Homework Assignment:

1. Adaptation of Sidebo Coffee/Mug Problem:

   A volume V = 0.41 L of coffee is at 1 atm, 92 °C is quickly poured into a room temperature (21 °C) ceramic mug with a mass of $m_{mug} = 0.365\ \mathrm{kg}$, inner diameter of $D = 0.083\ m$, inner height $H = 0.098\ m$, outer height $H_o = 0.109\ m$, and nominal wall thickness $w = 0.0040\ m$. The mug of coffee is placed on a table in a still room. Estimate the time it takes for the water to cool to 60 °C (above which it is too hot to drink) and to 45 °C (defined as "tepid" and unpleasant).

   a. Download 'ME342 – HW5 – Coffee Data.xlsx' from Moodle and read it into MATLAB. This file contains real data from Sidebo of the temperature of the top of the liquid and side of the mug.

   b. First attempt: Model the problem with only conductive and convective heat transfer. Unlike Sidebo's model, include separate capacitances for the coffee and mug. Plot the temperature of the top surface of the coffee and side of the mug as a function of time on the same plot as the real data (How should you plot the real data?).

      i. Use $h_{air} = 6.8\ \mathrm{W/m^2/K}$, $h_{coffee/mug} = 470\ \mathrm{W/m^2/K}$, $h_{coffee/air} = 300\ \mathrm{W/m^2/K}$, and look up appropriate values for conduction coefficients.

      ii. Force the initial temperature of the water and mug to be the temperature immediate after the initial heating of the mug (81.7 °C).

   c. Second attempt: Add radiative resistances to the model by calculating an appropriate radiation coefficients. Once again, plot the temperature of the top surface and the mug side as a function of time.

   d. Third attempt: Finally, add evaporative effects to the model using $h_{evap} = 1.00\ \text{e-}4\ \mathrm{W/m^2/K}$, and plot the final temperatures as a function of time.

   e. Is this a good model for the behavior of the system? Where/how does the model break down? How could the model be improved?

Homework Assignment:

2. For this problem, you will be modeling the wall in the house problem with conductive, convective, and radiative modes of heat transfer. Assume the wall is 0.2 m thick and made of a single material, oak.
   a. Model the problem with only conductive and convective resistances (and capacitance for the wall). Plot the temperature of the wall and its surfaces as a function of time.
   b. Add a "first guess" of radiative resistances to the model by assuming that the surface temperatures of the wall equal the temperatures of each room, respectively. Plot the temperature of the wall and its surfaces as a function of time. How did adding radiation affect the model and why?
   c. Devise a way to iteratively update your "guesses" for radiative resistances to better reflect the steady-state of the system. (*Hint: a "while" loop may be useful.*) Plot the temperature of the wall and its surfaces as a function of time using the final values for the radiative resistances.
      i. What are your final values for the radiative resistances? How many iterations did your model go through?
      ii. How does this model compare to your model in part b?