Total No. of Questions : 12]

SEAT No. :

P1597

[Total No. of Pages :4

[5058]-13
T.E.(Mech.)
HEAT TRANSFER
(2008 Course)(Semester-I)

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

Instructions to the candidates:

1) ***Answer to the two sections should be written in separate answer books.***
2) ***Answer any 3Questions from each section.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of non programmable calculator is allowed.***
5) ***Assume suitable data, if necessary.***

SECTION-I

Q1) a) State Fourier law of heat conduction with notations and deduce an expression for steady state heat conduction in a hollow cylinder of radii r_1 and r_2, subjected to temp T_1 and T_2. **[6]**

b) The walls of a house 4m high, 5m wide and 0.3 m thick are made with brick (k = 0.9W/m-K). Temperature of air inside house is 20°C and out side air is at -10°C. There is heat transfer coefficient of 10W/m^2-K at inside wall and 30W/m^2-K at outside wall. Calculate inside and outside wall temperatures heat flux and total heat transfer rate through the wall. **[10]**

OR

Q2) a) Define

i) Thermal conductivity and explain effect temperature on thermal conductivity of metals. **[3]**

ii) Electrical analogy for steady state heat conduction across a slab. **[3]**

b) A long hollow cylinder (k= 50 W/m-K) has an inner radius of 10 cm and outer radius of 20 cm. The inner surface is heated uniformly at constant rate of 1.16×10^5 W/m^2, while outer surface is maintained at 30°C. Calculate temperature at inner surface. **[10]**

Q3) a) Discuss the application of insulation on electrical cables. **[4]**

b) A hollow sphere of inside radius 30 mm and outside radius 50 mm is electrically heated at its inner surface at a constant rate of 10^5W/m^2. The outer surface is exposed to air at 30°C with h=170 W/m^2-K. Thermal conductivity of material is 20W/m-K. Calculate inner and outer surface temperatures. **[10]**

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c) Define thermal diffusivity. **[2]**

OR

Q4) a) Explain electrical analogy for steady state heat conduction through hollow sphere. **[4]**

b) Explain the concept of critical thickness of insulation on hollow cylinder with the help of material and surface resistances. **[6]**

c) Deduce an expression for overall heat transfer coefficient based on inner suface for 3 layers hollow cylinder of radii r_1, r_2, r_3, r_4 and length L. The cylinder is also subjected to convection heat transfer at inner and outer surfaces with h_1 and h_2 respt. **[6]**

Q5) a) Derive an expression for temperature distribution in constant cross sectional fin subjected temperature T_o at its base and insulated at its tip. **[6]**

b) Three identical straight fins, 10 mm in diameter and 120 mm long are exposed to an ambient with h= 32W/m^2-K. Compare their fin efficiency and relative heat flow performance. The material and thermal conductivity of three materials are **[12]**

Copper k= 380 W/m-K

Aluminium k= 210 W/m-K

Mild steel k= 45 W/m-K

OR

Q6) a) Define with physical significance

i) Biot Number **[3]**

ii) Fourier number **[3]**

b) A thermocouple junction in a form a 4 mm diameter sphere. The properties are

C = 420 J/kg.K k = 40 W/m-K

ρ = 800 kg/m^3 h = 40 W/m^2-K

The junction is initially at 40°C is inserted in a stream of hot air at 300°C.Find

i) Time constant

ii) After 10 minute exposure in air at 300°C junction is then kept in air stream at 30°C with h = 10 W/m^2-K for 20 seconds. Calculate the temperatures of junction at two states. **[12]**

SECTION-II

Q7) a) Define with notation and dimensions. **[8]**

i) Black body

ii) Irradiation

iii) Emissive power

iv) Radiosity

b) A spherical liquid oxygen tank 0.3 m in dia is enclosed concentrically in a spherical container of 0.4 m dia. The space in between is evacuated. The tank surface is at-183°C and has an emissivity of 0.2. The container outer surface is at 15C with emissivity of 0.25. Calculate net radiation heat exchange. **[8]**

OR

Q8) a) What is gray body approximation? **[6]**

b) Define radiation **[4]**

i) surface resistance and

ii) space resistance.

c) State **[6]**

i) Kirchoff's law

ii) Wien's displacement law

iii) Lambert cosine law

Q9) a) Make difference between natural and forced convection. **[4]**

b) Explain the physical mechanism of natural convection. **[4]**

c) Discuss the dimensional analysis for forced convection. **[8]**

OR

Q10)a) Define with physical significance **[6]**

i) Reynolds number

ii) Grashoff number

iii) Prandtl number

b) Water at 20°C flow through a small tube 1 mm in diameter with uniform velocity of 0.2m/s. The flow is fully developed and constant heat flux of 6kW/m^2 is imposed. How much further down water in tube will reach a temp of 74°C? **[10]**

The properties of water at 320K

ρ= 989 kg/m^3 C_p = 4180 J/kg.K

μ= 577 x 10^{-6} kg/ms k_f = 0.640 W/m-K.

Pr = 3.77

Q11)a) What are the different types of heat exchangers. Draw sketch of atleast two types. **[6]**

b) Derive an expression for LMTD for parallel flow heat exchanger. **[8]**

c) What do you mean by fouling of heat exchangers? Explain causes. **[4]**

OR

Q12)a) Compare film wise and dropwise condensation. **[4]**

b) State Limitations of LMTD method. **[4]**

c) A heat exchanger is required to cool 55000 kg/h of alcohol from 66°C to 40°C in a parallel flow heat exchanger using 40,000 kg/h of water entering at 5°C. Calculate **[10]**

i) Exit temperature

ii) Heat transfer rate

iii) Surface area required.

Take U = 580 W/m^2-K

C_p of alcohol = 3760 J/kg.K

C_p of water = 4180 J/kg.K