Exam.Code:0942
Sub. Code: 7061

2010

B.E. (Mechanical Engineering) Sixth Semester

MEC-604: Heat Transfer

Time allowed: 3 Hours **Max. Marks: 50**

NOTE: Attempt five questions in all, including Question No. I which is compulsory and selecting two questions from each Unit. Assume any missing data with appropriate values.

x-x-x

I. Answers the following:-

a) An important property of matter is defined by Fourier's law. What is it? What is its physical significance?

b) What is the difference between a local convection heat transfer coefficient and an average coefficient?

c) How is the Reynolds number defined? What is its physical interpretation?

d) What are the two possible arrangements for a concentric tube heat exchanger?

e) What are the characteristics of a blackbody? Does such a thing actually exist in nature? (5x2)

UNIT – I

II. A hollow cylinder with inner radius 30 mm and outer radius 50 mm is heated at the 10 inner surface at a rate of 10 5W/m^2 and dissipated heat by convection from outer surface into a fluid at 80°C with heat transfer coefficient of 400 W/m^{2}K. There is no energy generation and thermal conductivity of the material is constant at 15 W/m.K. Calculate the temperatures of inside and outside surfaces of the cylinder. (10)

III. a) Explain the criteria of selection of fins.

b) What is the difference between fin effectiveness and fin efficiency?

c) One end of a long rod 3 cm in diameter is inserted into a furnace with the outer end projecting into the outside air. Once the steady state is reached the temperature of the rod is measured at two points, 15 cm apart and found to be 140°C and 100°C, when the atmospheric air is at 30°C with convection coefficient of 20 W/m^2.K. Calculate the thermal conductivity of the rod material. (2,3,5)

IV. a) The crank case of an automobile is approximated as 0.6 m long, 0.2 m wide, and 0.1 m deep. Assuming that the surface temperature of the crank case is 350 K. Estimate the rate of heat flow from the crank case to atmosphere at 276 K at a road speed of 30 m/s. Assume that the vibration of the engine and chassis induce the transmission from laminar to turbulent flow very near to leading edge that for practical purposes the boundary layer is turbulent over the entire surface. Neglect the radiation and use for the front and rear surfaces, same heat transfer coefficient as for bottom and sides.

Use relation $Nu_L = 0.036\, Re_L^{0.8}\, Pr^{1/3}$

and $\rho = 1.092\ kg/m^3$,

$\mu = 19.123 \times 10^{-6}\ Ns/m^2$

UNIT – II

V. a) What does the view factor represent? When is the view factor from a surface to itself not zero?

b) State and explain Stefan Boltzmann law. Derive an expression for total emissive power of a black body. (4,6)

VI. a) Calculate the overall heat transfer coefficient based on outer surface of a steel pipe (k = 54 W/m.K) with inner and outer diameters as 25 mm and 35 mm respectively. The inside and outside heat transfer coefficients are 1200 $W/m^2 \cdot K$ and 2000 $W/m^2 \cdot K$ respectively.

b) What is a radiation shield ? Where is it used? (6,4)

VII. a) Explain the mechanism of laminar film condensation on a vertical plate.

b) The outer surface of a vertical tube 80 mm in outer diameter and 1 m long is exposed to saturated steam at atmospheric pressure. The tube surface is maintained at 50°C by flow of water through the tube. What is the rate of heat transfer to coolant and what is the rate of condensation of steam? Use following data.

Properties of saturated vapour and water

h_{fg} = 2257 kJ/kg, ρ = 975 kg/m^3,

ρ_v = 0.596 kg/m^3, k_f = 0.668 W/m.K,

$\mu = 375 \times 10^{-6}$ kg/ms.

$$h = 1.13 \left\{ \frac{g \rho (\rho - \rho_v) h_{fg} k_f^3}{\mu L (T_{sat} - T_s)} \right\}^{1/4}$$

(6,4)

x-x-x