CHG 2314
HEAT TRANSFER

Professor: **B. Kruczek** **2005/02/18**

Assignment No. 6

1 An 83 mm-high Styrofoam cup has 1.5 mm-thick walls and the outside diameter of 52 mm. The cup has a flat bottom and is placed on a large desk. The temperature of the desk and the temperature of surrounding air is 24°C. The cup is filled entirely with a hot coffee at 80°C and covered by a plastic lid of thickness 0.5 mm. The combined convective and radiative heat transfer coefficient for sidewalls of the cup and for the lid is 10 W/m^2 K. If the inside convective coefficient between the coffee and the walls of the cup is estimated to be 50 W/m^2 K,

i) Is it reasonable to assume a uniform temperature of coffee in the cup during the cooling process?
ii) What is the initial rate of heat loss from the coffee?
iii) Estimate the time for the coffee to cool to 60°C.

Use the following additional data: thermal conductivity of the Styrofoam, k_s = 0.035 W/m K, thermal conductivity of the desk, k_d = 0.25 W/m K, thermal conductivity of the lid, k_l = 0.13 W/m K; for coffee, the density and the specific heat are ρ = 985 kg/m^3 and c = 4180 J/kg K.

Hint: There are three distinct directions, in which heat is transferred from hot coffee: (1) through the side walls of the cup; (2) through the lid; (3) through the bottom of the cup. The conditions for lumped thermal capacitance model must be satisfied in all these directions.

2. Problem 5.23. To obtain answer to part c) you need to perform numerical integration.

3. Problem 5.58. In addition, determine the corresponding amount of energy transferred to the ball bearing.

.

Due Date: **March 4, 2005 at 4:00 p.m. in the assignment box.**