Tutorial 1

Science, Physics

Tutorial 1 (Conduction and Convection) 1. Consider a composite structure shown on below. Conductivities of the layer are: k1 = k3 = 10 W/mK, k2 = 16 W/mK, and k4 = 46 W/mK. The convection coefficient on the right side of the composite is 30 W/m2K. Calculate the total resistance and the heat flow through the composite. (0. 46, 173. 9 W) 2. Consider a 1. 2-m high and 2-m-wide glass window whose thickness is 6 mm and thermal conductivity is k= 0. 78W/m. 0C. 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 0C while the temperature of the outdoors is -5 0C. Take the convection heat transfer coefficients on the inner and outer surfaces of the window to be h1= 10 W/m2 . 0C and h2 = 25 W/m2 . 0C and disregard any heat transfer by radiation. (471W, 4. 40C) 3. Consider a 1. 2-m-high and 2-m-wide double-pane window consisting of two 3-mm-thick layers of glass (k= 0. 78 W/m . 0C) separated by 12-mm-wide stagnant air space. Determine the steady rate of heat transfer through this double-pane window and the temperature of its inner surface for a day during which the room is maintained at 24 0C while the temperature of the outdoors is -50C. Take the convection heat transfer coefficients on the inner and outer surfaces of the window to be h1= 10 W/ m2 . 0C and h2 = 25 W/m2 . 0C and disregard any heat transfer by radiation. Given also k air = 0. 026 W/ m . 0C (114W, 19. 20C) 4. A cylindrical resistor element on a circuit board dissipates 0. 15W of power in an environment at 400C. The resistor is 1. 2 cm long, and has a diameter of 0. 3cm. Assuming heat to be transferred uniformly from all surfaces, determine (a) the amount of heat this resistor dissipates during a 24-h period, (b) the heat flux on the surface of the resistor, in W/m2 and (c)

the surface temperature of the resistor for a combined convection and radiation heat transfer coefficient of 9 W/m2 . 0C. (3. 6 Wh, 1179 W/m2, 1710C) 5. Water is boiling in a 25-cm-diameter aluminum pan (k= 237 W/ m . 0C) at 95 0C. Heat is transferred steadily to the boiling water in the pan through its 0. 5-cm-thick flat bottom at a rate of 800 W. If the inner surface temperature of the bottom of the pan is 1080C, determine (a) the boiling heat transfer coefficient on the inner surface of the pan, and (b) the outer surface temperature of the bottom of the pan. (1254 W/m2 . 0C, 108. 30C) 6. Steam at 320 0C flows in a stainless steel pipe (k= 15 W/m. 0C) whose inner and outer diameters are 5 cm and 5. 5cm, respectively. The pipe is covered with 3-cm-thick glass wool insulation (k= 0. 038 W/m. 0C). Heat is lost to the surroundings at 50C by natural convection and radiation, with a combined natural convection and radiation heat transfer coefficient of 15 W/ m2. 0C. Taking the heat transfer coefficient inside the pipe to be 80 W/m2. 0C, determine the rate of heat loss from the steam per unit length of the pipe. Also determine the temperature drops across the pipe shell and the insulation. (93. 9 W, 0. 095 0C, 290 0 C) 7. Consider a 8-m-long, and 0. 22-m-thick wall whose representative cross section is as given in the Figure 1. The thermal conductivities of various material used, in W/m. 0C, are kA= kF= 3, kB= 10, kC= 23, kD= 15 and kE= 38. The left and right surface of the wall are maintained a uniform temperatures of 3000C and 1000C, respectively. Assuming heat transfer through the wall to be one-dimensional, determine (Given Rcond = x/kA and Rconv = 1/hA) a) The rate of heat transfer through the wall. b) The temperature at the point where the sections B, D and E

meet. c) The temperature drop across the section F. (6453. 0075 W, 259. 59380C, 134. 22220C)