

**NOTE:** Use engineering format for problems 1 through 3, and use non-engineering format for problem 4-8. This is an individual assignment.

1. The temperature of a 3kg mixture of two materials increases by  $11^{\circ}\text{C}$  when the mixture absorbs 11kJ of energy. If the specific heat of material 1 is  $200 \frac{\text{J}}{\text{kg}\cdot^{\circ}\text{C}}$  and the specific heat of material 2 is  $4000 \frac{\text{J}}{\text{kg}\cdot^{\circ}\text{C}}$ , then what is the mass of material 1?  $m_1 = 2.89\text{kg}$
2. A mixture is composed of 3kg of material 1 and 6kg of material 2. The temperature of the mixture increases by  $8^{\circ}\text{C}$  when heated by a resistive heater powered by a 12V voltage source supplying 4A of current. If the specific heat of material 1 is  $2080 \frac{\text{J}}{\text{kg}\cdot^{\circ}\text{C}}$ , then what is the specific heat of material 2 given that the heater was on for 20min?  $C_{p_{material2}} = 160 \frac{\text{J}}{\text{kg}\cdot^{\circ}\text{C}}$
3. Eight ounces of water is mixed with 2 ounces of chocolate syrup which has a specific heat of  $1600 \frac{\text{J}}{\text{kg}\cdot^{\circ}\text{C}}$ . The mixture is heated using a  $24\Omega$  resistor powered by a 12V source. If the initial temperature of the mixture is  $80^{\circ}\text{F}$ , how long will it take the mixture to increase to the preferred hot chocolate serving temperature of  $170^{\circ}\text{F}$ ?  $t=2.4\text{hrs}$
4. Build a thermistor circuit, a transistor and LED circuit (any color), and a piezospeaker circuit. You will use the output of the thermistor circuit to make the LED blink when the temperature is above the setpoint and the piezospeaker sound an alarm when the temperature is below the setpoint.

Write a sketch that performs the functions below. Include a screen shot of your sketch and your serial monitor output with your homework. Please bring your system to class ready to show your instructor. Also, please include separate functions for making the LED blink and the piezospeaker sound an alarm in your sketch since this will be a good programming strategy when you begin to program your fishtank system.

- Uses room temperature (the analog version) as the setpoint
- Prints the setpoint only once; please print the analog value and the degrees Celsius value
- Continuously reads analog values of temperature from the thermistor circuit
- Set a timer using the millis() command
- Prints the analog values on the serial monitor
- Converts the analog values to values in degrees Celsius
- Prints the values in degrees Celsius
- Checks to see if the analog value is above the setpoint value
- Checks to see the analog value if below the setpoint value
- If the analog value is above the setpoint, the transistor causes the green LED to blink in a pattern of your choosing; please print a notification that the temperature is above the setpoint; and print the time from the timer set earlier
- If the analog value is below the setpoint, the piezospeaker sounds an alarm of your choosing; please print a notification that the temperature is below the setpoint; and print the time from the timer set earlier

**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.

5. Use the fishtank fabrication presentation found on the downloads page to mark the holes in the wood for your platform.

6. Create SolidWorks drawings and hand sketches of the conductivity sensor parts. You should use your dial caliper to measure the parts in the kit you were given in class. Turn in two screen shots of your drawing, one at an intermediate stage (unassembled parts) and one of the final assembly (all parts assembled). Turn in your hand sketch along with your SolidWorks.

7. Search for the 3-way valve used in the fishtank project on the McMaster-Carr website (<https://www.mcmaster.com/>). Find the 3-D Solidworks file for the valve, download it and open it in your SolidWorks. You do not need to make a hand sketch of this part since you were able to download the part from the vendor, but include a printout of your SolidWorks drawing.



8. Along with your Arduino and assortment of electrical components, please bring your battery pack with batteries and your DC vibration motor to the next class.

9. **(Due Class 9)** Over the next few homework assignments you will be asked to draw various parts of your fishtank system. The SolidWorks assignments will culminate in HW 8 by combining all the parts listed below into one assembly. Save all SolidWorks drawings/assemblies of the individual components, and turn them in again with the final assembly.

*Parts to be created:*

- the fishtank reservoir with three fittings (inlet, outlet, overflow)
- the conductivity sensor with fittings (you don't have to draw the wires, terminals or tubing)
- the wooden platform assembly
- the 3-way valve
- the LCD screen (rough detail of shape is good enough, but use correct measurements)
- the Arduino (rough detail of shape is good enough, but use correct measurements)
- the pump (it's OK to use your pump assembly from ENGR 120)



*Final Assembly:* Turn in the SolidWorks assembly of the fishtank system using all of the components listed above. Please show your fishtank from at least two points of view.

