MEC E 301
Lab 3: Displacement Transducers

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Question 1

(a)

The plot of displacement over voltage can be found in Fig. 1. The slope, intercept, and R^2 value of the linear regression were determined using `=LINEST()` in Excel. The results can be found in Table 1.

Table 1: Linear regression of displacement over voltage

Slope (mm/V)	Intercept (mm)	R^2
12.67	-1.50	1.00

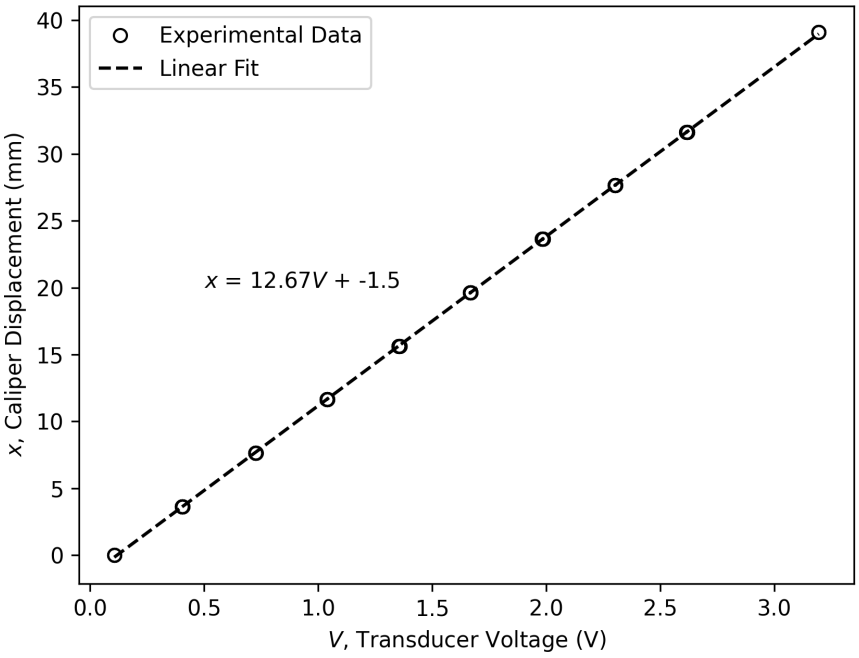

Figure 1: Displacement over voltage for the potentiometer

Note that 2 decimal places were chosen as linear regression involved sum of squares, and the limiting decimal place was 2, which comes from the caliper measurements.

The function is:

$$\boxed{x = 12.67V - 1.50}$$

(b)

First, all the voltages were converted to displacements using the linear regression equation found in the previous section. The displacement table can be found in Appendix B in Table B.4.

The deviation table can be found in Table 2. The deviation curve can be found in Fig. 2.

Table 2: Deviation table of potentiometer after conversion to displacement.

Caliper Reading (mm)	Up 1 (mm)	Down 1 (mm)	Up 2 (mm)	Down 2 (mm)	Up 3 (mm)	Down 3 (mm)
0.00		-0.16		-0.16		-0.16
3.64	-0.03	-0.03	-0.03	0.01	-0.03	0.01
7.64	0.05	0.05	0.05	0.05	0.05	0.09
11.64	0.05	0.05	0.05	0.02	0.02	0.02
15.64	0.06	0.02	0.02	0.02	0.02	0.06
19.64	0.01	0.01	-0.03	-0.03	0.01	-0.03
23.64	0.02	-0.02	0.02	-0.02	0.02	-0.02
27.64	0.06	0.02	0.02	0.02	0.06	0.02
31.64	0.03	-0.01	0.03	-0.01	0.03	0.03
39.10	-0.12		-0.12		-0.12	

The linear fit for the deviation curve was found by using `=LINEST()` in Excel. The results can be found in Table 3.

Table 3: Linear fit of deviation curve of potentiometer with respect to displacement (independent linearity).

Slope (V/mm)	Intercept (V)	R^2
5.29E-05	-1.49E-02	9.11E-05

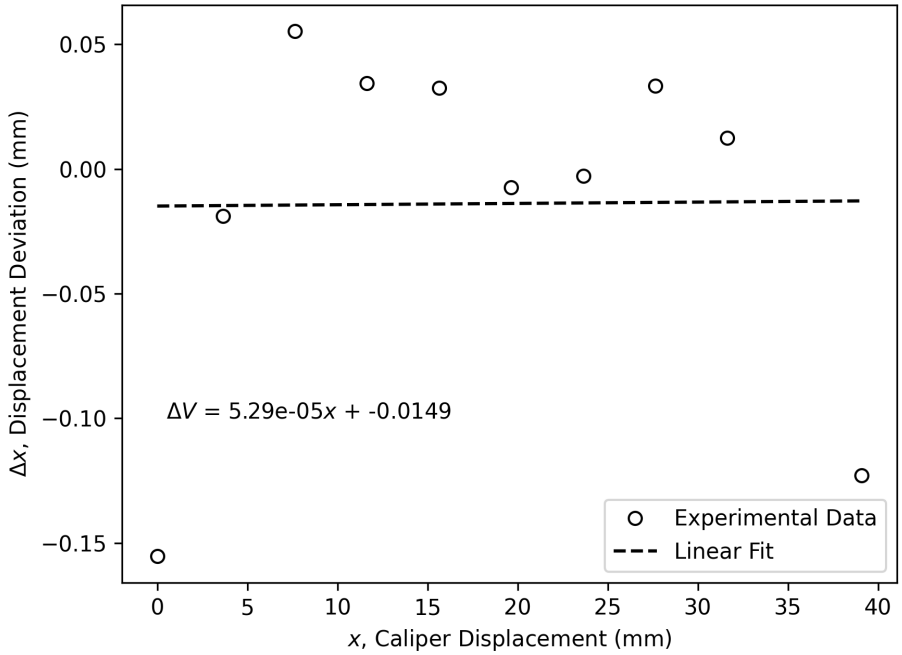

Figure 2: Displacement deviation curve of potentiometer with respect to displacement (independent linearity).

A Figures

(a) Schematic of the system

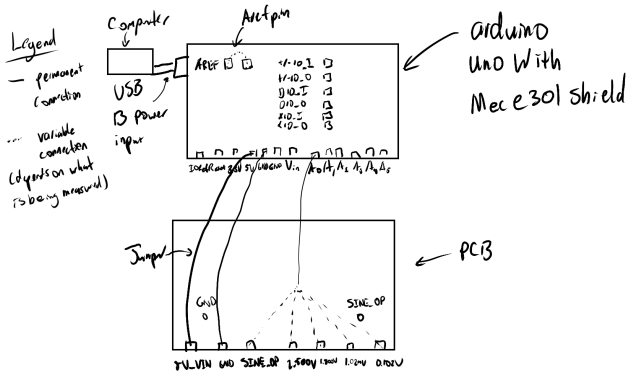

Figure A.3: Schematic of the system without a reference voltage used to measure the voltage across the PCB

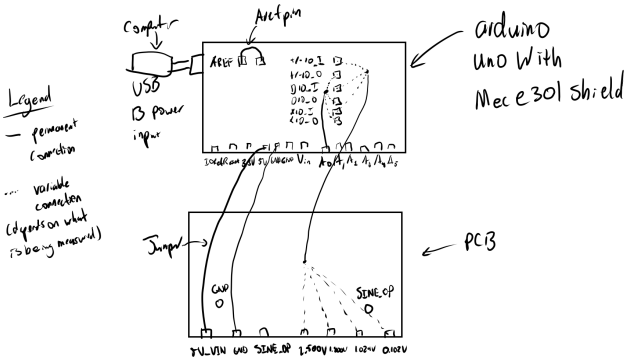

Figure A.4: Schematic of the system with a 3.3V reference voltage used to measure the voltage across the PCB

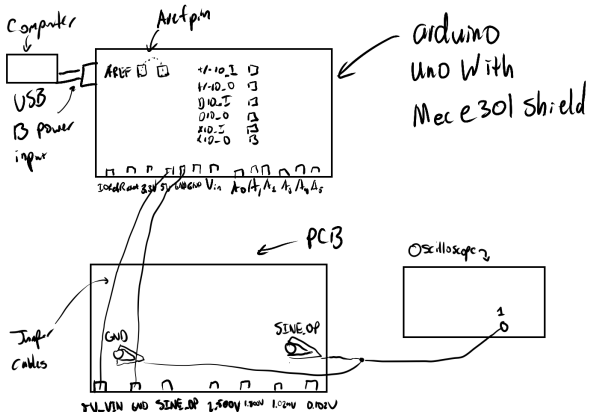

Figure A.5: Schematic of the system used to measure the voltage across the PCB with an oscilloscope

(b) Plots of Time-Varying Signals

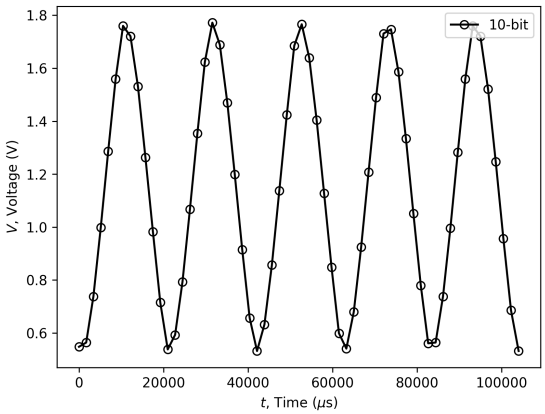

Figure A.6: Time varying signal of PCB 18 Measured with 10-bit ADC of the Arduino Uno

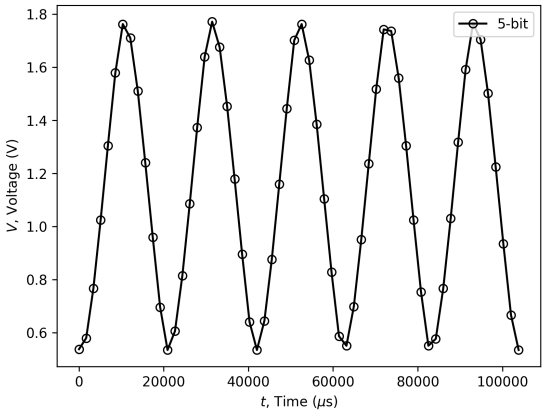

Figure A.7: Time varying signal of PCB 18 Measured with 5-bit ADC of the Arduino Uno

B Appendix: Displacement Table of Potentiometer

Table B.4: Displacement table of potentiometer

Caliper Reading (mm)	Up 1 (mm)	Down 1 (mm)	Up 2 (mm)	Down 2 (mm)	Up 3 (mm)
0.00		-0.16		-0.16	
3.64	3.61	3.61	3.61	3.65	3.61
7.64	7.69	7.69	7.69	7.69	7.73
11.64	11.69	11.69	11.69	11.66	11.66
15.64	15.70	15.66	15.66	15.66	15.70
19.64	19.65	19.65	19.61	19.61	19.65
23.64	23.66	23.62	23.66	23.62	23.66
27.64	27.70	27.66	27.66	27.66	27.70
31.64	31.67	31.63	31.67	31.63	31.67
39.10	38.98		38.98		38.98