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10AU65

Sixth Semester B.E. Degree Examination, June/July 2016
Heat & Mass Transfer

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Heat transfer data book and steam tables are permitted.***

PART – A

1 a. Explain the basic equations for conduction, convection and radiation. **(06 Marks)**

b. Derive an expression for the heat flow rate through a hollow cylinder provided with two layers of insulation by taking into account of convective effects. **(06 Marks)**

c. A hollow sphere made up of steel having thermal conductivity of 45W/m°C. It is heated by means of a coil of resistance 100Ω which carries a current of 5amperes. The coil is located inside the hollow space at the centre. The outer surface area of the sphere is $0.2m^2$ and its mass is 32kg. Assuming the density of sphere material to be 8gm/cc, find the temperature difference between inner and outer surfaces. **(08 Marks)**

2 a. Explain critical insulation thickness. **(04 Marks)**

b. A brick wall of 5 m length, 3 m height and 250 mm thick has temperatures of 800°C and 20°C maintained on its bounding surfaces. Assuming that the thermal conductivity of the brick material is related to its temperature by the relation.

$K = 1.00[1+0.001\ T]$ W/m°C

Calculate the average thermal conductivity, thermal resistance and heat loss from the wall. What will the temperature at 100mm distance from the wall surface at 800°C.? **(10 Marks)**

c. An electronic unit during operation generates an energy equal to 50 mill watts and the temperature at the surface of the unit is found to be 95°C. To increase the rate of heat transfer, the device is provided with aluminum fins of square cross section 0.5 mm × 0.5 mm of length 1cm, the temperature of the surrounding is 30°C. the heat transfer coefficient is $12.5W/m^{2^\circ}C$ and the thermal conductivity of aluminum is 175 W/m°C. Determine the number of fins required to dissipate the heat generated by the unit. Assume heat transfer from the end of fin is neglected. **(06 Marks)**

3 a. With neat sketch explain lumped system analysis show that $\frac{T-T_\infty}{T_o-T_\infty} = e^{-BiFo}$ and $Q = \rho v c_p (T_o - T_\infty)\ [e^{-BiFo} - 1]$ **(10 Marks)**

b. The average heat transfer coefficient for the flow of 100°C air over a flate plate is measured by observing the time history of a thick copper slab exposed to 100°C air. In one test run the initial temperature of the plate was 210°C and in 5 minutes the temperature becomes 170°C. Calculate the heat transfer coefficient in this case. **(05 Marks)**

c. An cron sphere K = 60W/m°C, C_p = 460 J/kg°C, ρ = 7850 kg/m^3 ; α = 1.6×10^{-5} m^2/s of diameter 5cm is initially at a temperature of 225°C. Suddenly the surface of the sphere is exposed to an ambient air at 25°Cwith heat transfer coefficient $500W/m^{2^\circ}C$. Calculate :

i) Centre temperature at t = 2min

ii) Temp at a depth of 1cm from the surface at t = 2min **(05 Marks)**

4 a. With the help of dimensional analysis, correlate the free convection data. **(10 Marks)**

b. Hot fluid at 300°C flows through a horizontal pipe of 30cm outside diameter and 90cm long. The pipe is exposed to an atmosphere maintained at 20°C. Determine the natural convection heat transfer. **(10 Marks)**

PART – B

5 a. Explain the significance of

i) Reynolds's number
ii) Prandtl number
iii) Nusselt Number
iv) Grashoff number
v) Stanton number. **(10 Marks)**

b. Determine the rate of heat loss per hour from a wall of a building when the wind is flowing parallel to its surface with a speed of 2km/hr. The wall is 5m long and 3m high Temperature of the wall is 25°C and air temperature is 5°C. **(10 Marks)**

6 a. Derive an expression for LMTD of a parallel flow heat exchanger. **(10 Marks)**

b. Water enters a cross flow heat exchanger (both fluids unmixed) at 15°C and flows 7.5kg/s. It cools air (C_p = 1.005 kJ/kg°C) flowing at the rate of 10 kg/s with inlet temperature of 120°C. The overall heat transfer coefficient is 225 W/m^2°C and surface area of the heat exchanger is 240m^2. Determine the total heat transfer rate and outlet temperatures using NTU method. **(10 Marks)**

7 a. With the help of boiling curve, explain various regimes of boiling. **(08 Marks)**

b. A vertical tube of 50 mm diameter and 2 m long is exposed to steam at atmospheric pressure. The outer surface of the tube is maintained at a temperature of 80°C by circulating water though the tubes. Determine the rate of heat transfer and condensate mass flow rate. **(08 Marks)**

c. Dry saturated steam at a pressure of 2.45 bar condenser on the surface of a vertical wall of tube of height 1 m. The tube surface temperature is 117°C. Estimate the thickness of the condensate film at a distance of 0.2 m from the upper end of the tube. **(04 Marks)**

8 a. With neat sketch explain the concept of black body. **(06 Marks)**

b. State and prove Kirchhoff's law of radiation. **(06 Marks)**

c. Two large parallel planes having emissivities 0.3 and 0.5 are maintained at temperature 800°C and 300°C respectively. A radiation shield having emissivity of 0.05 on both sides is placed between the two planes. Calculate ;

i) Heat transfer per unit area without shield
ii) Heat transfer per unit area with shield
iii) Temperature of the shield. **(08 Marks)**

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