TE - Sem-V - OLD - Mech

HMT

11/12/15

QP Code : 1782

(3Hours) [TOTAL MARKS 100

NB:

1) Question No:1 is compulsory
2) Answer any 4 from the remaining.
3) Assume suitable data if necessary.

Q-1 Answer any 4 questions. [20]

a) Find the heat flux across a slab of width 0.3m when its one surface is at 250°C and the other surface is at 30°C. Take the thermal conductivity of the materials as 388 W/m° K.

b) Assuming sun to be a black body emitting radiation with maximum intensity at wavelength, λ = 0.49μm. Calculate the surface temperature of the sun and the heat flux at the surface. ($\sigma = 5.67 \times 10^{-8}$ W/m^2K^4)

c) Draw the temperature profile for parallel and counter flow heat exchangers.

d) Define forced convection and Natural convection with appropriate examples.

e) What is lumped system analysis?

Q-2 a) Derive general differential equation of conduction in Cartesian coordinates. [10]

b) A pipe carrying steam at 230°C has an internal diameter of 12cm and the pipe thickness is 7.5mm. The conductivity of pipe material is 49 W/mK and the heat transfer coefficient on the inside is 85W/m^2K. The pipe is insulated by two layers of insulation one of 5cm thickness of conductivity 0.15 W/mK and over it another 5 cm thickness of conductivity 0.48 W/mK. The outside is exposed to air at 35°C with a convection coefficient of 18W/m^2K. Determine the heat loss for 5 m length. Also determine the interface temperature. [10]

Q-3 a) Define thermal boundary layer. [4]

b) Define critical thickness of insulation and derive an expression of critical radius for a cylinder. [6]

c) A wire of 8mm diameter at a temperature of 60°C is to be insulated by a material having conductivity, k = 0.174 W/m-K. Given, h_o= 8W/m^2-K and ambient temperature = 25°C, what is the minimum thickness of insulation and heat loss per meter length for maximum heat loss? Also find the increase in heat dissipation due to insulation. [10]

[TURN OVER

Q-4 a) A solid copper sphere of 10 cm diameter (ρ =8954 kg/m^3,C_p =383 J/kg-K, k= 386 W/m-K),initially at a uniform temperature t_i = 250°C, is suddenly immersed in a fluid which is maintained at a uniform temperature t_a =50°C. The heat transfer coefficient between the sphere and the fluid is h=200W/m^2-K. Determine the temperature of the copper sphere 5 minutes after the immersion. [10]

b) A steel rod (k = 30W/m C), 10 mm diameter and 50 mm long, with an insulated end is to be used as a spine. It is exposed to surroundings with a temperature of 65°C and a heat transfer coefficient of 50W/m^2K. The temperature of the base is 98°C. Determine (i) Fin efficiency (ii) temperature at the end of the fin (iii) heat dissipation. [10]

Q-5 a) For lumped heat analysis with usual notations prove that $\frac{\theta}{\theta o} = e^{-BiFo}$ [10]

b) Derive an equation for finding LMTD of a parallel flow heat exchanger. [10]

Q-6 a) Determine the radiant heat exchange in W/m^2 between two large parallel steel plates of emissivity 0.8 and 0. 5 held at temperatures 727°C and 227°C respectively, if a thin copper plate of emissivity 0.1 is introduced as a radiation shield between the two plates. Use σ = 5.67 x 10^{-8} W/m^2 K^4. [10]

b) In a double pipe parallel flow heat exchanger 2.8 kg/sec of oil (Cp = 2095 J/kg-K) is cooled from 80°C to 50 °C by 2.5 kg/sec water entering at 25°C. Determine the area of the heat exchanger for an overall U = 300 W/m^2K. Take C_p for water as 4180 J/kg-K. [10]

Q-7 a) Define shape factor. What are the properties of shape factor. [6]

b) Define Fick's law of diffusion with description. [6]

c) A cylinder of 350 mm diameter and 1.65 m height with a surface temperature of 28°C is kept in a wind of velocity 30 kmph and temperature 12°C. Using the co-relation Nu = 0.027 $(Re)^{0.805}$ $(Pr)^{1/3}$, determine the heat loss from the cylinder. [8]
Properties of air at 20°C are k=2.59 x 10^{-2} W/m°C, ϑ =15.0 x10^{-6} m^2/sec, P_r =0.707.
