ASEN 3300, Fall 2023: Lab 2 Report Submission

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4. Experiment (25 pts)

4.1. Voltage Divider (5 pts)

a. Record your responses to 4.1.a below:

Measured resistance R1:	4.97 kΩ
Measured resistance R2:	3.18 kΩ

b. Record your response to 4.1.b below:

Current through circuit (oscilloscope not in circuit):	0.591 mA

c. Record your responses to 4.1.c below

Voltage across (R1 + R2):	4.86 V
Current through (R1 + R2): (During $V_{(R1 + R2)}$ measurement)	0.595 mA
Voltage across R1:	2.975 V
Current through R1 (during V_{R1} measurement):	0.595 mA
Voltage across R2:	1.9 V
Current through R2 (during V_{R2} measurement):	0.591 mA

4.2. Grounding

a. Record your responses to 4.2.b below

Voltage across (R1 + R2):	5.16 V
Current through (R1 + R2): (During $V_{(R1 + R2)}$ measurement)	0.593 mA
Voltage across R1:	5.16 V
Current through R1 (during V_{R1} measurement):	0.979 mA
Voltage across R2:	2.1 V
Current through R2 (during V_{R2} measurement):	0.597 mA

b. Think about the inconsistencies you found between the measurements taken here and in the previous section for use in 5.1.

The value for R1+R2 matched the value for R1 when connecting the circuit to earth ground. This is due to the fact that we were earth grounding at terminal B of the circuit, so no current was flowing through R2.

4.3. Equivalent circuits and loading

a. Record your responses to 4.3.a below (R_{in} = 10 MΩ):

Voltage across (R1 + R2):	5.00 V
Voltage across R1:	2.37 V
Voltage across R2:	2.38 V

b. Record your responses to 4.3.b below (R_{in} ≅ 10 GΩ):

Voltage across (R1 + R2):	4.99 V
Voltage across R1:	2.49 V
Voltage across R2:	2.51 V

c. Record your responses to 4.3.c below (oscilloscope with R_{in} = 1 MΩ):

Voltage across (R1 + R2):	5.16 V
Voltage across R1:	2.10 V
Voltage across R2:	1.86 V

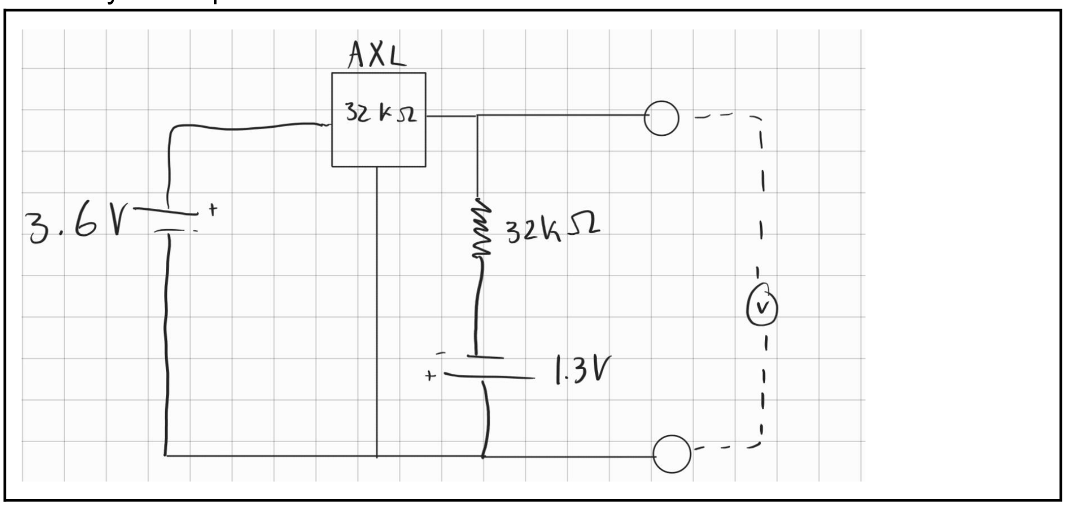
4.4. Accelerometer (6 pt)

a. - f. Record your responses to 4.4.a - 4.4.f in the below table

	X-axis Measurements (green)	Y-axis Measurements (white)
Flat on the table	1.27 V	1.29 V
X-axis up	1.23 V	1.28 V
Y-axis up	1.28 V	1.23 V
X-axis down	1.34 V	1.29 V
Y-axis down	1.29 V	1.34 V
Upside down	1.28 V	1.29 V

4.5. Signal Conditioning Design (6 pts)

a. Record your response to 4.5.a below:



b. Record your responses to 4.5.b in the table below:

	X-axis
Flat on the table:	-93.7 mV
X-axis up:	-126 mV
Y-axis up:	-99.0 mV
X-axis down:	-71.5 mV
Y-axis down:	-98.7 mV
Upside down:	-93.3 mV

c. Record your response to 4.5.c in below:

We got close to the requested sensitivity of the accelerometer. The initial value was ~70 mV/g and with our signal conditioned circuit, we saw a sensitivity of ~32 mV/g.

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5. Analysis (25 pts)

5.1. Voltage Divider and Grounding (10 pts)

a. Record your response to 5.1.a below:

Due to the resistance values used in the actual lab being slightly different than the values given in the pre-lab (3 kΩ vs 3.18 kΩ and 5 kΩ vs 4.97 kΩ) as well as having voltmeters that are non-ideal, the values recorded in section 4.1 vary slightly from the pre-lab answers. However, the results recorded are within acceptable ranges. Across R2, the expected value was 1.875 V and the recorded value was 1.9 V while the expected current was 0.625 mA and the actual current was 0.595 mA.

b. Record your response to 5.1.b below:

When the power supply is Earth grounded, less voltage is lost to the internal resistance of the oscilloscope, so across R1 + R2, a voltage drop of 5.16 V is seen. When measuring the voltage drop across just R2, a voltage drop of 2.1 V is seen (up from 1.9V). This would also be due to the fact that less voltage is lost to the internal resistance of the oscilloscope due to Earth ground. However, when measuring the voltage drop across just R1 while Earth grounded, a voltage drop of 5.16 V is seen. This is due to the fact that the R2 resistor is short circuited in this case because of the Earth grounding.

5.2. Equivalent circuits and loading (7 pts)

a. Record your response to 5.2.a below:

	R_{in} = 10 MΩ	R_{in} ≅ 10 GΩ	Oscilloscope with R_{in} = 1 MΩ
Voltage across R1+R2	5 V	4.99 V	5.16 V
Voltage across R1	2.37 V	2.49 V	2.10 V
Voltage across R2	2.38 V	2.51 V	1.86 V

Our table shows that the 10 GΩ impedance values giving the most accurate voltage measurements followed by the 10 MΩ and 1 MΩ impedance values getting progressively less accurate as the impedance decreases

b. Record your response to 5.2.b below:

In this portion of the lab, if we were using an ideal voltmeter, we would measure 5 volts across both resistors, and 2.5 volts across each individual resistor. However, we are not using an ideal voltmeter and rather relying on the input impedance of the real world voltmeter and oscilloscope. The voltmeter with the highest impedance will result in the most accurate values because it is closer to the infinite resistance provided by an ideal voltmeter. On the other hand, if we were using an ammeter to measure charge, we would want to use a lower input impedance because an ideal ammeter would have zero internal resistance.

c. Record your response to 5.2.c below:

The impedance of the voltmeter can switch between 10 MΩ and 10 GΩ. The impedance within the oscilloscope that we used is consistently 1 MΩ. The multimeter was not connected to earth ground during this portion, however, the oscilloscope measurement is naturally connected to earth ground.

5.3. Accelerometer (6 pts)

a.

We can verify the sensitivity axes based on our data. When the x-axis measurements were being taken, the voltage values fluctuated when the x-axis was either up or down, but returned to the zero-g's value when the y-axis was either up or down. The same can be said for when recording voltage values for the y-axis. The conversion/calibration equation for our sensor would be:

Acceleration (g) = (Measured Output Voltage (mV) - Zero-g Output Voltage (mV)) / Sensitivity (mV/g)

b. Record your response to 5.3.b below:

We were able to remove the offset voltage decently well, but we were still left with values within the -70 to -130 mV range. This discrepancy could be due to us being time constrained and using the 33 kΩ resistor rather than trying to get the ideal 32 kΩ resistor that we determined would be best. The sensitivity of the output was ~32 mV/g. We were able to get very close to successfully halving the sensitivity in comparison to 4.4f (~70 mV/g).

Optional: Do you have any useful feedback on this lab?

Not enough guidance given. Without the TA's help, we would have had no clue on how to build the circuit in 4.5.