ECE 241 **Lab 9** **Fall 2017**
Due: Oct. 31 – Nov. 6 **30 points**

Objective: Develop an understanding of the Analog to Digital Converters (ADC's), and look at how to interpret the numbers from the Arduino analogRead() function.

Description of Lab 9: In this lab we will be using the ADC to read in a voltage provided by a potentiometer, print the number returned by the ADC and the voltage it represents. One of the challenges will be to measure the actual voltage provided to the Arduino's input and the numbers that come in from the ADC.

The potentiometer was described in class, and consists of a resistor that has a sliding contact. As the contact moves the voltage at the contact varies between the voltage at the either end of the resistor. The diagram in Figure 9-1. shows how the potentiometer will be used in this lab, allowing us to apply a voltage of 0 to 5 volts to the ADC input on the Arduino. Also shown are connections to the Analog Discovery (AnaDisc) unit, which will be used to test the voltages read by the Arduino. The AnaDisc will be used to test the 5 volts provided by the Arduino.

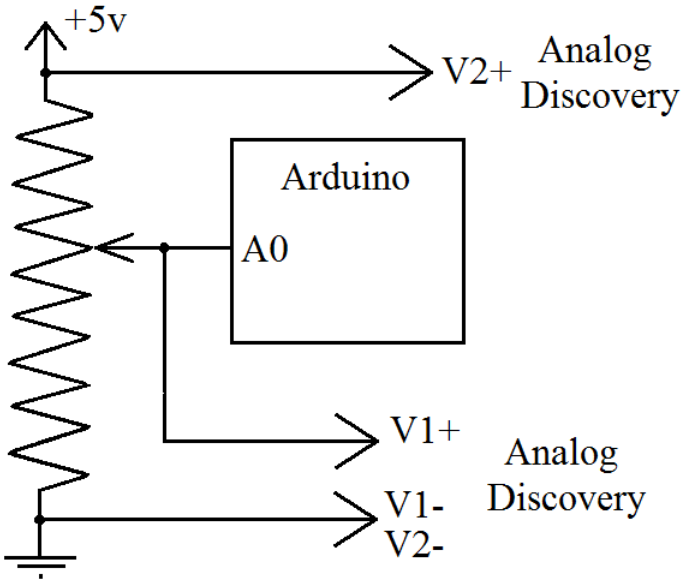

Figure 9-1. Analog Input and Output.

Lab Assignment: The code for this lab is very simple. It is intended to read the voltage every 0.5 seconds and then report it over the serial port.

Setup:
    Set up Timer
    Set up Serial port.

Loop:
    if 500 milliseconds has passed
        Read analog Input
        Convert Input to voltage, assuming a 5 volt reference.
        Send number from the ADC, and the computed voltage over the serial port.

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Prelab: Write the program described above and upload it to the Prelab 9 location.

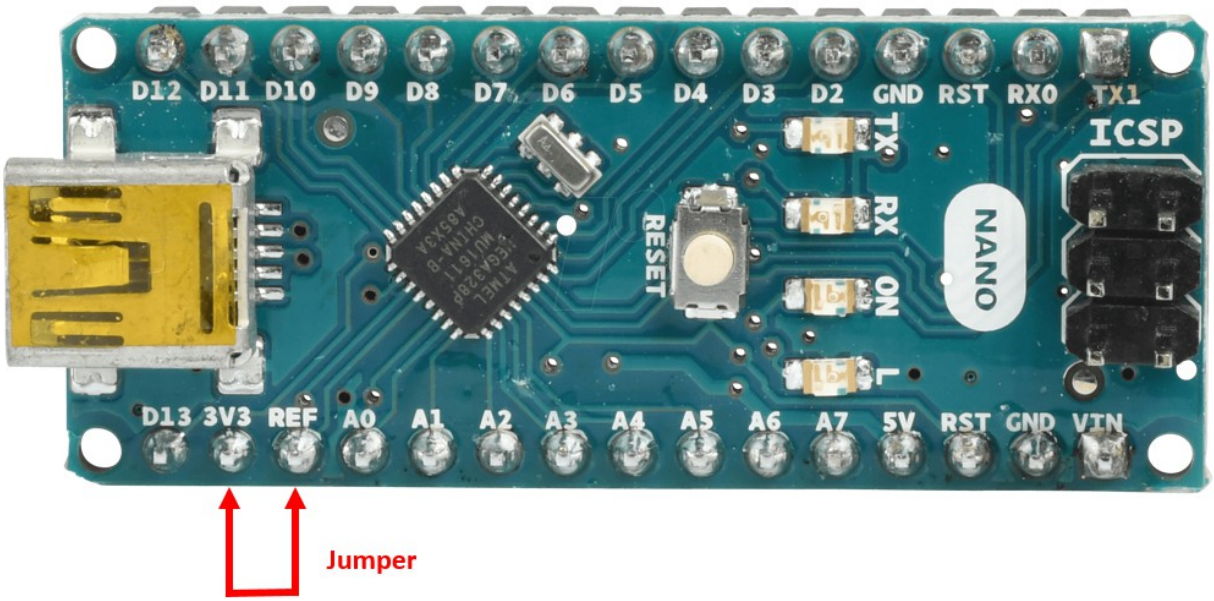
Lab 9:

1) Attach the potentiometer (available in the lab) to your Arduino, then demonstrate your program to your TA. Be sure to demonstrate the output of your system for the potentiometer turned to the two extremes and set the potentiometer such that you print out approximately 1.5, 2.5, and 3 volts.

2) Attach the AnaDisc's analog lines to your board as shown in Figure 9-1. Set the Waveform software up to measure the average value of the two voltages and repeat part 1, except this time compare the voltage from the AnaDisc with those being printed by the Arduino.

   Be sure to record the voltages, from the Arduino and AnaDisc, for each setting as they will be needed for future calculations. Also continue to use the assumed reference of 5 volts, since it is not common to know what the supply is on our system.

3) Change the ADC to use the 3.3 volt supply as the reference. Note a jumper is needed to connect ref and 3.3, and code will need to change to use a reference value of 3.3.



Note the potentiometer can stay connected to 5 volts, but the measurement range is now restricted to 0 to 3.3.

Repeat the readings that were done in part 2, (1.5, 2.5, and 3 volts). Record the readings from the Arduino, and AnaDisc for later calculations.

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Questions:

1) What was the error that was observed in part 2, where the error is the difference between the voltage computed by the Arduino (Vcomputed) and the voltage read from the AnaDisc (Vmeasued). It is best to compute the relative error, which is difference divided by the measurement that is the most trusted, which in this case is Vmeasured.

$$RelErr = \frac{|V_{computed} - V_{measured}|}{V_{measured}}$$

2) What was the error for the measurements in part 3(where the 3.3 reference was used) and how do they compare to the errors in question 1.

3) Are the relative errors consistent for all the various values, or does it change as the voltage being measured changes?