Mihir Mathur
April 7, 2016
Lab 15, Thursday 2pm
K. Choudhary
Allison Doami, Katie Luangkote

Experiment 0 : Sensor Calibration and Linear Regression

Homework:

1) Created a template cover page which would be used for all the experiments.

2) We know that,

$\Delta v = \Delta v_{best} \pm \delta\Delta v$ and,

$\Delta t = \Delta t_{best} \pm \delta\Delta t$

Also,

$a = \Delta v/\Delta t$

$\Rightarrow \frac{da}{dv} = \frac{d}{dv}(\frac{v}{t}) = \frac{1}{t}$ and,

$\frac{da}{dt} = \frac{d}{dt}(\frac{v}{t}) = \frac{-v}{t^2}$

$\delta a = ((\frac{1}{t}\delta v)^2 + (-\frac{v}{t^2}\delta t)^2)^{1/2} \quad | \; v_{best}, t_{best}$

3) Capstone displays 15 digits after the decimal point. If the sensor precision is exactly 4 digits, the actual measurement precision would be 4 digits. The other digits i.e. 5-10 would have values that are fluctuating within a range. Turning down the precision to eliminate fluctuation is not a good idea because uncertainty should be recorded for getting good data.

4)

Mass(g)	Force(N)	Sensor Voltage(V)
0.0	0.000	0.0015
50.5	0.495	-0.0752
100.3	0.983	-0.1536
150.8	1.478	-0.23
201.8	1.978	-0.2872
252.3	2.473	-0.385
302.1	2.961	-0.464
352.6	3.455	-0.541
403.1	3.950	-0.6192

Table 1: Data Recorded

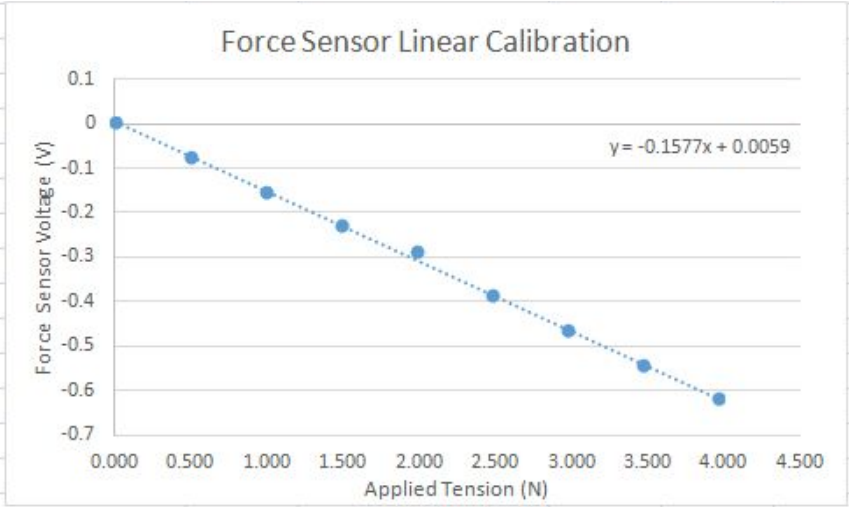

Figure 1: Applied tension versus Force sensor voltage for linear calibration

The table contains the data recorded in the lab. The graph shows the linear relationship between applied tension on the force transducer and the force sensor voltage.

5)
The x-axis represents the applied force and the y-axis represents the force sensor voltage reading. As expected, the trend-line has a negative slope with a y-intercept close to 0.

The equation of the trend-line obtained from this experiment is:
$y = -.157x + .0059$
It is of the form V = aF + b

Used Excel for linear regression. Obtained the slope uncertainty and intercept uncertainty from the Excel output.
$a = -.157 \pm .003\ V/N$
$b = .005 \pm .006 V$

Since the y-intercept is not 0, the taring procedure is not completely effective. This is because there is always a little fluctuation after taring as the instrument might not be perfect and some zero-error might persist.

6)
$V = aF + b$
$(V - b)/a = F$
$\frac{V}{a} - \frac{b}{a} = F$ and
$cV + d = F$

This implies, c = 1/a and d = -b/a
Uncertainty found using equation ii.23
c=-6.35 $\pm$ 0.08 N/V
d=.03 $\pm$ .03 N

Used Excel's linear regression to verify c and d, this time with force as y values and voltage as x values.

7) This is possible because Frankie and Avril are in different sections and Physics 4AL is curved to the section. Since in every section 1/3rd people get As, Bs and Cs each, the numerical score does not translate to a grade directly. The grading is relative to how a student performs in his or her section. Thus, the mean numerical score would be higher in Avril's section.