5E6201

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B.Tech. V Sem. (Main/Back) Exam., 2014
Mechanical Engineering
5ME1A Heat Transfer (Common with AE)

Time : 3 Hours

Total Marks : 80
Min. Passing Marks : 24

Instructions to Candidates :
Attempt any five questions selecting one question from each unit. All questions carry equal marks. Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.

UNIT-I

1. (a) A 10 cm diameter copper ball is to be heated from 100°C to an average temperature of 150°C in 30 minutes. Taking the average density and specific heat of copper in this temperature range to be 8950 kg/m^3 and 0.395 kJ/kg°C, respectively, determine
   (i) The total amount of heat transfer to the copper ball.
   (ii) The average rate of heat transfer to the ball, and
   (iii) The average heat flux. **(10)**

   (b) Explain the effect of temperature on thermal conductivity on solid, liquid and gases. **(6)**

OR

1. (a) Explain the concept of critical thickness of insulation with a neat sketch and its applications. **(6)**

   (b) 1.2 kg of liquid water initially at 15°C is to be heated to 95°C in a teapot equipped with a 1200-W electric heating element inside. The teapot is 0.5 kg and has an average specific heat of 0.7 kJ/kg°C. Taking the specific heat water to be 4.18 kJ/kg°C and disregarding any heat loss from the teapot, determine how long it will take for the water to be heated. **(10)**

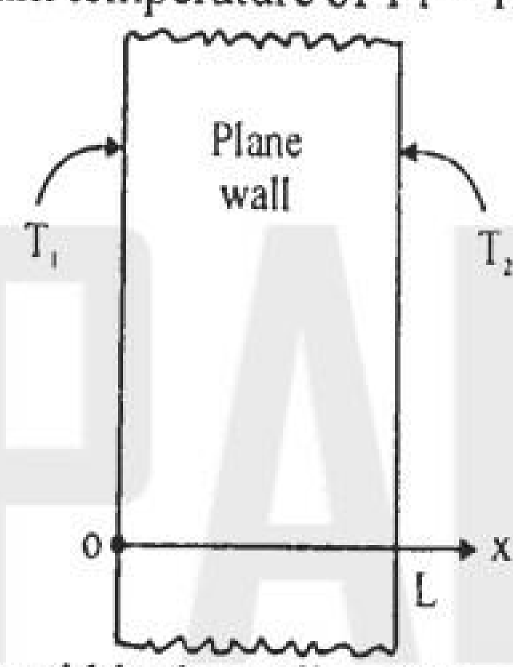
UNIT-II

2. (a) An aluminium fin [k = 200 W/m.°C] 3.0 mm thick and 7.5 cm long protrudes from a wall, as in figure. The base is maintained at 300°C, and the ambient temperature is 50°C with h=10 W/m^2°C. Calculate the heat loss from the fin per unit depth of material. Assume fin as insulated tip fin. **(10)**

   (b) How does turbulent flow differ from laminar flow? For which flow is heat transfer coefficient higher? **(6)**

OR

2. Consider a large plane wall of thickness L 0.2m, thermal conductivity k = 1.2 W/m °C, and surface area A = 15m^2. The two sides of the wall are maintained at constant temperature of T1 = 120 °C and T2 = 50 °C, respectively, as shown in figure.



Determine (a) the variation of temperature within the wall and the value of temperature at x = 0.1 m and (b) the rate of heat conduction through the wall under steady conditions. **(16)**

UNIT-III

3. (a) Explain the concept of thermal boundary layer. How is it related to convection heat transfer problem? **(4)**

   (b) Water at 60°C flows over the upper surface of a 5 m long flat plate whose temperature is 20°C with a velocity of 2 m/s. Determine the total drag force and the rate of heat transfer per unit width of the entire plate. **(12)**

OR

3. (a) What is the physical significance of the Nusselt number? How is it defined? **(4)**

   (b) Air at 2 atm and 200°C is heated as is flows through a tube with a diameter of 1 in (2.54 cm) at a velocity of 10 m/s. Calculate the heat transfer per unit length of tube is a constant heat- flux condition is maintained at the wall and the wall temperature is 20°C above the air temperature, all along the length of the tube. How much would the bulk temperature increase over a 3-m length of the tube? (12)

UNIT – IV

4. (a) Classify heat exchangers. (8)

(b) Water at the rate of 68 kg/min is heated from 35 to 75°C by an oil having a specific heat of 1.9 kJ/kg. °C. The fluids are used in a counter-flow double pipe heat exchanger, and the oil enters the exchangers at 110°C and leaves at 75°C. The overall heat- transfer coefficient is 320 W/m^2.°C. Calculate the heat- exchanger area. (8)

OR

4. (a) In which cases, LMTD (log mean temperature difference) approach is used for the design and analysis of heat exchangers? (4)

(b) A double pipe (shell and tube) heat exchanger is constructed of a stainless steel (k=15.1 W/m.°C) inner tube of inner diameter Di = 1.5 cm and outer diameter Do = 1.9 cm and an outer shell of inner diameter 3.2 cm. The convection heat transfer coefficient is given to be hi = 800 W/m^2 °C on the inner surface of the tube and ho = 1200 W/m^2 °C on the outer surface. For a fouling factor of $R_{f,i}$ = 0.0004 m^2. °C/W on the tube side and $R_{f,o}$ = 0.0001 m^2 °C/W on the shell side. Determine :

(a) The thermal resistance of the heat exchanger per unit length and

(b) The overall heat transfer coefficients, Ui and Uo based on the inner and outer surface areas of the tube, respectively. (12)

UNIT – V

5. (a) Classify different types of boiling. (6)

(b) Two very large parallel planes with emissivities 0.3 and 0.8 exchange heat. Find the percentage reduction in heat transfer when a polished aluminium radiation shield (ε = 0.04) is placed between them. (10)

OR

5. (a) What do you understand by 'Radiation Shape Factor'? How is it used in analysis of radiation heat transfer problem? (8)

(b) Explain film condensation and drop wise condensation with suitable diagrams. (8)