Summary:

Students will familiarize themselves with the Arduino Mega's analog-to-digital converter by building simple circuits on a breadboard, writing programs that introduce the ADC pins and functions, and plotting data in Excel.

Materials:

Each student should have the following materials, equipment, and supplies:

- Computer with Arduino IDE and Excel installed
- USB-AB programming cable
- Arduino Mega microcontroller
- Bench power supply capable of supplying 5 to 12 VDC
- Digital multimeter
- Tools: Wire strippers, wire cutters, resistor bender
- Wires/Jumpers (recommend 22 gauge solid wire)
- Breadboard
- 5k potentiometer
- 5k resistor
- P-N junction diode (1N457)

Procedure:

Example 1 – Potentiometer

1. Follow the schematic in figure 1 to connect the potentiometer to the microcontroller.

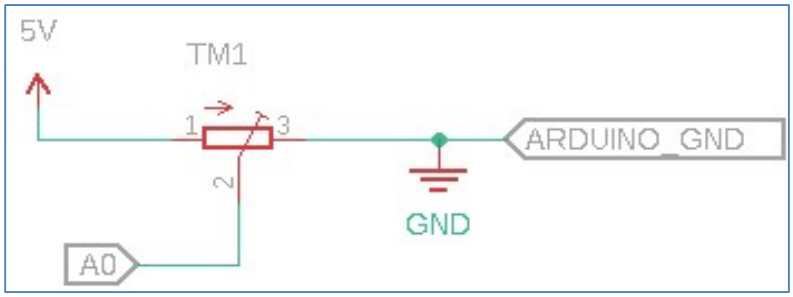

Figure 1: Schematic for a stand-alone potentiometer connected to pin A0 on the Arduino Mega

2. Write a simple program for analog pin 0 to read the voltage from the potentiometer.
3. Slowly turn the knob and observe the change in ADC.

4. Set the knob to return 0V, then slowly turn the knob and record at least 5 data points between 0 and 1023.

ADC	Corresponding voltage
0	0V
1023	5V

5. Plot your data in Excel
6. You should observe a linear relationship between the voltage and resistance that follows Ohm's law.
7. Calculate the corresponding voltage

$$\frac{Resolution\ of\ ADC}{System\ Voltage} = \frac{ADC\ Reading}{Analog\ Voltage\ Measured}$$

Figure 2: Formula to convert ADC to voltage

Example 2 – Diode

1. Follow the schematic in figure 5 to connect the diode in series with the resistor to the microcontroller
    a. Be careful not to connect the diode directly to the microcontroller. Without the resistor, you will experience a current surge which can overheat your circuit and can be potentially dangerous to you.

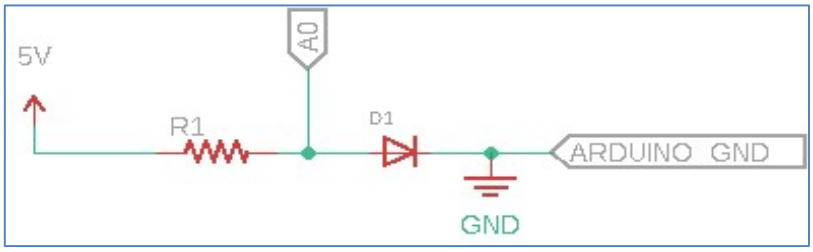

Figure 5: Schematic for resistor and diode in series

2. Use the same program from example 1 to read the ADC. If connected correctly, the diode should not be hot. Lightly pinch it with your fingers and observe the changes in the serial monitor. You should see the ADC change by approximately 1 to 5 ADC values.
3. Calculate the voltage. This is a silicon P-N junction diode and based on its material properties the voltage should fall near 0.7V.

Example 3 – Diode and Potentiometer in Series

1. Follow the schematic in figure 6 to connect the diode in series with the resistor to the microcontroller
   a. Make sure to connect the short circuit from the resistor to the diode, otherwise when the potentiometer is turned low it will cause a current surge.

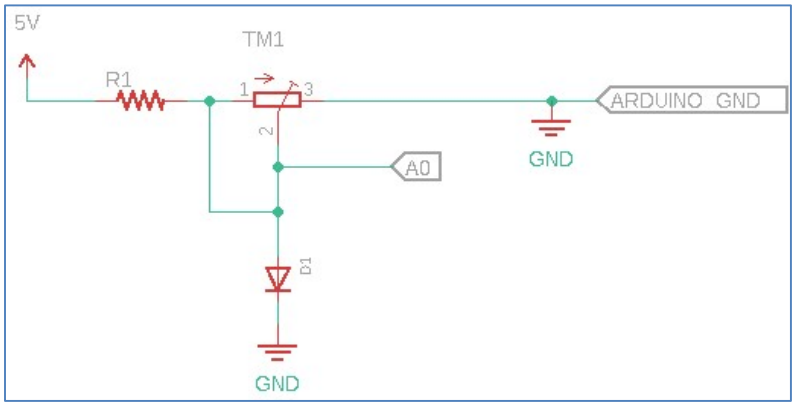

Figure 6: Schematic for resistor and diode in series

2. Use the same code to test the voltage as you turn the knob on the potentiometer. You should observe the voltage range from 0 to 0.7V. Calculate the ADC range and compare to the serial monitor.

Expected Outcomes:

Each team should complete the activity with the knowledge and skills to read the ADC on the Arduino Mega microcontroller and work with the data collected.