Grading Document - Lab 1

For your grading of lab 1.

## Pre Lab

Each pre lab question is worth 1 point (sub questions included).

1. Annotate the picture of the arduino, or provide a list of applicable pin numbers for the following:
   1. Which pins can use the digitalWrite command?
      1. Answer: pins 0-13 can use digitalWrite.
   2. Which pins can use the digitalRead command?
      1. Answer: pins 0-13 and A0-A5 can use the digitalRead.
   3. Which pins can use the analogWrite command?
      1. Answer: pins 3, 5, 6, 9, 10, and 11 can use analogWrite.
   4. Which pins can use the analogRead command?
      1. Answer: pins A0-A5 can use analogRead
2. What is the difference between digital and analog signals?
   1. So far, we have used a button and lightsensor, and in Lab 1 we will use a temperature sensor. Which sensors are digital? Which are analog?
      1. Answer: The button is a digital sensor, the light sensor and temperature sensor are analog.
3. How do you designate new rows and columns in a .csv file?
   1. Answer: New rows are denoted with a new line character (\n), and columns are separated with a comma.
4. What is the difference between the serial.print and serial.println commands?
   1. Answer: the serial.println command prints a newline character after the text you gave it is printed. The serial.print line does not.

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### Lab Discussion Questions

Two points per question.

1. **Discussion Question 1:** What does the serial monitor do?
   1. Answer: it receives messages from the arduino
   2. Half-credit: says something about communication

**New Question 2:** Resolution of the ADC: ~4.883 mV

**New Q3:** Calculated value of voltage values from ADC readings and find the percent error from the DDM values.

1. **Discussion Question 2:** Time can become a big number fast, too big for the int variable type. Checking the example at the bottom of the documentation page, what is the variable type that you should use for storing information from the millis function?
   1. Answer: you should use a long variable type.
   2. Half-credit: says something about variables.
2. **Discussion Question 3:** Qualitatively, how consistent are the strobes? At what frequency is your strobe flashing?
   1. Answer: Hard to give a set answer, but just trust your gut on this one. Typically the strobes are inconsistent, and the frequency has to be below ~5Hz.
   2. Half credit: talked about frequency?
3. **Discussion Question 4:** What is the temperature range of this thermistor?
   1. Answer: -40 to 125 degrees celsius.
   2. Half-credit: saying 10-125 degrees (which is another model)
4. **Discussion Question 5:** This datasheet gives us a voltage-temperature reference point. At what temperature are we given the reference point? What is the voltage at the reference point? What is the ADC digital value of the value of the reference point?
   1. The reference point is 750mV at 25 deg C. ADC reads 153 - 154.
   2. Half credit: saying 250 mV output at 25°C, or a 500 mV output at 25°C (the other models).
5. **Discussion Question 6:** The final spec we need is the sensor resolution. What is the mV/deg C for our sensor?
   1. Answer: From the datasheet, the mV/deg is 10mV/deg C.
   2. Half credit: 20 mV/°C (other model).
6. **Discussion Question 7:** What is the temperature when the sensor outputs 0 volts? What is the voltage at 125 deg C?
   1. Answer: At 0V, this the equation gives -50 deg C. At 125 deg C, voltage is 1.75 volts (1750 mV).
   2. Half Credit: wrong answer, showed decent work
7. **Discussion Question 8:** What is the rise time of your sensor? What is the falling time of your sensor? Are they the same, why or why not?
   1. Answer: Needs to be a spot check. Make sure that what they say makes sense.

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## Sign-Offs

Each signoff is out of 2 points.

1. \_\_\_\_\_\_\_ Brought the correct lab materials to the lab.
   1. Make sure that they had correct materials for ALL days of lab.
2. \_\_\_\_\_\_\_ Demonstrated a working serial monitor.
   1. Students should definitely use the println command for this, otherwise it's hard to read.
   2. Wave hand over sensor to make sure its changing.
3. \_\_\_\_\_\_\_ Plotted strobe light flashes.
   1. Trust your gut on what you see. Make sure that their x axis (time) makes sense.
   2. Have them do a sanity check on their data. Does the observed frequency of the strobe match what the data says?
   3. *Note:* If the strobe frequency is greater than ~5Hz, the arduino won’t be able to sample fast enough.
   4. Will post example plot later
4. \_\_\_\_\_\_\_ Demonstrated temperature sensor code that outputs correct temperature values.
   1. Warm the sensor with your finger to make sure that the sensor/code actually works.
   2. Numbers should be reasonable (room temperature in Celsius is about 23 degrees).
   3. Check code for correct conversion. See [here](https://learn.adafruit.com/tmp36-temperature-sensor) for more. I wrote out derivation [here](https://drive.google.com/file/d/1NYi_2PP4cb-vExXN7ZDbikWxtvpiunvW/view?usp=sharing).
5. \_\_\_\_\_\_\_ Recorded and plotted change in temperature response as sensor moved around stations.
   1. Have students describe how they qualitatively find the rise and falling time.

### Post-lab Questions

1. Calculate the rise time of your temperature sensor both for increasing and decreasing temperature scenarios.
   1. From student data. Just make sure it makes sense.
      1. [Rise time](https://en.wikipedia.org/wiki/Rise_time) is time for signal to rise from 10-90% of steady state value.
2. What is the time constant and why is it important to sensors? Calculate the time constant from your data for both increasing and decreasing scenarios.
   1. From student data. Just make sure it makes sense.
      1. [Time constant](https://en.wikipedia.org/wiki/Time_constant) is time for the signal to reach 63% of the way left. The idea is that every time constant period the signal has risen about 63% of the difference: (steadyStateReading - readingAtEndOfLastTimeConstant)
3. Describe the process that you had to go through to record a csv file with arduino.
   1. Very general look at process (basically its lab 1): Output to serial in Arduino -> Record data with putty as csv file -> read csv file with matlab -> plot data
4. What is the baud rate in the serial port? What does 9600 baud (for Serial.begin(9600) in your code) mean? What is the highest baud rate that you can set with the Serial.begin command? In theory, what is the fastest baud rate the Arduino could put out?
   1. Baud rate is the established communication speed between the PC and arduino for serial communications. Baud is bits per second (th/f 9600 baud is 9600 bits per second). Optional (??): Officially you can set the highest baud rate as 115200. Theoretical highest is 2 Mbps ([here](https://arduino.stackexchange.com/questions/296/how-high-of-a-baud-rate-can-i-go-without-errors)).