TE - sem - V - Mechanical
HMT
(old)

4/6/15

QP Code : 3723

(OLD COURSE)

(3 Hours) **[Total Marks : 100**

Instructions :

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

Q1 Answer any 4 questions [20]

a) What is hydrodynamic and thermal boundary layer?

b) Define thermal conductivity, thermal resistance and thermal conductance

c) Define Fin efficiency and Fin effectiveness

d) What is the mode of heat transfer in Vacuum? Define absorptivity, reflectivity and transmissivity.

e) How do the Heat exchangers are classified?

Q2 a) What is overall heat transfer coefficient? [4]

b) A brick (k = 1.2W/mK) wall 0.15 m thick separates combustion gases in a furnace from the atmospheric air at 30°C. The outside surface temperature is 100°C while the convective heat transfer coefficient is 20W/m^2K. Find the inner surface temperature of the brick wall. [6]

c) Derive the general three dimensional steady state differential equation for conduction without heat generation in Cartesian co-ordinates for isotropic material [12]

Q3 a) What is lumped system analysis? When is it applicable? [4]

b) 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=200 W/m^2-K. Determine the temperature of the copper block 5 minutes after the immersion. [10]

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

Q4 a) Derive an equation for finding LMTD of a parallel flow heat exchanger [10]

b) A product in a chemical plant (16.5kg/sec) at 650°C (cp = 3.55 kJ/kg°C)is used to heat 20.5kg/sec of the incoming fluid from 100°C (cp = 4.2 kJ/kg°C). If the overall heat transfer coefficient is 0.95kW/m^2 °C and the installed heat transfer surface is 44m^2, calculate the fluid out let temperatures for the parallel flow and counter flow arrangements. [10]

Q5 a) Define shape factor. What are the properties of shape factor. [6]

b) With the help of Buckingham π-theorem show that for a forced convection $Nu = C\,Re^m\,Pr^n$ [10]

c) Define Radiosity and Irradiation. [4]

[TURN OVER

RJ-Con. 11993-15.

Q6 a) Assuming that a man can be represented by a cylinder of 350 mm diameter and 1.65 m height with a surface temperature of 28°C. Calculate the heat he would lose while standing in a wind of 30 kmph at 12°C. Use the co-relation $Nu = 0.027 (Re)^{0.805} (Pr)^{1/3}$. [10]
Properties of air at 20°C are $k=2.59 \times 10^{-2}$ W/m°C, $\vartheta = 15.0 \times 10^{-6}$ m^2/sec,
$P_r = 0.707$.

b) An electric wire of 0.25 mm diameter, $\epsilon = 0.4$ is placed within a tube of 2.5 mm diameter, $\epsilon = 0.6$ having negligible thickness. This tube in turn is placed concentrically within a tube of 5 mm diameter, $\epsilon = 0.7$. Annular spaces can be assumed to be completely evacuated. If the surface temperature of outer tube is maintained at 5°C, what must be the temperature of wire so as to maintain the temperature of the inner tube at 120 °C. [10]

Q7 a) 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. (Stefan Boltzmann Constant = 5.67×10^{-8}) [6]

b) A longitudinal copper fin (k=380W/m-K) 600 mm long and 5 mm diameter is exposed to an air stream at 20°C. The convective heat transfer coefficient is 20 W/m^2-K. If the fin base temperature is 150°C, determine the rate of heat transfer and Fin efficiency. [8]

c) Define Reynolds number & Grashoff number by explaining the significance of each number. [6]
