Homework 2

Read Chapter 3 in *Fundamentals of Heat and Mass Transfer* and solve the following problems. Remember to start each problem on a new sheet of paper.

1. Consider 1-D, steady-state heat conduction without generation in a slab of length $L$. The left side of the slab is maintained at a temperature of $T_0$ and the right side is exposed to a constant heat flux, $q_0$. Determine the temperature distribution in the slab and the temperature at $x = L$ in terms of the notation given in the problem statement.

2. Problem 3.12 (a). Sketch the temperature distribution across the window.

3. Problem 3.29

4. Consider a steel plate with $L = 4$ in., $k = 7.2$ Btu/h-ft-°F, and $\epsilon = 0.7$, as shown in the figure. Assume 1-D, steady-state heat conduction without generation. The left side of the slab is maintained at a temperature of $T_0$ and at the right side heat is being lost due to convection and radiation. Note: $\sigma = 0.1714 \times 10^{-8}$ Btu/hr-ft$^2$-R$^4$.
   (a) Write the governing equation and boundary conditions for this situation using the notation given in the figure.
   (b) Sketch the resistance network. Label all resistances and nodes. Denote the temperature at the right side of the plate as $T_L$.
   (c) The left side of plate is maintained at $T_0 = 90^\circ$F, and assume the plate is in space where $h = 0$ and $T_\infty = T_{\text{surr}} = 0$ R. Find the temperature of the right side of the plate and the heat flux through the plate.
   (d) The left side of plate is maintained at $T_0 = 90^\circ$F, and assume $h = 10$ Btu/h-ft$^2$-°F and $T_\infty = T_{\text{surr}} = 32^\circ$F. Find the temperature of the right side of the plate and the rate of heat loss per unit area due to convection and radiation.

\[ \begin{array}{c|c}
T_i & \eta, T_\infty \\
\hline
x = 0 & \epsilon, T_{\text{surr}} \\
x = L \\
\end{array} \]

5. Problem 3.51

6. Following the approach taken in class, analyze 1-D, steady-state heat conduction in sphere. The inner surface is maintained at a temperature of $T_i$ and the outer surface is exposed to convection with $h$ and $T_\infty$.
   (a) Solve for the temperature distribution in the sphere. Assume that $T_i > T_\infty$, and sketch the temperature distribution versus the radius.
   (b) Determine the rate of heat transfer through the sphere.
   (c) Determine an expression for the critical radius for a sphere.