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(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 4078 Roll No.

B.Tech

(SEM V) ODD SEMESTER THEORY EXAMINATION 2009-10

HEAT & MASS TRANSFER

Time : 3 Hours] *[Total Marks : 100*

Note : *Attempt all questions. The figures on the **right** hand side indicate marks. Use of Heat transfer data book permitted.*

1 Attempt any **two** parts of the following : **10×2=20**

(a) Derive an expression for the steady state overall heat transfer coefficient for a composite hollow cylinders, whose inner surface is exposed to hot fluid and outside surface is exposed to a cold fluid.

(b) The interior of a refrigerator having inside dimensions 60×50 cm base area and 1.2 m height, is to be maintained at 7°C. The walls of the refrigerator are constructed of two mild steel sheets 3 mm thick with 5 cm of glass wool insulation between them. If the convective heat transfer coefficients at inner and outer surfaces are 11.6 and 14.5 W/m^2-°C respectively, estimate the rate at which heat must be removed to maintain the specified temperature in the kitchen at 28°C. What will be the temperature at the surface of wall?

K (glasswool) = 0.0464 W/m-°C.

K (mild steel) = 46.44 W/-°C.

(c) An electric cable 1.2 cm O.D. has to be insulated with rubber (K = 0.15 W/mK). The cable is to be located in air (h_o = 8.7 W/m^2 - °C) at 18°C. Calculate :
(i) the heat dissipation from bare pipe (cable)
(ii) the maximum heat dissipation and
(iii) the critical thickness of insulation assuming a cable surface temp of 70°C.

2 Attempt any **two** parts of the following : **10×2=20**

(a) What is the effectiveness of fin ? Calculate the amount of energy required to solder together two very long pieces of bare copper wire 1.5 mm in diameter with solder that melts at 190°C. The wires are positioned vertically in air at 20°C. Assume that heat transfer coefficient on wire surface is 20 W/m^2-°C and thermal conductivity of wire alloy is 330 W/m °C.

(b) Prove that for a body whose thermal resistance is zero, the temperature required for cooling or heating can be obtained from the relation :

$$\frac{t - t_a}{t_i - t_a} = \exp\left[-B_i F_o\right]$$

where the symbols have their usual meanings.

(c) A steel ball of 5 cm diameter at 500°C is suddenly placed in a controlled environment maintained at 100°C. Taking following data find the time required to maintain centre point temperature of 150°C in the ball.
C_p = 450 J/kg °C
K = 35 W/M-C
h = 10 W/m^2 - K
p = 8000 kg/m^3.

3 Attempt any **two** parts of the following : **10×2=20**

(a) Prove that the heat transfer coefficient is independent of axial location for thermally fully developed flow of a fluid of constant properties through a pipe.

(b) Air flows over a flat plate at a velocity of 3 m/s and ambient conditions are the pressure is 760 mm of Hg and temperature is 15°C. The plate is maintained at 85°C. If the length of the plate is 100 cm long the flow of air, find out the heat lost by 50 cm of the plate, which is measured from the trailing edge. Width of the plate is 50 cm. Properties of air at 50°C are
ρ = 1.093 kg/m^3, C_p = 1.005 kJ/kg-K,
K = 2.824 x 10^{-2} W/m-K, P_r = 0.698
V = 17.95 x 10^{-6} m^2/s.

(c) Differentiate between
(i) Natural and forced convection
(ii) Hydrodynamic and thermal boundary layer thickness.
(iii) Reynold's number and Grashoff's number.

4 Attempt any **two** parts of the following : **10×2=20**

(a) Explain self radiation rule, summation rule and reciprocity rule for shape factor algebra. A cylindrical cavity of diameter 10 cm and depth 20 cm is maintained at 60°C. Find the heat transfer rate from this cavity to atmosphere at 30°C. Assume cavity and atmosphere to be black bodies.

(b) Two parallel plates are at temperatures T_1 and T_2 and have emissivities $\epsilon_1 = 0.8$ and $\epsilon_2 = 0.5$. A radiation shield having the same emissivity ϵ_3 on both sides is placed between the plates. Calculate the emissivity ϵ_3 of the shield in order to reduce the radiation loss from the system to one-tenth of that without the shield.

(c) Derive an expression for surface resistance of a gray body. Derive an expression for radiation heat exchange between small gray body in a large gray enclosure.

5 Attempt any **two** parts of the following : **10×2=20**

(a) (i) Discuss the various regimes of saturated pool boiling.

(ii) Differentiate between the mechanism of filmwise and dropwise condensation.

(b) Discuss Fick's law of diffusion. Derive expression for steady state equimolar counter diffusion.

(c) Derive expression for effectiveness of parallel flow heat exchanger in terms of NTU.
