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M.Tech.(ME)   (Sem.–1)
ADVANCE HEAT AND MASS TRANSFER
Subject Code : MME-503
M.Code : 38204

Time : 3 Hrs.   Max. Marks : 100

INSTRUCTIONS TO CANDIDATES :
1. **Attempt any FIVE questions out of EIGHT questions.**
2. **Each question carries TWENTY marks.**

1. Derive the one dimensional steady state conduction equation with internal distributed heat source.

2. a) Alloy tool steels can be hardened by cooling them in air or oil. A rectangular block 10cm long, 2cm wide and 2cm thick is hardened by heating it to 890°C and cooling it. Estimate the time required to cool it from 890°C to 400°C and the rate of cooling when its temperature is 500°C if it is cooled (i) in a current of air at 30°C with a surface heat transfer coefficient of $110W/m^2°C$, (ii) by immersing it in a large bath of oil at 30°C with convective heat transfer coefficient of $200W/m^2°C$. The properties of alloy steel are; $c_p = 580j/kg K, k = 28 W/m K$ and $\rho = 7850kg/m^3$.

    b) What is internal energy generation? Give some examples where internal energy generation occurs.

3. Steam is generated on the surfaces of tubes (surrounded by water) with pressurized water flowing inside 25mm I.D. tubes. At a distance of 2.5m from the inlet of the tube, the velocity of the water is 3 m/s and the temperature of the water is 280°C. The tube surface is at 250°C. To get an appreciation of the values of the heat transfer coefficients from the different correlations, find the convective heat transfer coefficient by different correlations.

4. a) Give the difference between heat transfer in laminar flow and turbulent flow.

    b) Discuss Reynold's analogy between skin friction aad heat transfer.

5. Briefly explain the following :

    a) Planck's Law

    b) Lambert's cosine law

    c) Explain Absorptivity, Reflectivity and Transmissivity and give relations between them.

6. A $0.5m^2$ plane, gray, diffuse, opaque surface with a = 0.7 is maintained at 500°C. With an irradiation G, of 10,000W/m^2, determine the following :

   (a) Absorbed energy

   (b) Emitted energy

   (c) Total energy leawng the surface per unit area

   (d) Radiant energy emitted by the surface in the wave band of 0.2 μm to 4 μm Net radiative heat transfer rate from the surface.

7. In a laboratory experiment, air at 347K and 1 atm flows at a high speed around a single naphthalene ($C_{10}H_8$) sphere, this sublimates partially. When the experiment begins, the diameter of the sphere is 2.0cm. At the end of the experiment, 14.32min later, the diameter of the sphere is 1.85cm. Estimate the mass-transfer coefficient when the driving force is expressed in terms of molar concentrations. The density of naphthalene is 1.145g/cc and its vapour pressure at 347K is 670Pa. Molecular weight of naphthalene is 128.2.

8. a) Explain Fick's law of Diffusion.

   b) Explain :

      (i) Convective Mass transfer

      (ii) Mass Transfer Coefficient

NOTE : Disclosure of Identity by writing Mobile No. or Making of passing request on any page of Answer Sheet will lead to UMC against the Student.