Problems from chapter 2

2.5

Solve for the temperature distribution in a thick-walled pipe if the bulk interior temperature and the exterior air temperature, $T_{\infty i}$, and $T_{\infty o}$, are known. The interior and the exterior heat transfer coefficients are h_i and h_o, respectively. Follow the method in Example 2.6 and put your result in the dimensionless form:

$$\frac{T - T_{\infty_i}}{T_{\infty_i} - T_{\infty_o}} = \text{fn}\left(\text{Bi}_i, \text{Bi}_o, r/r_i, r_o/r_i\right)$$

2.15

An isothermal sphere 3 cm in diameter is kept at 80°C in a large clay region. The temperature of the clay far from the sphere is kept at 10°C. How much heat must be supplied to the sphere to maintain its temperature if k_{clay} = 1.28 W/m·K? (*Hint:* You must solve the boundary value problem not in the sphere but in the clay surrounding it.)
[Q = 16.9 W.]

2.17

A wall consists of layers of metals and plastic with heat transfer coefficients on either side. U is 255 W/m^{2}K and the overall temperature difference is 200°C. One layer in the wall is stainless steel (k = 18 W/m·K) 3 mm thick. What is ΔT across the stainless steel?

2.35

A type 316 stainless steel pipe has a 6 cm inside diameter and an 8 cm outside diameter with a 2 mm layer of 85% magnesia insulation around it. Liquid at 112°C flows inside, so hi = 346 W/m^{2}K. The air around the pipe is at 20°C, and h_0 = 6 W/m^{2}K. Calculate U based on the inside area. Sketch the equivalent electrical circuit, showing all known temperatures. Discuss the results.