Total No. of Questions : 12]

SEAT No. :

P1367

[Total No. of Pages : 4

[4858] - 113

T.E. (Mechanical) (Mechanical S/W) (Automobile)

HEAT TRANSFER

(2008 Pattern)

Time : 3 Hours] *[Max. Marks : 100*

Instructions to the candidates:

1) ***Answer three questions from Section - I and three questions from Section - II.***
2) ***Answers to the two sections should be written in separate answer books.***
3) ***Draw neat diagrams wherever necessary.***
4) ***Assume suitable data, wherever necessary.***
5) ***Figures to the right indicate full marks.***

SECTION - I

Q1) a) Differentiate between : **[6]**

i) Steady and Unsteady state heat transfer

ii) Conduction and Convection

b) Derive a general three dimensional heat conduction equation in Cartesian coordinate system. Reduce it as **[10]**

i) Poisson equation,

ii) Fourier equation,

iii) Laplace equation.

OR

Q2) a) A steel tube of 5 cm inner diameter and 8 cm outer diameter (k = 16 W/mK), is covered with an insulation of 3 cm thickness (k = 0.3 W/mK). A hot gas at 350°C with h = 400 W/m^{2}K flows inside the tube. Outer surface of the insulation is exposed to air at 30°C with h = 60 W/m^{2}K. Calculate the heat loss from the tube for 20 meter length. Also calculate the temperature at the interface of insulation and steel. **[8]**

b) A carbon steel plate (thermal conductivity = 45 W / m°C) 600 mm × 900 mm × 2.5 mm is maintained at 310°C. Air at 15°C blows over the hot plate. If convection heat transfer coefficient is 22 W / m^2 C and 250 W is lost from the plate surface by radiation, calculate the inside plate temperature. **[8]**

Q3) a) Explain the concept of Thermal contact resistance. What are the methods to minimize the thermal contact resistance? Give examples where thermal contact resistance is desirable and where it is undesirable. **[10]**

b) A 3mm diameter stainless steel wire (k = 20 W/m°C, resistivity 'ρ' = 10×10^{-8} Ωm) 100 metres long has a voltage of 100 V impressed on it. The outer surface of the wire is maintained at 100 °C. Calculate the centre temperature of the wire. If the heated wire is submerged in a fluid maintained at 50°C, find the heat transfer coefficient on the surface of the wire. **[8]**

OR

Q4) a) Derive an expression for critical radius of insulation for sphere with usual notations. Explain the significance of critical radius. **[10]**

b) A flat furnace wall is constructed of 114 mm layer of sil-o-cel brick, with a thermal conductivity of 0.138 W/mK backed by 229 mm layer of common brick (k = 1.38 W/mK). The temperature of inner face of wall is 760 °C and that of the outer face is 76 °C. Determine heat loss through the wall. If contact between two brick layers is poor and that a contact resistance of 0.09 °C/W is present, what would be the heat loss. **[8]**

Q5) a) Explain the following terms : **[8]**

i) Fin efficiency
ii) Fin effectiveness
iii) Biot Number
iv) Fourier Number

b) Derive the expression for Lumped heat capacity with usual notations. **[8]**

OR

Q6) a) Two long rods of the same diameter, one made of brass (k = 85 W / m °C) & other made of copper (k = 375 W / m °C) have one of their ends inserted into furnace. Both of the rods are exposed to the same environment. At a distance 105 mm away from the furnace end, the temp of brass rod is 120 °C. At what distance from the furnace end the same temperature would be recorded in the copper rod? **[8]**

b) A solid copper sphere of 10 cm diameter (ρ = 8954 kg/m^3, Cp = 383 J/kgK, k = 386 W/mK) is initially at a temperature of 250 °C is suddenly immersed in a well stirred fluid which is maintained at a uniform temperature of 50 °C. The heat transfer coefficient between the sphere and the fluid is h = 200 W/m^2K. Verify, whether lumped heat capacity method is applicable. If yes, determine the temperature of the copper sphere 5 minutes after the immersion. **[8]**

SECTION - II

Q7) a) Two large parallel plates with ε = 0.5 each, are maintained at different temperatures and are exchanging heat only by radiation. Two equally large radiation shields with surface emissivity 0.05 are introduced in parallel to the plates. Find the percentage reduction in net radiative heat transfer. **[8]**

b) Explain : **[10]**

i) Shape factor

ii) Emissivity

iii) Wien's Law

iv) Radiosity

v) Lambert's cosine law

OR

Q8) a) A filament of a 75 W light bulb may be considered as a black body radiating into a black enclosure at 70 °C. The filament diameter is 0.1 mm and length is 5 cm. Considering the radiation, determine the filament temperature. **[4]**

b) Determine the rate of heat loss by radiation from a steel tube of outside diameter 70 mm and 3 m long at a temperature of 227 °C if the tube is located within a square brick conduit of 0.3 m side and at 27 °C. Take ε_{steel} = 0.79 and ε_{brick} = 0.93 **[8]**

c) Explain the concept of surface resistance and space resistance. **[6]**

Q9) a) Explain the significance of : **[8]**

i) Nusselt Number, ii) Prandtl Number,

iii) Reynolds Number, iv) Grashoff Number

b) Air at 2 atmosphere pressure and 200 °C is heated as it flows at a velocity of 10 m/s through a tube with diameter of 3 cm with constant heat flux maintained at the wall with wall temperature 20 °C above the air temperature all along the length of tube. Calculate heat transfer per unit length of tube. **[8]**

Use $Nu = 0.023 (Re)^{0.8} (Pr)^{0.4}$

Properties of air are Pr = 0.681, $\mu = 2.57 \times 10^{-5}$ Ns/m^2, k = 0.0386 W/mK, Cp = 1.025 kJ/kgK.

OR

Q10) a) Compare Natural Convection with Forced Convection. **[6]**

b) Differentiate between Nusselt Number and Biot Number. **[4]**

c) Calculate the heat transfer from a 60 W incandescent bulb at 115 °C to ambient air at 25°C. Assume the bulb as a sphere of 50 mm diameter. Also find the percentage of power lost by free convection. **[6]**

Use $Nu = 0.6 (GrPr)^{1/4}$

Properties of air are k = 0.02964 W/mK, Pr = 0.694, $\upsilon = 20.02 \times 10^{-6}$ m^2/s.

Q11) a) Determine heat transfer surface area and length for a heat exchanger constructed from a 25.4 mm O.D. tube to cool 6.93 kg/min of a 95 % ethyl alcohol solution (Cp = 3810 J/kgK) from 65.6°C to 39.4 °C. Water at 10 °C is available as coolant at a flow rate of 6.3 kg/min. Take U = 568 W/m^{2}K. Calculate for **[8]**

i) Parallel flow ii) Counter flow

b) Derive the expression of LMTD for parallel flow heat exchanger with usual notations. **[8]**

OR

Q12) a) Explain Pool Boiling curve. **[8]**

b) In a tube type parallel flow heat exchanger, hot water at 80 °C is cooled to 65 °C by cold water entering at 20 °C and leaving at 35 °C. What would be the exit temperature if the flow rate of water is doubled? **[8]**

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