[Total No. of Questions - 9] [Total No. of Printed Pages - 4] (2125)

15170

B. Tech 5th Semester Examination

Heat Transfer (NS)

ME-313

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

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Attempt any five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators, Heat transfer data book and steam table is allowed.

SECTION - A

1. (a) Discuss the effect of various parameters on the thermal conductivity of solids.

   (b) A reactor's ball, 320 mm thick, is made up of an inner layer of fire brick (K = 0.84 W/m°C) covered with a layer of insulation (K = 0.16 W/m°C). The reactor operates at a temperature of 1325°C and the ambient temperature is 25°C.

   (i) Determine the thickness of fire brick and insulation which gives minimum heat loss.

   (ii) Calculate the heat loss presuming that the insulating material has a maximum temperature of 1200°C. (10×2=20)

[P.T.O.]

2. A 250 mm steam main, 210 metres long is covered with 50 mm of high temperature insulation (K = 0.092 W/m°C) and 40 mm of low temperature insulation (K = 0.062 W/m°C). The inner and outer surface temperatures as measured are 390°C and 40°C respectively. Calculate:

   (i) The total heat loss per hour,

   (ii) The heat loss per m^2 of pipe surface, and

   (iii) The total heat loss per m^3 of outer surface, and

   (iv) The temperature between two layers of insulation. Neglect heat conduction through pipe material. (20)

SECTION - B

3. (a) An average convective heat transfer coefficient for flow of 90°C air over a flat plate is measured by observing the temperature time history of a 40 mm thick copper slab (ρ = 9000 kg/m^3, c = 0.38 kJ/kg°C. K = 370 W/m°C) exposed to 90°C air. In one test run, the initial temperature of the plate was 200°C, and in 4.5 minutes the temperature decreased by 35°C. Find the heat transfer coefficient for this case. Neglect internal thermal resistance.

   (b) A steel ball 50 mm in diameter and at 900ºC is placed in still atmosphere of 30°C. Calculate the initial rate of cooling of the ball in °C/min, Take: ρ = 7800 kg/m^3, c = 2 kJ/kg°C (for steel); h = 30 W/m^{2o}C. Neglect internal thermal resistance. (10x2=20)

4. Air at 20°C and at a pressure of 1 bar is flowing over a flat plate at a velocity of 3 m/s. if the plate is 280 mm wide and at 56°C, calculate the following quantities at x = 280 mm, given that properties of air at the bulk mean temperature

$\left(\frac{20+56}{2}\right) = 38^{\circ}C$ are: ρ=1.1374 kg/m^3; K = 0.02732 W/m°C; c_p = 1.005 kJ/kgK; v = 16.768 × 10^{-6} m^3/s; Pr = 0.7.

(i) Boundary layer thickness,

(ii) Local friction coefficient,

(iii) Average friction coefficient,

(iv) Shear stress due to friction,

(v) Thickness of the boundary layer,

(vi) Local convective heat transfer coefficient,

(vii) Average convective heat transfer coefficient,

(viii) Rate of heat transfer by convection,

(ix) Total drag force on the plate, and

(x) Total mass flow rate through the boundary. (20)

SECTION - C

5. Calculate the following for an industrial furnace in the form of a black body and emitting radiation at 2500°C:

   (i) Monochromatic emissive power at 1.2 μm length,

   (ii) Wavelength at which the emission is maximum

   (iii) Maximum emissive power,

   (iv) Total emissive power, and

   (v) Total emissive power of the furnace if it is assumed as a real surface with emissivity equal to 0.9. (20)

6. Enumerate some salient features of thermal radiation. What position does thermal radiation occupy in the electromagnetic spectrum? What limits this band width on the short and long wavelength sides? (20)

[P.T.O.]

SECTION - D

7. Exhaust gases (c_p = 1.12 kJ/kg-deg) flowing through a tubular heat exchanger at the rate of 1200 kg/hr are cooled from 400°C to 120°C. The cooling rate is affected by water (c_p = 4.18 kJ/kg K) that enters the system at 10°C at the rate of 1500 kg/hr. If the overall heat transfer coefficient is 500 kJ/m^2-hr-deg, what heat exchanger area is required to handle the load for (a) parallel flow and (b) counter flow arrangement? (20)

8. A hot fluid at 200 °C enters a heat exchanger at a mass flow rate of 10^4 kg/h. Its specific heat is 2000 J/kg K. It is to be cooled by another fluid entering at 25°C with a mass flow rate 2500 kg/h and specific heat 400 J/kg K. The overall heat transfer coefficient based on the outside area of 20 m^2 is 250 W/m^{2}K. Find the exit temperature of the hot fluid when the fluids are in parallel flow. (20)

SECTION - E

9. (a) Explain briefly the terms thermal capacity and thermal diffusivity of a material.

   (b) What is meant by transient heat conduction?

   (c) What are Heisler charts?

   (d) Define radiation heat transfer

   (e) State Plank's law.

   (f) Define the terms absorptivity and transmittivity of radiation.

   (g) Define a geometrical or shape factor.

   (h) What is radiation shield?

   (i) What do you mean by fouling in heat exchangers?

   (j) What is turbulent flow? (10×2=20)