mech 262 – assignment 1

thermal conductivity through flat and cylindrical surfaces

question 1

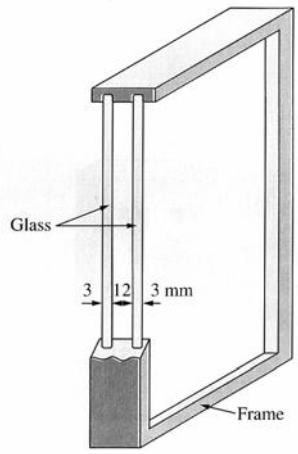

FIGURE P8-59

8-59 Consider a 1.2-m-high and 2-m-wide double-pane window consisting of two 3-mm-thick layers of glass [$k = 0.78\ \text{W/(m} \cdot \text{°C)}$] separated by a 12-mm-wide stagnant air space [$k = 0.026\ \text{W/(m} \cdot \text{°C)}$]. Determine the steady rate of heat transfer through this double-paned window and the temperature of its inner surface for a day during which the room is maintained at 24°C while the temperature of the outdoors is −5°C. Take the convection heat transfer coefficients on the inner and outer surfaces of the window to be $h_1 = 10\ \text{W/(m}^2 \cdot \text{°C)}$ and $h_2 = 25\ \text{W/(m}^2 \cdot \text{°C)}$, and disregard any heat transfer by radiation. *Answers:* 113 W, 19.2°C

question 2

FIGURE P8-86

8-86 Clothing made of several thin layers of fabric with trapped air in between, often called ski clothing, is commonly used in cold climates because it is light, fashionable, and a very effective thermal insulator. So it is no surprise that such clothing has largely replaced thick and heavy old-fashioned coats.

Consider coat made of five layers of 0.1-mm-thick synthetic fabric [$k = 0.13\ \text{W/(m} \cdot \text{°C)}$] with 1.5-mm-thick air space [$k = 0.026\ \text{W/(m} \cdot \text{°C)}$] between the layers. Assuming the inner surface temperature of the jacket to be 28°C and the surface area to be 1.1 m^2, determine the rate of heat loss through the jacket when the temperature of the outdoors is −5°C and the heat transfer coefficient at the outer surface is $25\ \text{W/(m}^2 \cdot \text{°C)}$.

What would your response be if the jacket were made of a single layer of 0.5-mm-thick synthetic fabric? What should the thickness of a wool fabric [$k = 0.035\ \text{W/(m} \cdot \text{°C)}$] be if the person is to achieve the same level of thermal comfort wearing a thick wool coat instead of a ski jacket?

question 3

8-159 Hot water at an average temperature of 80°C and an average velocity of 1.5 m/s is flowing through a 25-m section of a pipe that has an outer diameter of 5 cm. The pipe extends 2 m in the ambient air above the ground, dips into the ground [$k = 1.5\ \text{W/(m} \cdot \text{°C)}$] vertically for 3 m, and continues horizontally at this depth for 20 m more before it enters the next building. The first section of the pipe is exposed to the ambient air at 8°C, with a heat transfer coefficient of $22\ \text{W/(m}^2 \cdot \text{°C)}$. If the surface of the ground is covered with snow at 0°C, determine (*a*) the total rate of heat loss from the hot water, and (*b*) the temperature drop of the hot water as it flows through this 25-m-long section of the pipe.

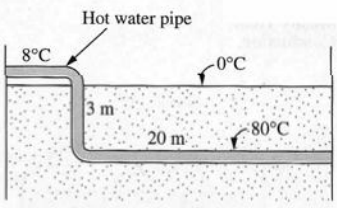

FIGURE P8-159