ME 120 – Winter 2016 **Homework 2** **Due 19 January 2016**

Use the Direct Solution Format for all problems on this assignment. Use a word processor to include the source code for problem 1, the photograph for problem 3, and the plot for problem 4. The source code, photograph and plot should be in a word processing document that includes a cover sheet with your name, and the assignment number. The cover sheet does not need to be a separate page. The problem number for each of these components should be clearly labeled. Do not just print the source code, or photo, or plot on an 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.

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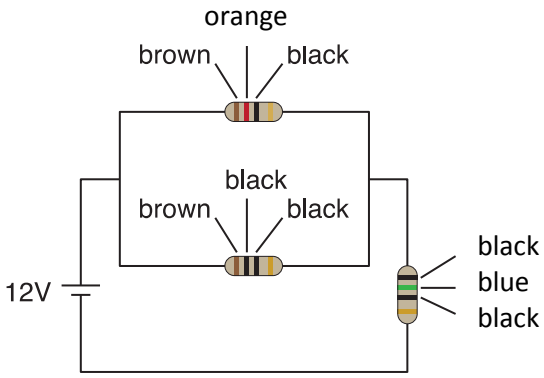
1. (5 points) Your kit comes with red and yellow LEDs. Build a circuit on your breadboard that uses one yellow LED and two red LEDs. The circuit should allow that the red LEDs can be turned on independently of the yellow LED and that both red LEDs are turned on at the same time. Note that there is more than one way to build this circuit, but be sure that each LED circuit includes a current-limiting resistor to protect the LED. Write a program that causes the LEDs to be turned on and off in the following pattern: The red LEDs turn on for 1 sec. Then the yellow LED also turns on for 0.5 sec. The red LEDs then turn off while the yellow LED stays on for another second. Then all LEDs are off for 0.5 sec. The process then repeats indefinitely.

   Print out the program listing and have your Arduino running this program at the start of class on the due date. Keep your homework at your desk and open to your program listing. The instructor will check the function of your blinking LED program and circuit, make a note on your paper, and collect your homework at that point.

2. (5 points) To the right is a circuit with a battery and three resistors.



   (a) Redraw the circuit with symbolic labels R_1, R_2 and R_3 for the three resistors and V_b for the battery. Obtain the *algebraic* formulas for the equivalent resistance of the circuit, the current through the black-blue-black resistor, and the power dissipated by the brown-black-black resistor. These formulas should be algebraic expressions involving R_1, R_2, R_3 and V_b, and *not* the numerical values of these quantities.

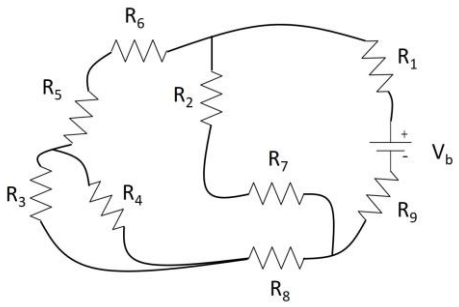
   (b) Determine the resistance of each resistor based on the color codes.

   (c) Evaluate the formulas for the equivalent resistance of the circuit.

   (d) What is the current flowing through the black-blue-black resistor?

   (e) What is the power dissipated by the brown-black-black resistor?

3. (5 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 of the circuit if all the resistors are 330Ω.

   (c) Build the circuit on your breadboard and measure the overall resistance. What value do you obtain? Use your cell phone or a digital camera to take a picture of the circuit on your breadboard. Include the picture in the word processor file that you print as part of your solution.

   (d) How much power is dissipated by R_6 if $V_b = 5V$? How much power is dissipated by R_6 if $V_b = 12V$?

4. (5 points) An excel sheet called HW2_Excel and showing the results of a battery test, can be downloaded from the ME120 web page (next to HW2, in the table located in Lecture notes).

   (a) Open the file with Excel (or other spreadsheet software) and plot the battery voltage versus time in minutes. Note that the first column is the time in seconds. Before you make the plot, you will need to convert the first column to minutes. We recommend that you create another column that stores the time in minutes converted from the time in seconds.

   (b) Label the axes of the plot and copy the result in a word-processor file that you print as part of your completed homework assignment.

   (c) How many hours does the battery last before the voltage falls below 0.5V?