Hall Ticket No | | | | | | | | | | | Question Paper Code: AAE515

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Four Year B.Tech V Semester End Examinations(Regular) - November, 2019

Regulation: IARE – R16

HEAT TRANSFER

Time: 3 Hours **(AE)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) What are the mechanisms of heat transfer? How are they distinguished from each other? **[7M]**

   (b) In a nuclear reactor, heat is generated uniformly in the 5-cm-diameter cylindrical uranium rods at a rate of 7* 107 W/m^3. If the length of the rods is 1 m, determine the rate of heat generation in each rod. **[7M]**

2. (a) Write down the one-dimensional transient heat conduction equation for a plane wall with constant thermal conductivity and heat generation in its simplest form, and indicate what each variable represents. **[7M]**

   (b) Consider a large plane wall of thickness L = 0.4 m, thermal conductivity k = 2.3 W/m°C, and surface area A = 20 m^2. The left side of the wall is maintained at a constant temperature of T1 = 80°C while the right side loses heat by convection to the surrounding air at T = 15°C with a heat transfer coefficient of h = 24 W/m^2°C. Assuming constant thermal conductivity and no heat generation in the wall

   i) Express the differential equation and the boundary conditions for steady one-dimensional heat conduction through the wall

   ii) Obtain a relation for the variation of temperature in the wall by solving the differential equation **[7M]**

UNIT – II

3. (a) Distinguish between steady state conduction and unsteady state conduction. **[7M]**

   (b) Determine the heat transfer rate from the rectangular fin of length 20cm, width 40 cm and thickness 2 cm .The tip of the fin is not insulated and the fin has a thermal conductivity of 150 W/mk. The base temperature is 100^0C and the fluid is 20^0C . The heat transfer coefficient between the fin and the fluid is 30W/m^2K **[7M]**

4. (a) What is critical thickness of insulation on a small diameter wire or pipe. Explain its physical significance? **[7M]**

   (b) A cylindrical resistor element on a circuit board dissipates 0.15 W of power in an environment at 40^0C. The resistor is 1.2 cm long, and has a diameter of 0.3 cm. Assuming heat to be transferred uniformly from all surfaces, determine i) The amount of heat this resistor dissipates during a 24-h period ii) The heat flux on the surface of the resistor, in W/m^2 **[7M]**

UNIT – III

5. (a) What is boundary layer thickness what do you mean by laminar and turbulent boundary layers. **[7M]**

   (b) A 0.15m outer diameter steel pipe lies 2m vertically and 8m horizontally in a large room with an ambient temperature of 30^0C. The pipe surface is at2500C and has an emissivity o f 0.60. Estimate The total rate of heat loss from the pipe to the atmosphere. **[7M]**

6. (a) Define local and mean heat transfer coefficient. On what factors 'h' value depends on? **[7M]**

   (b) Engine oil 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. **[7M]**

UNIT – IV

7. (a) Draw the boiling curve and identify the burnout point on the curve. Explain how burnout is caused. Why is the burnout point avoided in the design of boilers? **[7M]**

   (b) Two very large parallel plates are maintained at uniform temperatures of T_1= 600 K and T_2 = 400 K and have emissivity's €1 = 0.5 and €2 = 0.9, respectively. Determine the net rate of radiation heat transfer between the two surfaces per unit area of the plates. **[7M]**

8. (a) Sketch the film wise condensation on a vertical wall showing film thickness, velocity and temperature profiles. **[7M]**

   (b) Consider a hemispherical furnace of diameter D = 5m with a flat base. The dome of the furnace is black, and the base has an emissivity of 0.7. The base and the dome of the furnace are maintained at uniform temperatures of 400 and 1000 K, respectively. Determine the net rate of radiation heat transfer from the dome to the base surface during steady operation **[7M]**

UNIT – V

9. (a) How does a cross-flow heat exchanger differs from a counter-flow one? What is the difference between mixed and unmixed fluids in cross-flow? **[7M]**

   (b) Water at an average temperature of 107°C and an average velocity of 3.5 m/s flows through a 5-m-long stainless-steel tube (k = 14.2 W/m - °C) in a boiler. The inner and outer diameters of the tube are D_i = 1.0 cm and D_o = 1.4 cm, respectively. If the convection heat transfer coefficient at the outer surface of the tube where boiling is taking place is ho = 8400 W/m^2 - °C, determine the overall heat transfer coefficient U_i of this boiler based on the inner surface area of the tube.

   [7M]

10. (a) Derive an expression for LMTD in case of a counter – current flow double pipe heat exchanger. **[7M]**

    (b) A hot fluid enters a heat exchanger at a temperature of 200^0 C at a flow rate of 2.8 kg/sec (sp. heat 2.0 kJ/kg-K) it is cooled by another fluid with a mass flow rate of 0.7 kg/sec (Sp. heat 0.4 kJ/kg-K). The overall heat transfer coefficient based on outside area of 20 m^2 is 250 W/m^2 -K. Calculate the exit temperature of hot fluid when fluids are in parallel flow. **[7M]**