Fluid Power Laboratory
Module 4

Data acquisition and calibration of a pressure transducer – Part 2

(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 to derive the calibration equation using voltage and pressure
2. Learn how to develop an Arduino code that uses the calibration equation to convert readings from a pressure transducer
3. Get hands-on experience with simple data acquisition systems, instrumentation, and programming methods to measure pressure using a pressure transducer

Discussion

Students can work in **groups of 3 or 4** to achieve the **calibration of the pressure transducer** (1/8 NPT Thread Stainless Steel Pressure Transducer 0-100 psi) **using a deadweight tester**. In this part 2, the goal of the lab is to derive the **function relating voltage and pressure** from a **pressure transducer**. For this purpose, students will use **data collected from the previous lab** (Refer to *Figures 1-2* for setup used) to find the best-fit curve then write a code that converts voltage readings from the sensor to pressure values.

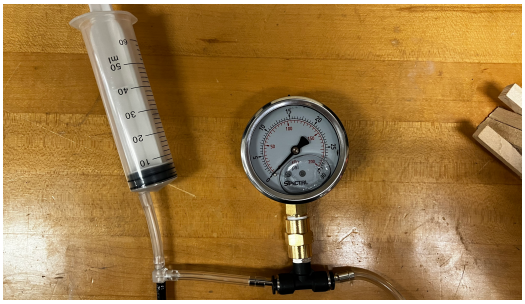


Figure 1. Pressure gauge setup

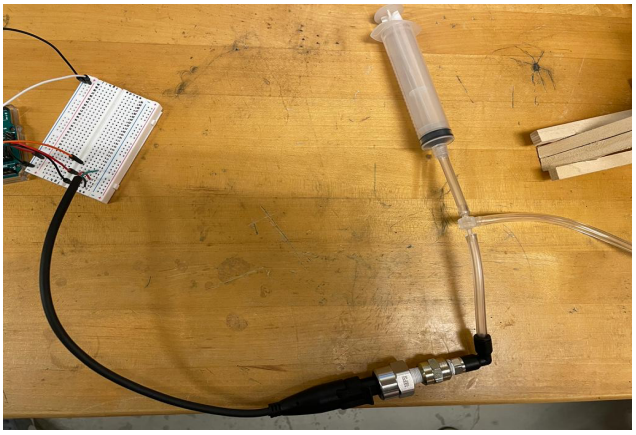
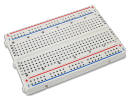


Figure 2. Pressure transducer setup

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

Table 1. Utilized components for system and circuit design

Arduino Uno	
1/8 NPT Thread Stainless Steel Pressure Transducer (0-100PSI) (voltage output 0-5 volts)	
Jumper wires	
Breadboard	
Syringes 20 cc (20 mL)	
Hoses (1/8 diameter or syringe fitting)	
NPT threads (1/8)	
Female-female pipe fitting	
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 (Derivation of calibration equation, Testing)

1. **Derivation of calibration equation**

   The goal of a calibration equation is to verify the pressure readings displayed on the sensor with the known pressure values created by the deadweight pressure.

1.1. Retrieve the Excel sheet you worked on in your previous lab. Ensure you have 3 distinct columns for **weights** (lb) that were placed on the deadweight tester, **pressure** (psi) readings, and **voltage** (V) data.

1.2. Since the transducer is a component that allows the system to obtain a response signal from a physical phenomenon such pressure, **what electrical value is altered within the sensor and is directly proportional to pressure?** (**Hint:** Find this information on the label of the pressure transducer)

1.3. **Which data column represents the sensor output? What is its range?**

Note: The pressure transducer 1/8 NPT Thread Stainless Steel Pressure Transducer (0-100 psi) has a 0.5V - 4.5V linear voltage output, such that 0.5V corresponds to a pressure of 0 psi, 2.5V corresponds to 50 psi, and 4.5V to 100 psi.

1.4. **Which column corresponds to the input of the calibration equation?**

1.5. **What type of behavior is expected on the graph? (e.g., linear, exponential, polynomial)? Why?**

1.6. In Excel, select the columns data for **pressure** and **voltage** and build a line graph ("Insert" tab > "Charts" section) showcasing the change in pressure (psi) as a function of the change in voltage (V). **Save your graph as a picture to be uploaded with the lab report**.

1.7. From the graph, extract the equation relating pressure and voltage. **Report the equation you obtained. What is the slope? What is the y-intercept?**

Hint: Right-click on any point in the plot and select "Add Trendline." In the "Format Trendline" panel, select the "Linear" option and check the box next to "Display Equation on chart."

1.8. Assume now that you are using a pressure transducer to make a reading. You obtain a value of 3.75 V. **Estimate the pressure value measured by the sensor in psi.**

1.9. If the system was filled with water instead of air, **would the pressure readings be similar? How would the pressure values vary when using water?**

2. Testing

2.1. Setup preparation

2.1.1 Re-build the pressure transducer circuit from the previous lab using the provided breadboard and jumper wires, as per the below wiring (*Figure 3*).

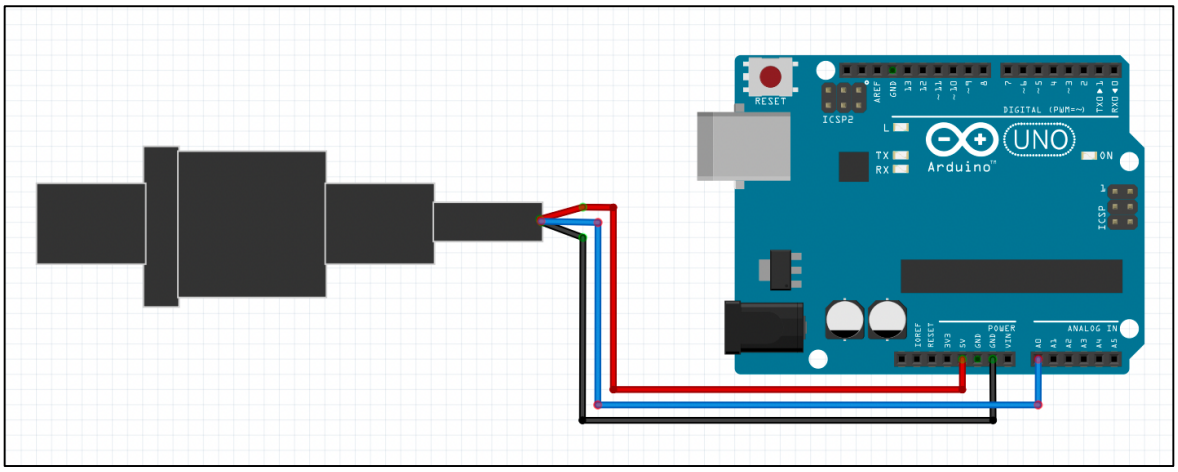


Figure 3. Pressure transducer wiring

Note: You can use different digital pins.

2.1.2 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.

2.1.3 Then, connect the NPT thread to a 20-cc syringe via the hose.

2.1.4 You will be applying an inward force on the separate syringe to increase pressure in the system and display pressure readings after completing section 2.2.

2.2. Coding

2.2.1 Use the code you used in the previous lab to convert analog pressure readings to voltage values in Volts. For reference, the line of code needed to accomplish this is:

```
float pressureValue = analogRead(sensorInput); //set pressure value equal to sensor input and convert to volts
voltageValue = pressureValue/204.6;
Serial.print(voltageValue);  //display voltage in serial monitor
```

2.2.2 In the void loop, add a code that converts voltage readings (V) from the sensor to pressure values (psi) using the equation you derived in section 1. Then, display both voltage and pressure values in Arduino serial monitor.

2.2.3 After writing the code, compile it to check if there are any errors in the code.

2.2.4 After reviewing and checking your code, upload it into Arduino to start testing. **Upload your code in the lab submission.**

Report

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

Thank you