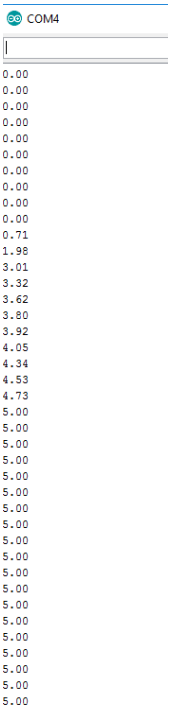
**Objective:** Develop an understanding of the Analog to Digital Converters (ADC's), and look at how to interpret the numbers from the Arduino analogRead() function.

**Prelab:** The code was written and uploaded to the website. The code written is used to calculate the voltage and display it in the console. The Voltage can be changed through an attached potentiometer that utilizes a sliding contact to alter the voltage.

**Part 1)** In part one, the code was uploaded to the Arduino the output was observed in the console. As the knob turns the output calculated changes. The knob was adjusted so that it measured about 1.5,2.5, and 3 volts, as well as 0 and 5 volts. Below is a screenshot of the output.




**Part 2)** In part two the A_discs lines were connected to the Arduino so that the actually voltages that were running on the board could be captured by waveform.

**Part 3)** In part three the code was altered so that it used a 3.3V as a reference. A jumper was also added to the board to connect the 3v3 and Ref ports. The noted change be seen in appendix B.

1.

| 1. Voltage Read on Console | 2. Voltage measure in waveform | 3. Relative Error |
|---|---|---|
| 4. 1.5 | 5. 1.436 | 6. .045 |
| 7. 2.5 | 8. 2.383 | 9. .049 |
| 10. 3.0 | 11. 2.849 | 12. .053 |
| 13. 5.0 | 14. 4.746 | 15. .054 |

2.

| Voltage Read on Console | Voltage Measured | Relative Error |
|---|---|---|
| 0 | 4 mV | -1 |
| 1.5 | 1.637 | -.106 |
| 2.5 | 2.703 | -.075 |
| 3.0 | 3.232 | -.072 |
| 3.3 | 4.746 | -.305 |
| | | |

In comparison to the relative errors part two. The relative errors in part 3 started large and went down. They were also negative because they were measured as higher than they were reading.

3. The relative error changes based on the voltage being measure. In part 2 the relative error went up as the voltage went up. In part 3 the relative error went down as the voltage went up, with the exception of the 5V max because the console could only read it as 3.3V.

4. When the voltage goes above the reference voltage like in part 3. The Voltage measured continues to go up. This explains the much large relative error in question 2. This is because of the console is set to 3.3V max in it's calculations, however the board itself is not limited to that number and the voltage will continue to go up as the knob is turned.

Appendix A) Code for part ½

```
unsigned long timer; //initialize the timer

void setup() {
  timer = millis(); //set the timer equal to the number of milliseconds since
the program started
  Serial.begin(9600); //initialize the serial port and sets the baud rate to
9600
  analogReference(DEFAULT); //initialize the analog port as an external

}


void loop() {
  if ((millis() - timer) >= 500) { //checks if the over half a second has
passed
    float AnalogRead = analogRead(A0); //sets analogRead to the value read of
port 0
    Serial.println(5.0*AnalogRead / 1024.0); //prints and calculate the
voltage
    timer += 500; //increments the timer by 500 milliseconds
  }
}
```

Appendix B) Code for part 3

```
unsigned long timer; //initialize the timer

void setup() {
  timer = millis(); //set the timer equal to the number of milliseconds since
the program started
  Serial.begin(9600); //initialize the serial port and sets the baud rate to
9600
  analogReference(EXTERNAL); //initialize the analog port as an external

}


void loop() {
  if ((millis() - timer) >= 500) { //checks if the over half a second has
passed
    float AnalogRead = analogRead(A0); //sets analogRead to the value read of
port 0
    Serial.println(3.3*AnalogRead / 1024.0); //prints and calculate the
voltage
    timer += 500; //increments the timer by 500 milliseconds
  }
```