ENGR 121 **Homework 3**

NOTE: Use engineering format for problems 1 and 2, and use non-engineering format for problem 3. This is an individual assignment. You must complete the assignment on your own, although you may discuss the problems with classmates (but no direct copying of work).

1. A fishtank is 3cm in diameter and contains water 5cm deep. What power will be needed to increase the temperature by 25°C if the heater runs for 3hrs? P=342mW

> ***Note:*** *Include ALL units in calculations. Use consistent SI units! For example, you should use …*
>
> - *kilograms (kg) for mass*
> - *meters (m) for length*
> - *volts (V) for voltage*
> - *amps (A) for current*
> - *seconds (s) for time*
> - *Joules (J) for Energy*
>
> ***First Law of Thermodynamics***
>
> *For a system with water being heated by a heater:*
>
> $$\Delta E = Q - W$$
> $$\rho \cdot Vol \cdot C_p \cdot \Delta T = V \cdot I \cdot t$$ (W = 0)
>
> ***Remember:***
>
> Density of water (ρ) = 1000kg/m^3 1 kilogram = 1000 grams m = ρ · Vol
> 0.001 m^3 = 0.264 gal 1 in = 2.54 cm
> Cp_{water} = 4180 J/(kg·°C) 16 oz = 453.592 g

2. In preparation for camping, you pack a 10.75oz can of tomato soup to heat up and eat for supper. Before leaving, you learn that a fire ban is in place at the campsite. So, remembering the survival skills learned in ENGR121, you scramble to find a resistor that could be used to heat the soup. If you use the 12V battery in your car and wish to heat the soup from 25°C to 100°C in 20min, then what size resistor should you bring?
Note: A quick internet search tells you that tomato soup has a specific heat of 3.67 kJ/(kg·°C). R=2.06Ω

3. Finish the program from class where you turned an LED on when the analog value read from the thermistor circuit fell below the LCL and turned the LED off when the analog value rose above the UCL. Modify the program to use a setpoint of 25°C. At a minimum, your serial monitor should print:
   - Analog values of the setpoint, LCL and UCL (print these only once)
   - Temperature values in °C for the setpoint, LCL and UCL (print these only once)
   - Every analogRead value collected
   - The temperature in °C for every analogRead value collected
   - An alert noting that you are entering the "heater on" function
   - An alert noting that you are leaving the "heater on" function
   - An alert noting that you are entering the "heater off" function
   - An alert noting that you are leaving the "heater off" function

   Provide a screen shot of your sketch and serial monitor with in your homework.

   For more programming practice once, you could try the following ***(not required for the hw)***:
   - Add a timer to each section using the `millis()` command. Print the time when you enter the main loop, the "heater on" function, and the "heater off" function.
   - When measuring temperature, collect 100 data points instead of just one, finding and printing the minimum, maximum and average values of temperature (remove the minimum and maximum values when computing the average). This will eliminate outliers and provide a more stable system response.

Note: **Have your circuit out on your table with the program running so that your instructor or class assistant can quickly check your work. Do not turn your homework in at the front; have it ready so that the instructor / assistant can grade this activity.**

4. If you have not already done so, please complete the Engineering Student Survey found on the META ENGR 121 Moodle page.