CHG 2314/3314
Midterm Exam

March 5, 2004

Duration: 85 min
Open book exam
Do any 2 problems; the exam will be marked out of 20
State clearly all assumptions
Calculator permitted: TEXAS TI-30X or equivalent

Good Luck!!!

(10) Problem 1

Two identical spherical reactors are insulated with different materials. The first reactor is insulated with a 10 cm layer of fused silica (k_1 = 1.38 W/m K). The inner and outer surface temperatures of the silica insulation are 85°C and 35°C, respectively. The second reactor is covered with an 8 cm thick layer of borosilicate (k_2 = 1.09 W/m K), and the temperature drop across the borosilicate insulation is 55°C. If the heat losses from both reactors are identical ($\dot{Q}_1 = \dot{Q}_2$), what is the outer diameter of the reactors?

If both reactors are in the same environment ($T_{e1} = T_{e2}$ = 25°C) with the same outside heat transfer coefficient ($h_{o1} = h_{o2}$), what are the inner and outer surface temperatures of the borosilicate insulation?

(10) Problem 2

Consider two slender rods of the same length and diameter but different materials. One end of each rod is attached to a base surface maintained at 100°C, while the surface of the rods are exposed to ambient air at 20°C. The thermal conductivity of rod A is k_A = 70 W/m K and its tip temperature is 60°C. What is the thermal conductivity of rod B (k_B) if its tip temperature is 40°C? What are the corresponding temperatures of the rods at half of their length (i.e., at $x = L/2$)?

Assume that the side surface of the rod is much larger than the surface of the rod's tip.

(10) Problem 3

An ice layer forms on the exterior surface of a 5 mm-thick windshield of a car while parked during a cold night for which the ambient temperature is –20°C. Upon start-up, using a new defrost system, the interior surface is suddenly exposed to an air stream at 30°C. If the ice layer on the exterior surface of the windshield is assumed to behave as a perfect insulation, the thermal response of the windshield can be described using the model for a convectively heated infinite plane slab. Why?

It is desired that 60 s after the start-up of the defrost system the interior and exterior surface temperatures reach 5°C and 0°C, respectively. What should be the interior heat transfer coefficient to achieve this requirement? The windshield thermophysical are k = 1.2 W/m K, ρ = 2200 kg/m^3, and c = 830 J/kg K.