Mansoura University
Faculty of Engineering
Mech. Power Department

October 2nd

M. Sc. Final Exam.
Advanced Heat Transfer
Timed Allowed 3 Hours

Attempt Al Questions Tables and Charts Are Allowed

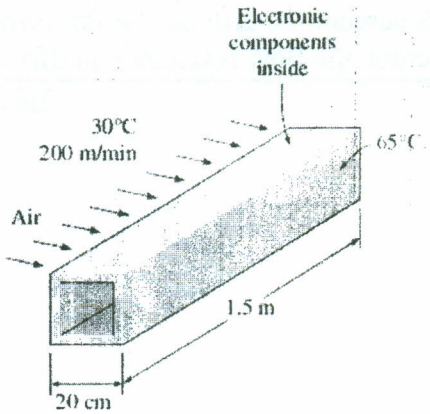
Question 1 (20 Marks)

(A) Draw the boiling curve and identify the different boil-ing regimes. Also, explain the characteristics of each regime.

(B) A thin aluminum sheet with an emissivity of 0.15 on both sides is placed between two very large parallel plates, which are maintained at uniform temperatures T_1=900 K and T_2=650 K and have emissivities ε_1=0.5 and ε_2=0.8, respectively. Determine the net rate of radiation heat transfer between the two plates per unit surface area of the plates and compare the result with that without the shield.

Question 2 (12 Marks)

The components of an electronic system are located in a 1.5-m-long horizontal duct whose cross section is 20 cm 20 cm. The components in the duct are not allowed to come into direct contact with cooling air, and thus are cooled by air at 30° C flowing over the duct with a velocity of 200 m/min. If the surface temperature of the duct is not to exceed 65°C, determine the total power rating of the electronic devices that can be mounted into the duct.



Question 3 (20 Marks)

Hot oil (Cp=2200 J/kg·°C) is to be cooled by water (Cp=4180 J/kg ·°C) in a 2-shell-pass and 2-tube-pass heat exchanger. The tubes are thin-walled and are made of copper with a diameter of 1.8 cm. The length of each tube pass in the heat exchanger is 3 m, and the overall heat transfer coefficient is 340 W/m^2·°C. Water flows through the tubes at a total rate of 0.1 kg/s, and the oil through the shell at a rate of 0.2 kg/s. The water and the oil enter at temperatures 18°C and 160°C, respectively. Determine the rate of heat transfer in the heat ex-changer and the outlet temperatures of the water and the oil.

Question 4 (16 Marks)

A) An average man has a body surface area of 1.8 m2 and a skin temperature of 33°C. The convection heat transfer coefficient for a clothed person walking in still air is expressed as $h = 8.6V^{0.53}$ for $0.5 \leq V \leq 2$ m/s, where V is the walking velocity in m/s. Assuming the average surface temperature of the clothed person to be 30°C, determine the rate of heat loss from an average man walking in still air at 10°C by convection at a walking velocity of (a) 0.5 m/s, (b) 1.0 m/s, (c) 1.5 m/s, and (d) 2.0 m/s.

B) A 6-mm-diameter electrical transmission line carries an electric current of 50 A and has a resistance of 0.002 ohm per meter length. Determine the surface temperature of the wire during a windy day when the air temperature is 10 ° C and the wind is blowing across the transmission line at 40 km/h.

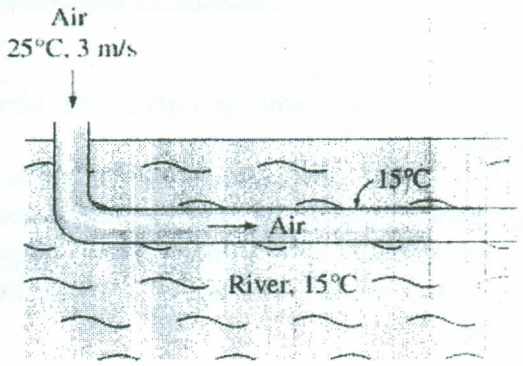
Question 5 (20 Marks)

Consider a water-to-water counter-flow heat ex-changer with these specifications. Hot water enters at 95°C while cold water enters at 20°C. The exit temperature of hot water is 15°C greater than that of cold water, and the mass flow rate of hot water is 50 percent greater than that of cold water .The product of heat transfer surface area and the overall heat transfer coefficient is 1400 W/m^2·°C. Taking the specific heat of both cold and hot water to be Cp=4180 J/kg·°C, determine:

(a) the outlet temperature of the cold water, (b) the effectiveness of the heat exchanger, (c) the mass flow rate of the cold water, and (d) the heat transfer rate.

Question 6 (12 Marks)

A house built on a riverside is to be cooled in summer by utilizing the cool water of the river, which flows at n aver-age temperature of 15°C. A 15 m-long section f a circular duct of 20 cm diameter passes through the water. Air enters the underwater section of the duct at 25°C at a velocity of 3 m/s. Assuming the surface of the duct to be at the temperature of the water, determine the outlet temperature of air as it leaves the underwater portion of the duct. Also, for an overall fan efficiency of 55 percent, determine the fan power input needed to overcome the flow resistance in this section of the duct.



Best Wishes Prof. Ahmed Sultan