UNIVERSITY OF TORONTO

FACULTY OF APPLIED SCIENCE AND ENGINEERING

FINAL EXAMINATION, April 2001

Third Year - Program 03

MIE 313S – Heat and Mass Transfer

Examiner - S. Chandra

Each of the following five questions is of equal value. You may use your textbook, any notes, and any type of calculator.

1) Stainless steel (AISI 316) balls of 4 mm diameter, initially at 30°C are heated for 1 minute by blowing air at 95°C (convective heat transfer coefficient of 40 $W/m^2 °C$) and then cooled in 25°C air for 1 minute (convective heat transfer coefficient of 20 $W/m^2 °C$). What is the temperature of the balls when they are removed from the cool air?

2) To enhance heat transfer from a silicon chip a copper pin fin is brazed on to its surface. The pin is 12 mm in length and 2 mm in diameter. Atmospheric air with a velocity of 10 m/s and a temperature of 27°C is in cross-flow over the pin. The surface of the chip, and hence the base of the pin, is at a temperature of 77°C. Determine:

   a) The average heat transfer coefficient over the surface of the pin.

   b) The total rate of heat transfer from the pin.

3) Under steady state conditions the surface temperature of a 20 W light bulb is 125°C when the temperature of the room air and surrounding walls is 25°C. Approximating the bulb as a sphere 40 mm in diameter with a surface emissivity of 0.8, what is the rate of heat transfer from the surface of the bulb to the surroundings?

4) Dry air at 35°C and a velocity of 20 m/s flows over a plate of length 500 mm and width 150 mm, which is wetted with a thin film of water. An electrical heater embedded in the plate maintains its surface temperature at 20°C.

   a) What is the evaporation rate (kg/h) of water from the plate? What electrical power is required to maintain steady state conditions?

   b) After a long period of evaporation, all the water is evaporated from the plate and its surface is dry. For the same free stream conditions and heater power of part (*a*), calculate the temperature of the plate.

5) A 5 m x 5 m square room has a ceiling maintained at 28°C and a floor maintained at 20°C. The walls of the room are 4 m high and perfectly insulated. The emissivity of the ceiling is 0.62 and that of the floor is 0.75. Calculate the radiation heat transfer from the ceiling to the floor.