Exam.Code:0942
Sub. Code: 6733

2014
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 Part. Make suitable assumptions, wherever necessary.*

x-x-x

Question1: Solve the following:
(a) What is a boundary condition? How many boundary conditions do we need to specify for a two-dimensional heat transfer problem?
(b) Is the thermal conductivity of a medium, in general, constant or does it vary with temperature?
(c) Consider heat conduction through a wall of thickness L and area A. Under what conditions will the temperature distributions in the wall be a straight line?
(d) What is the physical significance of the Nusselt number? How is it defined?
(e) What is the difference between pool boiling and flow boiling?

(5x2)

Part - A

Question-2. A 5-m-long 1-kW electrical resistance wire is made of 0.1-cm-diameter stainless steel (k = 14.1 W/m · °C). The resistance wire operates in an environment at 35°C with a heat transfer coefficient of 155 W/m 2 · °C at the outer surface. Determine the surface temperature of the wire.

Question-3. Consider a 1.5-m-high and 1.5-m-wide glass window whose thickness is 5 mm and thermal conductivity is k = 0.9 W/m · °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 24°C while the temperature of the outdoors is = 10°C. Take the convection heat transfer coefficients on the inner and outer surfaces of the window to be h_1 = 15 W/m ^{2} · °C and h_2 = 19 W/m ^{2} · °C.

Question-4. Steam in a heating system flows through tubes whose outer diameter is 5 cm and whose walls are maintained at a temperature of 180°C. Circular aluminum alloy fins (k = 190 W/m · °C) of outer diameter 6 cm and constant thickness 1 mm are attached to the tube. The space between the fins is 3 mm, and thus there are 250 fins per meter length of the tube. Heat is transferred to the surrounding air at T = 25°C, with a heat transfer coefficient of 40 W/m^2 · °C. Determine the increase in heat transfer from the tube per meter of its length as a result of adding fins.

(2x10)
P.T.O.

Part - B

Question-5: The top surface of the passenger car of a train moving at a velocity of 70 km/h is 2.8 m wide and 8 m long. The top surface is absorbing solar radiation at a rate of 200 W/m 2 , and the temperature of the ambient air is 30°C. Assuming the roof of the car to be perfectly insulated and the radiation heat exchange with the surroundings to be small relative to convection, determine the equilibrium temperature of the top surface of the car.

Question-6. In a gas-fired boiler, water is boiled at 250°C by hot gases flowing through 48-m-long, 5-cm-outer-diameter mechanically polished stainless steel pipes submerged in water. If the outer surface temperature of the pipes is 170°C, determine (a) the rate of heat transfer from the hot gases to water, (b) the rate of evaporation, (c) the ratio of the critical heat flux to the present heat flux, and (d) the surface temperature of the pipe at which critical heat flux occurs.

Question-7: A furnace is of cylindrical shape with R = H = 2 m. The base, top, and side surfaces of the furnace are all black and are maintained at uniform temperatures of 500, 700, and 1200 K, respectively. Determine the net rate of radiation heat transfer to or from the top surface during steady operation.

(2x10)

x-x-x