PVP 12

Code: ME5T5

III B.Tech - I Semester – Regular Examinations – November 2015

HEAT TRANSFER
(MECHANICAL ENGINEERING)

Duration: 3 hours Max. Marks: 70

Answer any FIVE questions. All questions carry equal marks

1. a) Explain the variation of thermal conductivity with temperature. 6 M

   b) Derive the general heat conduction equation in cylindrical coordinate system. 8 M

2. a) Develop the expression for the heat transfer through a very long fin. 7 M

   b) Consider a 0.8-m-high and 1.5 m wide glass window with a thickness of 8 mm and a thermal conductivity of $k = 0.78$ W/m^{0}C. Determine the steady rate of heat transfer through this glass window and the temperature of its inner surface for a day during which the room is maintained at 20^{0}C while the temperature of the outdoors is – 10^{0}C. Take the heat transfer coefficients on the inner and outer surfaces of the window to be $h_1 = 10$ W/m^2 ^{0}C and $h_2 = 40$ W/m^2 ^{0}C, which includes the effects of radiation. 7 M

3. a) What are the assumptions in lumped system analysis? 6 M

b) The temperature of a gas stream is to be measured by a thermocouple whose junction can be approximated as a 1-mm-diameter sphere. The properties of the junction are $k = 35$ W/m ^{0}C, $\rho = 8500$ kg/m^3, and $Cp = 320$ J/kg ^{0}C, and the convection heat transfer coefficient between the junction and the gas is $h = 210$ W/m^2 ^{0}C. Determine how long it will take for the thermocouple to read 99 percent of the initial temperature difference. 8 M

4. a) Explain different regimes in hydrodynamic boundary layer on the flat plate 6 M

b) Water at 60^{0}C flows over the upper surface of a 5-m-long flat plate whose temperature is 20^{0}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. 8 M

5. a) Show that for laminar flow inside the pipe line with constant wall heat flux Nusselt number Nu = 48 / 11. 7 M

b) A 6-m-long section of an 8-cm-diameter horizontal hot water pipe passes through a large room whose temperature is 20^{0}C. If the outer surface temperature of the pipe is 70^{0}C, determine the rate of heat loss from the pipe to surrounding air by natural convection. 7 M

6. a) Differentiate between drop wise and film wise condensation. 6 M

b) Water is to be boiled at atmospheric pressure in a mechanically polished stainless steel pan placed on top of a heating unit. The inner surface of the bottom of the pan is maintained at 108^0C. If the diameter of the bottom of the pan is 30 cm, determine (i) the rate of heat transfer to the water and (ii) the rate of evaporation of water. 8 M

7. a) Derive the expression for LMTD of parallel flow heat exchanger. 7 M

b) Steam in the condenser of a power plant is to be condensed at a temperature of 30^0C with cooling water from a nearby lake, which enters the tubes of the condenser at 14^0C and leaves at 22^0C. The surface area of the tubes is 45 m^2, and the overall heat transfer coefficient is 2100 $W/m^2\ ^0C$. Determine the mass flow rate of the cooling water needed and the rate of condensation of the steam in the condenser. 7 M

8. a) Explain the concept of black body. 6 M

b) The temperature of the filament of an incandescent light bulb is 2500 K. Assuming the filament to be a blackbody, determine the fraction of the radiant energy emitted by the filament that falls in the visible range. 8 M