2817

Reg. No. : ....

Name : ....

Sixth Semester B.Tech. Degree Examination, May 2016
(2008 Scheme)
08.604 : HEAT AND MASS TRANSFER (MU)

Time : 3 Hours | Max. Marks : 100

Instructions : *1) Answer **all** questions from Part **A** and **one full** question from **each** Module of Part **B**.*

*2) Heat and Mass Transfer data book is **permitted**.*

PART – A **(10×4=40 Marks)**

1. What are the factors influencing the value of thermal conductivity of a material ?

2. Explain thermal contact resistance and the methods used for reducing thermal contact resistance.

3. Write down the general heat diffusion equation in Cartesian coordinate system and explain each term.

4. Define Prandtl number and explain its significance heat transfer.

5. Explain the hydrodynamic and thermal entry length for an internal flow.

6. Explain critical thickness of insulation.

7. Explain different modes of pool boiling.

8. Differentiate between monochromatic and total emissive power.

9. Explain what is a grey body and its significance.

10. Explain the analogy between heat and mass transfer.

PART – B

Module – 1

11. a) A cylinder of radius r_0, length L, and thermal conductivity k is immersed in a fluid of convection coefficient h and unknown temperature T_∞. At a certain instant the temperature distribution in the cylinder is $T(r) = a + br^2$, where a and b are constants. Obtain expressions for the heat transfer rate at r_0 and the fluid temperature. 10

b) A heat rate of 3 kW is conducted through a section of an insulating material of C S area 10 m^2 and thickness 2.5 cm. If the inner surface temperature is 415° C and the thermal conductivity of the material is 0.2 W/m-k, what is the outer surface temperature ? 10

12. a) Derive the heat diffusion equation in cylindrical coordinates. 10

b) The temperature distribution across a wall 1 m thick at a certain instant of time is given as $T(x) = a + bx + cx^2$, where T is in degree Celsius and x is in meters, while a = 900° C, b = –300° C/m and c = –50° V/m^2. A uniform heat generation, q = 1000 W/m^3, is present in the wall of area 10 m^2 having the properties ρ = 1600 kg/m^3, k = 40 W/mK, and c_p = 4kJ/kg.K. Determine : i) the rate of heat transfer entering the wall (x = 0) and leaving the wall (x = 1m). ii) the rate change of energy storage in the wall. 10

Module – 2

13. a) Show that the local heat transfer coefficient in a thermally fully developed internal flow does not change in the direction of flow. 10

b) Consider atmospheric air at 25° C and a velocity of 25m/s flowing over both the surface of a 1 m long flat plate that is maintained at 125° C. Determine the rate of heat transfer per unit width from the plate for the values of the Reynolds number corresponding to 10^5, 5×10^5 and 10^6. 10

14. a) Derive the expression for LMTD for a counter flow heat exchanger. 10

b) Determine the percentage increase in HT associated with attaching aluminum fins of rectangular profile to a plane wall. The fins are 50 mm long, 0.5 mm thick and are equally spaced at a distance of 4 mm (250 fins/m). The HT coefficient associated with bare wall is 40 W/m^2 K, while that resulting from attachment of the fins is 30 W/m^2 K. 10

Module – 3

15. a) From Planck's law derive Stefan-Boltzmann law. 10

    b) Liquid air boiling at-153° C is stored in a spherical container of diameter 320 mm. The container is surrounded by a concentric spherical shell of diameter 360 mm in a room at 27° C. The space between the two spheres is evacuated. The surfaces of the spheres are flushed with aluminium ($\varepsilon = 0.03$). Taking the latent heat of vaporization of liquid air as 210 kJ/kg, find the rate of evaporation of liquid air. 10

16. a) Determine the fraction of the total, hemispherical emissive power that leaves a diffuse surface in the directions $\pi/4 \leq \theta \leq \pi/2$ and $0 \leq \varphi \leq \pi$. 10

    b) A mixture of CO_2 and N_2 is in a container at 25°C, with each species having a partial pressure of 1 bar. Calculate the molar concentration, the mass density, the mole fraction, and the mass fraction of each species. 10
