

# ME 120

## Homework 3

Due 17/18 October 2016

Use the Direct Solution Format for all problems on this assignment, except for Problem 5, where you will use the Engineering format. Use a word processor to include the source code for problems 3, 4 and 5. The first sheet of the source code listing should have your name, the assignment number and the date. The first page does not need to be a separate cover sheet. The problem number and name of the Arduino sketch should be clearly labeled for each problem. In other words, do not just print the source code on otherwise unlabeled sheets of paper. Print the word-processor file and include it with any other sheets of paper you submit as part of your assignment. Do not email the document to your instructor.

Here is a suggestion for problems 1 and 2. You should be able to work out the answers by hand, but you can always check your work by writing Arduino programs to evaluate the code. One way to write test codes is shown in the examples on the last two slides of “Arduino Programming Part II” from Lecture 5.

Refer to <http://arduino.cc/en/Reference/> for any new Arduino expressions or functions that you encounter in this assignment.

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1. (3 points) What are the values of i, j, k, and n at the end of each of the following code blocks? Ignore any variables that do not appear in the code block. For example, do not list values of j or k for code block b.

a.	<pre>int i,j,k,n;  i = 5; j = 2*i/3; k = i - j; n = 2*k;</pre>	b.	<pre>int i,n;  i = 2; i = 4*i + i; n = i - 3; i += 1;</pre>	c.	<pre>int i,j,n;  i = sqrt(5); j = sqrt(5); n = i*j;</pre>
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2. (3 points) What are the values of x, y and z at the end of each of the following code blocks? Ignore any variables that do not appear in a code block.

a.	<pre>float x,y,z;  x = sqrt(5); y = sqrt(5); z = x*y;</pre>	b.	<pre>int i,n; float x,y,z;  i = 5; n = i/2; x = n; y = i/2.0; z = float(i)/2;</pre>	c.	<pre>int i; float x,y,z;  i = 5; x = sqrt(5)/(i/2); y = sqrt(5)/i/2; z = sqrt(i)/float(i)/2.0;</pre>
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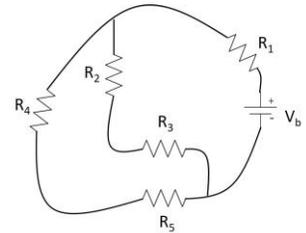
3. (5 points) A thermistor is a sensor with an electrical resistance that varies with temperature. By measuring the resistance of a thermistor (or by using the thermistor in a voltage divider and measuring the voltage), one can use a thermistor as a temperature sensor. The calibration formula for a particular thermistor is

$$T = \frac{1}{a_1 + a_2 \log R_t + a_3 (\log R_t)^3}$$

where  $R_t$  is the resistance of the thermistor in ohm, and the calibration constants are  $a_1 = 1.009250 \times 10^{-3}$ ,  $a_2 = 2.378405 \times 10^{-4}$  and  $a_3 = 2.019203 \times 10^{-7}$ . The  $\log(x)$  function returns the natural logarithm of  $x$ . Write the Arduino code to evaluate  $T$  for  $R_t = 15 \text{ k}\Omega$ . What is  $T$  for  $R_t = 15 \text{ k}\Omega$ . Your solution should involve definitions for the variables,  $a_1$ ,  $a_2$ ,  $a_3$ ,  $R_t$  and  $T$ . In other words, define Arduino variables for all symbols that appear in the equation for  $T$ , and then use those variables to write an Arduino expression for  $T$ .

4. (5 points) Build the breadboard circuit, and write an Arduino program that uses a potentiometer to change the rate of blinking of an LED. The wiper pin of the potentiometer is connected to an analog input pin. On each pass through the `loop` function, the code should
- Read and store the voltage at the potentiometer wiper.
  - Turn on an LED.
  - Wait a number of milliseconds equal to the reading of the potentiometer voltage. (Use the raw reading on the 10-bit scale returned by `analogRead`.)
  - Turn off the LED.
  - Wait a number of milliseconds equal to the reading of the potentiometer.

What is the maximum possible duration that the LED is on? Write a second version of the code so that the LED is on for a minimum of 0.1 seconds and a maximum of 3 seconds. In other words, the extreme positions of the potentiometer correspond to blink half-cycles of 0.1 seconds and 3 seconds. Include print-outs of both versions of the code and a sketch of the electrical circuit. You will show your second version of the program connected to your circuit and functioning to your instructor at the beginning of Lecture 7.



5. (4 points) Consider the circuit shown to the right.
- (a) Redraw the circuit so that the resistors are oriented parallel to either the horizontal or vertical axes.
  - (b) Obtain the equivalent resistance for  $R_1 = 100 \Omega$ ,  $R_2 = 200 \Omega$ ,  $R_3 = 300 \Omega$ ,  $R_4 = 400 \Omega$ ,  $R_5 = 0.5 \text{ k}\Omega$ .
  - (c) How much power is dissipated by  $R_3$  if  $V_b = 9\text{V}$ ? Show your work for full credit.