Assignment #1

Due Date Feb. 20th, 2007 (WEDNESDAY at 10:10 am in class).

Heat Transfer phenomena plays an important role in many industrial and environmental problems. We will devote much time to acquire an understanding of heat transfer effects and to develop skills needed to predict heat transfer rates. In order to get familiar with the subject, please follow the following procedure:

1. Select one of the "Real World Application" of Heat Transfer
2. Sketch a schematic to describe the phenomenon. Draw boundaries to separate your system from the surroundings
3. Identify which modes of heat transfer are involved
4. Is there any energy being generated in your system?
5. Is the internal energy of your system increasing?
6. What material and process parameters you need to know to find the temperature of your selected system?
7. How is this information useful in engineering analysis and design?

Please type or provide the answer to the above questions in not more than 2 single spaced pages.

P1. An inexpensive food and beverage container is fabricated from 25-mm-thick polystyrene (k=0.023W/m.K) and has interior dimensions of 0.8mX0.6mX0.6m. Under conditions for which an inner surface temperature of approximately 2 C is maintained by an ice-water mixture and an outer surface temperature of 20 C is maintained by the ambient, what is the heat flux through the container wall? Assuming negligible heat gain through the 0.8mX0.6m base of the cooler, what is the total heat load for the prescribed conditions?

KNOWN: Dimensions and thermal conductivity of food/beverage container. Inner and outer surface temperatures.
FIND: Heat flux through container wall and total heat load.
ASSUMPTIONS: (1) Steady-state conditions, (2) Negligible heat transfer through bottom wall, (3) Uniform surface temperatures and one-dimensional conduction through remaining walls.

P2. An electric resistance heater is embedded in a long cylinder of diameter 30mm. When water with a temperature of 25 C and velocity of 1 m/s flows crosswise over the cylinder, the power per unit length required to maintain the surface at a uniform temperature of 90 C is 28 kW/m. When air, also at 25 C, but with a velocity of 10 m/s is flowing, the power per unit length required to maintain the same surface temperature is 400 W/m. Calculate and compare the convection coefficients for the flows of water and air.

KNOWN: Long, 30mm-diameter cylinder with embedded electrical heater; power required to maintain a specified surface temperature for water and air flows.
FIND: Convection coefficients for the water and air flow convection processes, $h_w$ and $h_a$, respectively.
ASSUMPTIONS: (1) Flow is cross-wise over cylinder which is very long in the direction normal to flow.
P3. Under condition for which the same room temperature is maintained by a heating or cooling system, it is not uncommon for a person to feel chilled in the winter but comfortable in the summer. Provide a plausible explanation for the situation (with supporting calculations) by considering a room whose air temperature is maintained at 20°C throughout the year, while the walls of the room are nominally at 27°C and 14°C in the summer and winter, respectively. The exposed surface of a person in the room may be assumed to be at a temperature of 32°C throughout the year and to have an emissivity of 0.90. The coefficient associated with the heat transfer by natural convection between the person and the room air is approximately 2 W/m²·K.

**KNOWN:** Air and wall temperatures of a room. Surface temperature, convection coefficient and emissivity of a person in the room.

**FIND:** Basis for difference in comfort level between summer and winter.

**ASSUMPTIONS:** (1) Person may be approximated as a small object in a large enclosure.