T.E Sem. V (CBSGS) Mech — Heat Transfer
19/12/16

Q. P. Code : 600902

[3 Hours]

[Total Marks:80

Notes: 1) Question no.1 is **compulsory.**
2) Attempt any **THREE** from questionno.2 to 6.
3) Use illustrative diagrams wherever possible.
4) Use of Steam table is permitted.
5) Assume suitable data wherever required.

1. Solve any **Four :-** 20

a) Draw a neat boiling curve for water and mark the different boiling regimes.

b) A steel ball 50mm in diameter and at 900^{0}C is placed in still atmosphere of 30^{0}C.Calculate the initial rate of cooling of the ball in ^{0}C/min.
Take ρ = 7800 kg/m^3 , C = 2 kJ/kg^{0}C(for steel), h=30W/m^2 ^{0}C.Neglect internal thermal resistance .

c) Explain non dimensional numbers used in convection heat transfer.

d) Explain briefly the term thermal capacity and thermal diffusivity of material.

e) Define intensity of radiation.What is a solid angle? What is its unit?

2. a) A wall of a furnace is made up of inside layer of silica brick120 mm thick covered with a layer of magnesite brick 240 mm thick. The temperature at inside surface of silica brick wall and outside surface of magnesite brick wall are 725°C and 110°C respectively. The contact thermal resistance between the two walls at the interface is 0.0035°C/W per unit wall area. If thermal conductivities of silica and magnesite bricks are 1.7W/m°C and 5.8 W/m°C, calculate. 10
(i) The rate of heat loss per unit area of walls.
(ii) The temperature drop at interface.

b) Derive the formula for rate of heat transfer for an insulated tip fin from the differential equation 10

$$\frac{d^2\theta}{dx^2} - m^2\theta = 0$$

3. a) Air at 30^{0}C flows with a velocity of 2.8 m/s over a plate 1000 mm (length) X 600 mm (width) X 25mm (thickness). The top surface of the plate is maintained at 90^{0}C. If the thermal conductivity of the plate material is 25 W/m^{0}C, calculate: i) heat lost by the plate; ii) bottom temperature of the plate for the steady state condition. The thermo – physical properties of air at mean file temperature at 60^{0}C are ρ = 1.06 kg/m^3, k = 0.02894 W/m^{0}C, C_p= 1.005 kJ/kg^{0}C, Pr = 0.696; ν = 18.97 x 10^{-6} m^2/s. Choose the appropriate relation from the following: 10
$\overline{Nu}$ = 0.664 $(Re_L)^{1/2}$ $(Pr)^{1/3}$ – For Laminar flow;
$\overline{Nu}$ = 0.036 $(Re_L)^{0.8}$ $(Pr)^{1/3}$ – For Turbulent flow

b) With the help of dimensional analysis method prove that for free convection 10
Nu=constant x $(Gr.)^m$ x$(Pr.)^n$

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4. a) State and explain the reciprocity theorem. Derive the equation $A_1 F_{1-2} = A_2 F_{2-1}$. 10
   b) An electric wire of 0.25mm diameter ,ε=0.4 is placed within a tube of 2.5 mm diameter, ε=0.6 having negligible thickness.This tube in turn is placed concentrically within a tube of 5 mm diameter , ε=0.7.Annular spaces can be assumed to be evacuated completely. If the surface temperature of the outer tube is maintained at 5^0C, what must be the temperature of wire so as to maintained the temperature of inner tube at 120^0C? 10

5. a) Derive the expression for log mean temperature difference in a counter flow heat exchanger. State your assumption. 08
   b) In a certain double pipe heat exchanger hot water flows at the rate of 50000 kg/hr and gets cooled from 95°C to 65°C. At the same time 50000 kg/hr of cooling water at 30^0C enters the heat exchanger. The flow conditions are such that overall heat transfer coefficient remains constant at 2270W/m^2K.Determine the heat transfer area required and the effectiveness, assuming two streams are in parallel flow. Assuming for the both streams C_p = 4.2 kJ/kg K. 08
   c) Explain Heat Exchangers effectiveness. 04

6. a) Write short note on **any Two** of the following - 08
      i) Heisler Chart.
      ii) Explain efficiency and effectiveness of fin.
      iii) Time constant of thermocouple.
   b) Explain Hydrodynamic and thermal boundary layer. 04
   c) A steel rod (K= 32 W/m°C), 12 mm in diameter and 60 mm long, with an insulated ends to be used as spine. It is exposed to surroundings with a temperature of 60°Cand a heat transfer coefficient of 55 W/m^2°C. The temperature at the base of the fin is 95°C. Determine- 08
      (i) The fin efficiency
      (ii) The temperature at the edge of the spine:
      (iii) The heat dissipation.

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