Fluid Power Laboratory
Module 3

Data acquisition and calibration of a pressure transducer – Part 1

(using Arduino Microcontroller)

Report: Answer the green bolded questions for report submission. Turn in one report per group and upload a video of your working system, and make sure to write your names (first and last name), lab topic, and section day and time.

Lab objectives

1. Gain an understanding of sensor calibration method using a deadweight tester and a pressure gauge
2. Understand the circuit design for a pressure transducer connected to an Arduino microcontroller
3. Learn how to develop an Arduino code that converts analog sensor readings to voltage

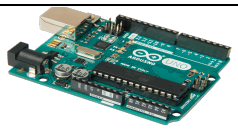
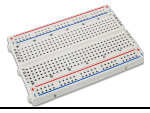
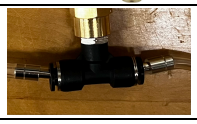
Discussion

Students can work in **groups of 3 or 4** to achieve the **calibration of the pressure transducer using a deadweight tester**. In Module 3, the goal of the lab is to **record measurements** using a **pressure gauge** first then a **pressure transducer**.
In this lab, you will use your own built deadweight tester from the previous lab (Figure 1).

Figure 1. Model of previously built deadweight tester

The components presented in *Table 1* will be provided for designing the circuit and building the piping connections.

Table 1. Utilized components for piping and circuit design

Arduino Uno	
1/8 NPT Thread Stainless Steel Pressure Transducer (0-100PSI) (voltage output 0-5 volts)	
Jumper wires	
Breadboard	
Pressure gauge (0-60 psi)	
2-way in line gauge connector	
Syringes 20 cc (20 mL) and 60 cc (60 mL)	
Hoses (1/8 diameter or syringe fitting)	
Tee fitting (1/8)	
NPT threads (1/8)	
Female-female pipe fitting	
Teflon tape	
Weights for deadweight tester (0.5 lb and 2 lb)	 Picture shown is an example. The can also be bags of rice, suger, or a beaker filled with varying amounts of water.

Procedure (Pressure gauge measurements, Sensor measurements)

1. Identification of deadweight tester parts

Familiarize yourself with the components of the deadweight tester (base, a piston-cylinder assembly (Fgiure 2), a systems of varying weights (chosen by the user), a pressure gauge, and various fittings and adapters).

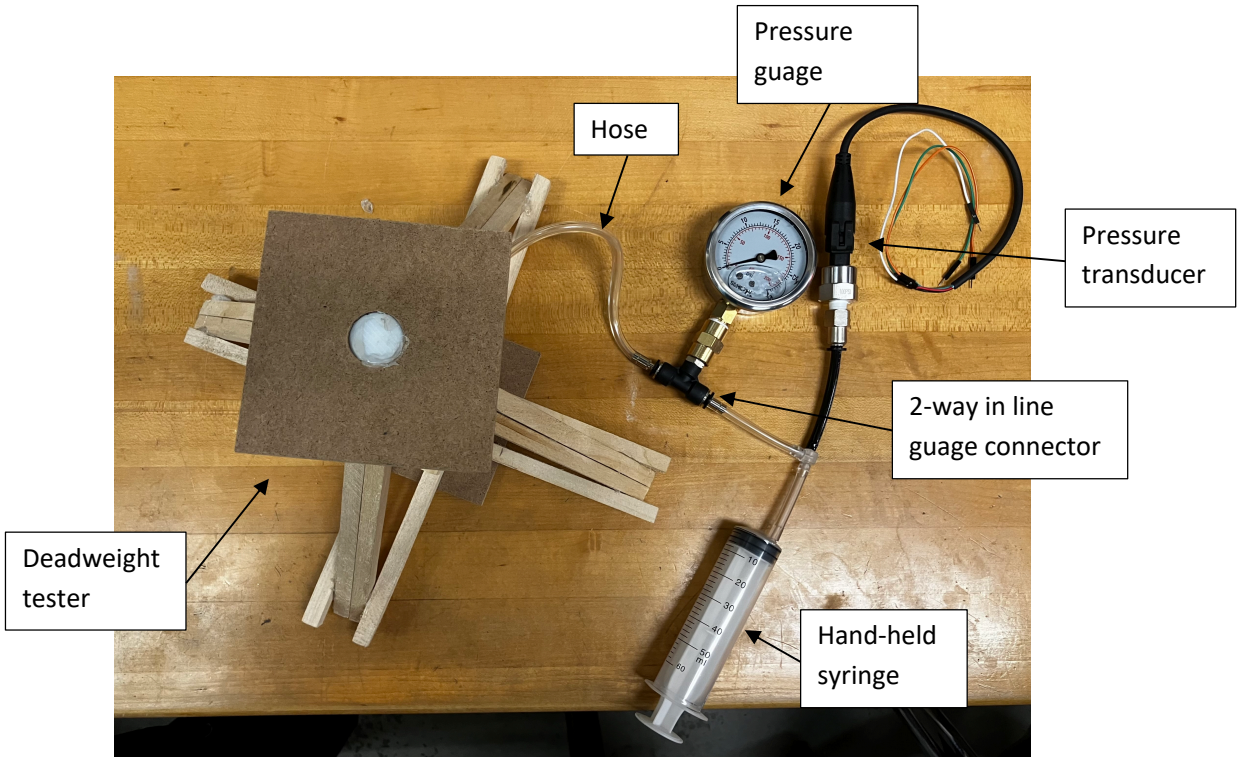


Figure 2. Deadweight tester Assembly

2. Pressure gauge measurements

2.1. Prepare the pressure gauge setup by connecting the pressure gauge and the in-line connector via the female-female pipe fitting. Ensure all joints are tightly connected and use about one turn of Teflon tape.

2.2. Attach a hose linking the syringe of the deadweight tester to one outlet of the pressure gauge, ensuring a secure connection. Use the minimum necessary length of hose to minimize pressure losses due to compressibility.

2.3. Attach another hose to link the separate 60 cc syringe to the other outlet of the pressure gauge, ensuring a secure connection. Use the minimum necessary length of hose to minimize pressure losses.

2.4. Make sure the plunger of the syringe is secure and doesn't move freely. Also, ensure the syringe is clean and free from any debris or air bubbles.

Provide a photo of the pressure gauge system similar to *Figure 3* labeling all components.

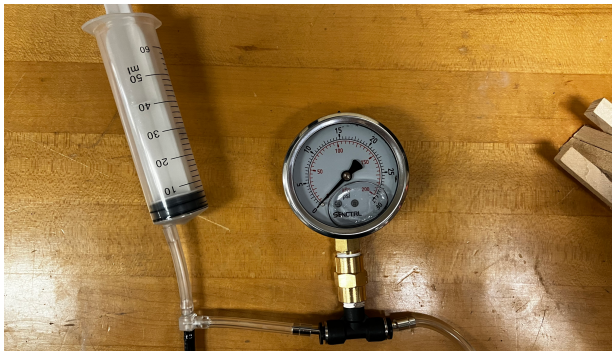


Figure 3. Pressure gauge setup

2.5. Adjust the height of the piston of the deadweight tester to its zero state. Ensure the pressure gauge is reading zero and that the hand-held syringe is opened to its maximum.

2.6. Start by placing a known weight on the vertical piston of the deadweight tester. **Note: this weight can be anything, as long as its value is known. For example, increasing amounts of water, or varying bags of sugar or rice, can be placed in a container on the tester and act as the weights mentioned.**

2.7. Apply an inward force on the separate syringe to increase pressure in the system.

2.8. Stop as soon as the piston of the deadweight tester is lifted.

2.9. When the system is stabilized, record the pressure reading in psi from the gauge.
Create an Excel sheet to note your measurements of pressure (psi) for each weight (lb).

2.10. **Gradually add 1 lb weights until you reach 5 lb and note pressure readings in Excel.** Ensure the piston is set back to zero, the system is decompressed, and the hand-held syringe is open between measurements.

2.11. **Upload a video with the report showing how you used the deadweight tester.**

3. Sensor measurements

3.1. Electric circuit design

Using the provided jumper wires, connect the pressure transducer to Arduino as per the below schematic (*Figure 4*).

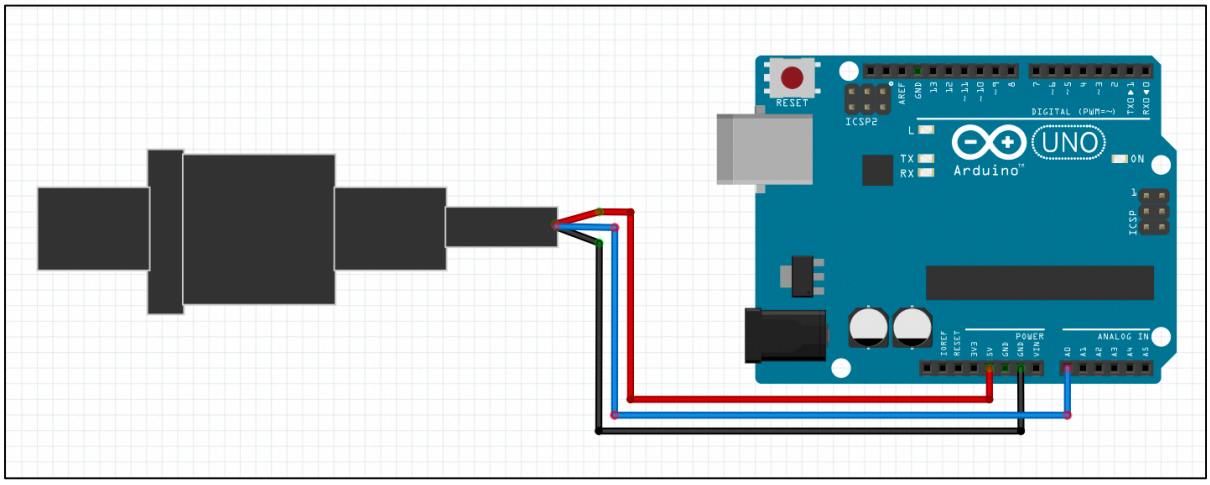


Figure 4. Pressure transducer wiring

Provide a photo of the first part of your circuit (pressure transducer connected to Arduino), and draw the corresponding circuit schematic using the fritzing software (provided in lab folder).

P.S: You can use other analog pins.

3.2. Coding

1. Start by defining your input (analog sensor reading), sensor delay (delay between sensor readings in milliseconds), and output (pressure value in psi).
   Example:
   int sensorInput = (specified analog pin);
   int sensorReadDelay = 500;
   float pressureValue = 0; // initial value 0 psi
2. In the void setup, initialize the baud rate at 1200 bits per second to enable real-time reading of pressure values in the serial monitor.
3. In the void loop, write a code for reading the analog value from the sensor and displaying it in Volts in Arduino serial monitor.

   P.S: Note that analog readings go from 0 to 1023 and should be converted to a voltage between 0 and 5V.

   Hint: Use *delay(sensorReadDelay)* at the end of the void loop to delay read values.
4. After writing the code, compile it to check if there are any errors in the code.
5. After reviewing and checking your code, upload it into Arduino to start testing. **Upload your code in the lab submission.**

An example of the code can be found in the appendix.

```
// initialize component pins
```

```
int sensorInput = A0;
int sensorReadDelay = 500;
float pressureValue = 5;

void setup() {
  // put your setup code here, to run once:
  Serial.begin(1200);
  pinMode(sensorInput, INPUT);
}

void loop() {
  // put your main code here, to run repeatedly:
  analogRead(sensorInput);
  float pressureValue = analogRead(sensorInput); //set pressure value equal to sensor input and
convert to volts
  pressureValue = pressureValue/204.6;
  Serial.print(pressureValue);  //display voltage in serial monitor
  Serial.println();   //move to new line
  delay(sensorReadDelay); //delay sensor reading
}
```

3.3. Setup and measurements

3.3.1 Prepare the pneumatic setup by connecting the pressure transducer to the NPT thread via the female-female pipe fitting. Ensure all joints are tightly connected and use about one turn of Teflon tape.

3.3.2 Attach a tee fitting and hoses linking the syringe of the deadweight tester, the handheld 20 cc syringe, and the pressure transducer (see *Figure 5*). Ensure secure connections. Use the minimum necessary length of hose to minimize pressure losses.

3.3.3 Make sure the plunger of the syringe is secure and doesn't move freely. Also, ensure the syringe is clean and free from any debris or air bubbles, if using a liquid.

Provide a photo of the pressure gauge system similar to *Figure 6* labeling all components.

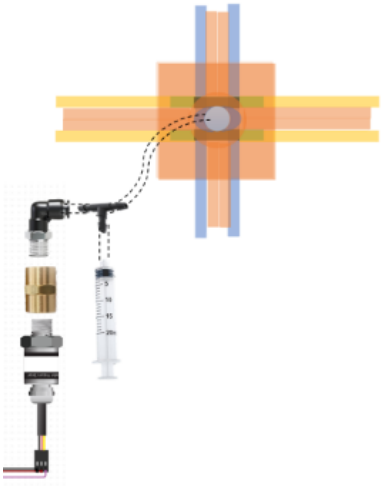


Figure 5. Tee fitting connections

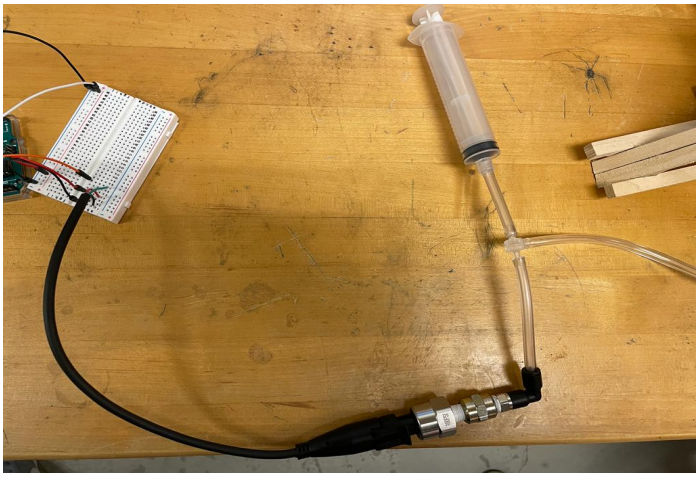


Figure 6. Pressure transducer setup

3.3.4 Adjust the height of the piston of the deadweight tester to its zero state. Note the voltage reading of ~ 0.5 V displayed in the serial monitor. Ensure that the separate syringe is opened to its maximum.

3.3.5 Repeat steps 2.6-2.8 from the section 2.

3.3.6 When the system is stabilized, record the voltage reading in volts from the serial monitor. **Create an Excel sheet to note your measurements of voltage (V) for each weight (lb).**

3.3.7 **Gradually add 1 lb weights until you reach 5 lb and note voltage readings in Excel.** Ensure the piston is set back to zero, the system is decompressed, the voltage reading is back to ~ 0.5 V, and the separate syringe is open between measurements.

3.3.8 **Upload a video with the report showing how you used the deadweight tester.**

3.3.9 **Attach the Excel file with the report in the lab submission.**

Report

Please, answer green bolded questions. Turn in one report per group, attach your code, and upload the required videos. Make sure to write your names (first and last name), lab topic, and section date and time.

Thank you