4 Post processing

Due Monday, Feb. 5. Submit as a hard-copy, one per team. **Answers without proper units will be marked incorrect.**

1. Import your data file into the data processing software of your choice: a spreadsheet, MATLAB, JAVA program, or similar. Convert the ADC readings to voltages and use those to find resistance of the thermistor at each timestep. Finally, convert the resistance to temperatures. If you reset the Uno when you started the experiment, then your timestamps should line up. If not, you'll have to manually adjust them so that $t = 0$ when you first put the power resistor in the container.

2. Using the calculated value of Q_i and the steady-state value for T_i, find K_s.

   K_s: usually $\sim 1 \frac{W}{C}$

3. Calculate the time it took for the temperature differential between inside and outside to reach 63.2% of the steady-state difference. As we'll discuss more next week, this is one way to calculate the *rise-time* of the system (why 63.2%?). Use the rise time to find C_{in} for your model.

   Rise-time: usually $\sim$ 300 - 500 secs

   C_i: for $K = 1 \frac{W}{C}$ & $\tau = 400$ sec $\Rightarrow C = K \cdot \tau = 400 \frac{J}{C}$

4. Create another data set that corresponds to your parameterized model. That is, put C_i, K_s, and Q_i into the solution of the governing equation (Equation 2) and plot the resulting curve on the same graph as your experimental data. How well does it compare to the collected data? Can you adjust the parameters to qualitatively improve the fit? varies

5. Submit a graph comparing your actual data to your parameterized model. Fill in the table below with both the calculated values of the coefficients and the "best-fit' values after adjustment.

Parameter	Calculated	Best-fit
K_s		
C_i		
Q_i		

Table 2: Model parameters.

6. For each parameter in our model, C_i, K_s, and Q_i, how would raising them affect the steady-state temperature in a heating scenario, all else being equal? Fill in Table 3.

Parameter	Effect on steady-state temperature
$K_s \uparrow$	↓
$C_i \uparrow$	—
$Q_i \uparrow$	↑

Table 3: Effect of raising model parameters.

7. The greenhouse from IKEA are substantially larger than the ones we used for the in-lab experiment. It is not always easy to apply a small-scale experiment to a larger one, but it is often possible to approximate K by scaling according to surface area (assuming the thermal conductance of the material per unit area doesn't change, which is reasonable in this case). Estimate the surface area of the IKEA greenhouse and estimate K_s for the full-scale model. How big of a heater would be needed to maintain a 10C temperature differential above the outside temperature?

~ 10:1 ratio

$Q \approx 10 \frac{W}{C} \cdot \Delta T \approx \boxed{100\ W}$

8. Find the ~~resistance~~ tolerance, ~~$\Delta R/R$~~ on B, on the datasheet for the thermistor. (we're using the 'J' model). Calculate the error bounds for the steady-state temperature, in Celsius. Calculate the resultant error bounds on K. Ignore all other sources of error.

$B = 4300 \pm 3\%$

You'll have to redo $\frac{1}{T} = \frac{1}{T_0} + B \ln\left(\frac{R}{R_0}\right)$ with $B = 4300 + 3\% = \underline{4429K}$

& $B = 4300 - 3\% = \underline{4171K}$