Homework 1
Due: 31 August 2017

Read Chapters 1 and 2 in Fundamentals of Heat and Mass Transfer and solve the following problems. Remember to start each problem on a new sheet of paper.

1. Solve for $\theta(t)$, given:
   \[
   \frac{d\theta}{dt} + m\theta = 0 \quad \text{with} \quad \theta(0) = \theta_i
   \]
   where $m$ is a constant.

2. Solve for $A(x)$, given:
   \[
   \frac{d^2A}{dx^2} + \lambda^2 A = 0 \quad \text{with} \quad A(0) = \theta_0 \quad \text{and} \quad A(L) = 0
   \]
   where $\lambda$ is a constant.

3. Solve for $B(y)$, given:
   \[
   \frac{d^2B}{dy^2} - \lambda^2 B = 0 \quad \text{with} \quad \frac{dB}{dy} \bigg|_{y=0} = 0 \quad \text{and} \quad B(L) = \theta_L
   \]
   where $\lambda$ is a constant.

4. Solve for $T(x)$, given:
   \[
   \frac{d^2T}{dx^2} + \frac{\dot{g}}{k} = 0 \quad \text{with} \quad T(L) = T_s \quad \text{and} \quad T(-L) = T_s
   \]
   where $\dot{g}$ and $k$ are constants.

5. The equation from Problem 4 governs one-dimensional steady conduction through a planar wall with uniform generation and constant properties subject to constant temperature boundary conditions. Plot the temperature distribution $T(x)$ for $-L \leq x \leq L$ with $k = 60$ W/m-K, $\dot{g} = 2 \times 10^4$ W/m$^3$, $L = 0.2$ m, and $T_s = 100^\circ$C.
   
   Show (mathematically) that the governing equation result from Problem 4 also satisfies the condition $dT/dx = 0$ at $x = 0$.

6. Using the approach outlined in class, derive the 3-D, transient heat conduction equation in cylindrical coordinates. Simplify for an isotropic material and steady-state conditions.

7. Using the approach outlined in class, derive the 1-D, transient heat conduction equation in spherical coordinates. Simplify for an isotropic material and steady-state conditions.