SUSTECH ME 425: Sensing Technology

Instructions for Using Your Laboratory Notebook

Why is it Important to Keep a Good Laboratory Notebook?

Here at the ME 425 we are very interested in protecting our intellectual property (IP) and required you to keep a complete and accurate record of your experimental methods and data, which is a vital part of science and engineering. Your laboratory notebook is a permanent record of what you did and what you observed in the laboratory. It is an essential resource when describing what you have done to a colleague, or for writing scientific papers. Learning to keep a good notebook now will establish good habits that will serve you throughout your career.

- Your notebook should be like a diary, recording what you do, and why you did it, and should be written at the time you are doing your experiment. You should feel free to record your mistakes and difficulties performing the experiment - you will frequently learn more from these failures, and your attempts to correct them, than from an experiment that works perfectly the first time.
- It is extremely important that your notebook accurately record **everything** you did. A good test of your work is the following question: could someone else, with an equivalent technical background to your own, use your notebook to repeat your work, and obtain the same results? For that matter, **could you come back six months later, read your notes, and make sense of them?** If you can answer yes to these two questions, you are keeping a good notebook.
- It is also important to maintain a good laboratory notebook in order to protect your intellectual property (e.g. patents). The laboratory notebook forms a permanent record that can be referred to while completing a disclosure report (often the first step in patent preparation) and later, provides accurate documentation of the work done. According to the US Patent and Trading Office, if two inventors claim the same invention, a process called "interference proceedings" will be used to determine who had the concept first, in which case lab notebooks regain their important legal status.

Most scientists and engineers can relate stories of thinking they were writing everything in their notebook, only to go back several months to years later looking up a crucial piece of information to find that it isn't there. Do not worry about filling it up, we will give you another one if you need it! Record not just methods and results while doing experiments, but also thoughts while planning experiments or designing products and descriptions of data analysis techniques. For example, if you write a complicated Matlab script to analyze your data, it can be quite helpful to describe in words what you are doing in each part of the script in your lab notebook should you desire to modify the script for another application later. Feel free to tape relevant material (like the Matlab script) in your notebook, as well as any spec sheets, graphs, photographs, or other information that will be useful to you later. The lab notebook is for YOU – as an invaluable resource in describing all the work you have done.

Your lab notebook will be evaluated at the end of the term according to the following metric:

Metric	Requirements	Worth
Informative Contents: (ToC, Titles, Objectives, etc)	• all required data and information • descriptive comments of your observations • an up-to-date Table of Content (ToC) with dates and page numbers at the beginning of your lab notebook • Title of experiment or project listed at the 1st page of each new entry • Objectives of experiment or activity listed on 1st page of each entry, below the title	40%
Readability and Professional Organization:	• Obvious care taken to make it readable, even if you have bad handwriting • Write in pen, not pencil • Date **every** page at the top • Begin each experiment on odd page • Attach printouts and plots of data as needed • Mistakes crossed out with one line and explained	30%
Go Forth & Measure	Notebook used consistently and correctly for Go Forth and Measure project – entries are in chronological order, not added at the end right before turning in notebook	20%
Signed Notebook	• Notebook signed by Lab Manager or Lab Supervisor after each lab experiment. Not necessary to get notebook signed for Go Forth entries • Points deducted if lab notebook forgotten more than once	10%

Example Table of Contents

1

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Example: Complete Experiment

Do not copy the words from this example into your notebook – some of the experimental procedure has changed!

First Page:

Experiment starts on an odd page

5

02.23.2010 Soda Can Experiment

02.23.2010

Date at top corner

02.23.2010

Experiment number and title clearly stated

Experiment #3:
Estimation of Internal Pressure within an Aluminum Soda Can

Second page for Example 1

Objectives:

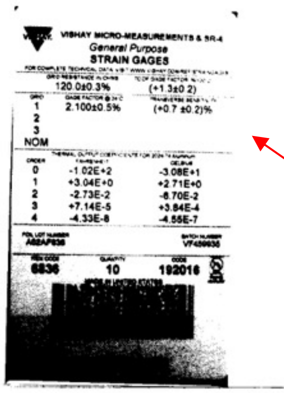
Clear statement of objectives

- To learn to use a strain gauge & associated instrumentation circuitry
- To lean to use calipers & a digital micrometer for precision distance measurements.
- To measure the internal pressure of a soda can & compare two cans to answer a specific question
- To quantify the uncertainty in your measurements
- To write a cohesive & clear "Journal Article" on our experiment

Notes and Observations on Procedure: (note: numbers correspond to procedure steps in lab notebook)

2.0

2.



Strain gauge spec sheet

Spec sheet taped into lab notebook and labeled

Succinct description of procedure.
The step number from the instructions are listed

3. We chose the following question to answer during our lab experiment:
(a) How consistent is the internal pressure for a given type of drink? Choose two cans of the same drink.

Notebook signed by Lab Manager or Supervisor on same day as experiment performed

2/23 RG

02.23.2010

Date at top corner

Soda Can Experiment

We chose two (2) coca-cola cans (we initially chose pepsi, but the cans had dents) & inspected them for dents ⇒ dent free

Description of something interesting that affected how the cans were selected

2.1

Notes on gluing on strain gauges: we could easily apply the catalyst in a controlled manne according to procedure, but when applying the adhesive, some excess oozed out the edges of the tape (howeve, it was never in contact w/ catalyst)

2.3

Section and step number listed for clarity

When aligning the strain gauges, we used the "Nutrition Facts" as a reference to align them in the correct orientation to measure hoop strain. (horizontal along the can)

Therefore, we will approximate $\theta \simeq 0$ for both cans.

Important or interesting information is clearly listed. A sketch is used for clarity

At this point we marked the cans (labelled #1 & #2)

We soldered the leads to the strain gauge & can #1

measured resistance between 2 leads = 120.2 Ω

between lead & can is infinite resistance

Can #2

measured resistance between 2 leads = 120.2 Ω

between lead & can is infinite resistance

Mistake is crossed out with one line and explained

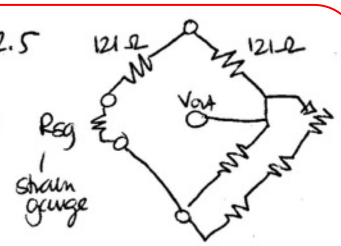
2.4

Performing the 4W Resistance measurement from HP 34401A

Can #1 120.059 ~~kΩ~~ misread, Range is 1.000000 kΩ

Can #2 120.128 ~~kΩ~~ misread, Range is 1.000000 kΩ

2.5



$V = IR$

We are assuming the lower right leg ~ lower left leg

↳ we measured lower left leg

Can #2 = 120.128 Ω

$$\frac{1}{R_{eq}} = \frac{1}{121\,\Omega + R_{sg}} + \frac{1}{121\,\Omega + R_{sg}}$$

$R_{eq} = 120.564\,\Omega$ (case of Can #2)

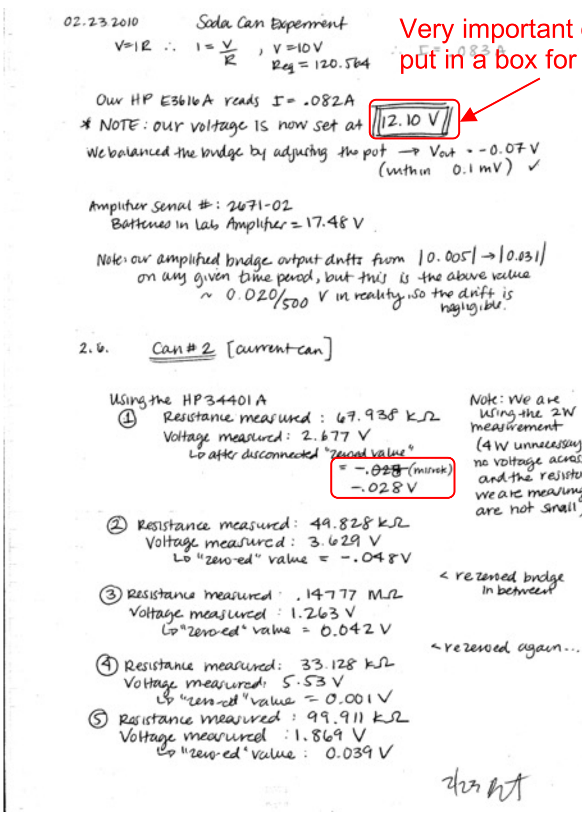
Schematic drawing makes clear to what the resistances in the equations refer.

4 hr. [signature]

SIGNED

DATE

Remaining pages for Example 1:



02.23.2010 Soda Can Experiment

V=IR ∴ I = V/R , V=10V
Req = 120.564

Our HP E3616A reads I= .082A
* NOTE: our voltage is now set at $\boxed{12.10 \text{ V}}$
We balanced the bridge by adjusting the pot → Vout = -0.07 V
(within 0.1 mV) ✓

Amplifier Serial #: 2671-02
Batteries in lab Amplifier = 17.48 V

Note: our amplified bridge output drifts from |0.005| → |0.031|
on any given time period, but this is the above value
~ 0.020/500 V in reality, so the drift is negligible.

2.6. Can#2 [current can]

Using the HP34401A
① Resistance measured: 67.938 kΩ
Voltage measured: 2.677 V
↳ after disconnected "zeroed value"
= -.~~028~~ (mistake)
-.028 V

Note: We are using the 2W measurement
(4W unnecessary - no voltage across and the resistors we are measuring are not small)

② Resistance measured: 49.828 kΩ
Voltage measured: 3.629 V
↳ "zero-ed" value = -.048V

< rezeroed bridge in between

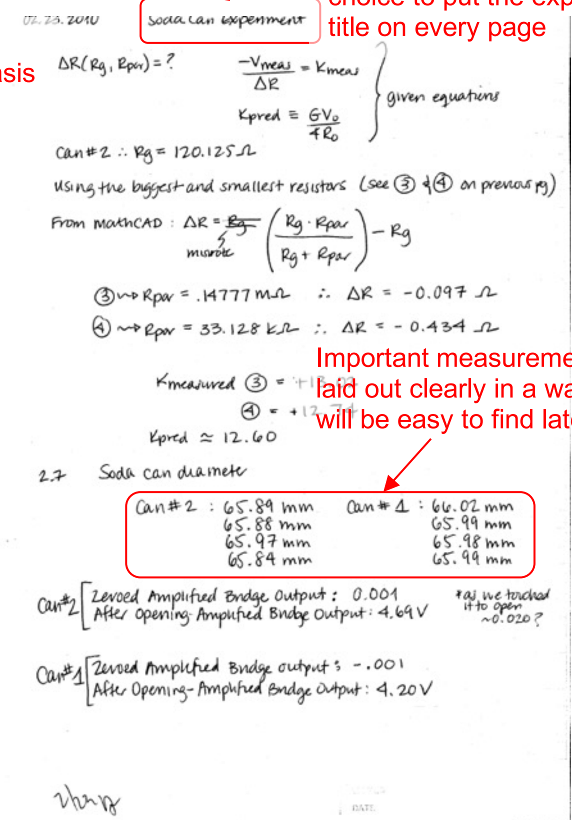
③ Resistance measured: .14777 MΩ
Voltage measured: 1.263 V
↳ "zero-ed" value = 0.042 V

< rezeroed again...

④ Resistance measured: 33.128 kΩ
Voltage measured: 5.53 V
↳ "zero-ed" value = 0.001 V
⑤ Resistance measured: 99.911 kΩ
Voltage measured: 1.869 V
↳ "zero-ed" value: 0.039 V

2/23 [signature]

Very important data is put in a box for emphasis



02.23.2010 Soda can experiment

Not required, but a nice choice to put the experiment title on every page

ΔR(Rg, Rpar) = ?

$\frac{-V_{meas}}{\Delta R} = K_{meas}$
$K_{pred} \equiv \frac{GV_o}{4R_o}$
given equations

Can#2 ∴ Rg = 120.125 Ω

using the biggest and smallest resistors (see ③ & ④ on previous pg)

From MathCAD: $\Delta R = \cancel{Rg} \left(\frac{Rg \cdot Rpar}{Rg + Rpar}\right) - Rg$ (mistake)

③ ⇝ Rpar = .14777 MΩ ∴ ΔR = -0.097 Ω
④ ⇝ Rpar = 33.128 kΩ ∴ ΔR = -0.434 Ω

Kmeasured ③ = +13.02
④ = +12.74
Kpred ≃ 12.60

Important measurements laid out clearly in a way that will be easy to find later

2.7 Soda can diameter

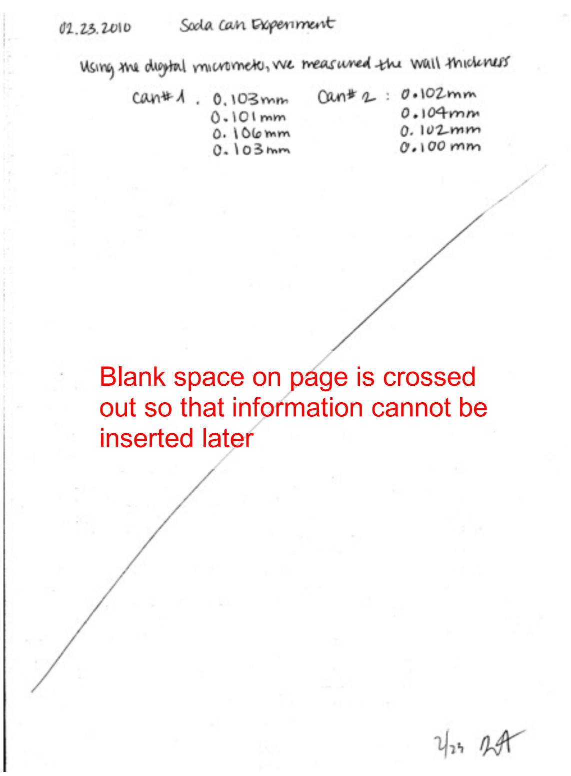
Can#2		Can#1	
	65.89 mm		66.02 mm
	65.88 mm		65.99 mm
	65.97 mm		65.98 mm
	65.84 mm		65.99 mm

Can#2 [Zeroed Amplified Bridge Output: 0.001
After opening Amplified Bridge Output: 4.69 V

*as we torched it to open ~0.020?

Can#1 [Zeroed Amplified Bridge output: -.001
After Opening - Amplified Bridge Output: 4.20 V

2/23 [signature]



02.23.2010 Soda can Experiment

Using the digital micrometer, we measured the wall thickness

Can#1	Can#2
0.103 mm	0.102 mm
0.101 mm	0.104 mm
0.106 mm	0.102 mm
0.103 mm	0.100 mm

Blank space on page is crossed out so that information cannot be inserted later

2/23 [signature]

Key points in this example:

1. Neat and legible handwriting
2. Experiment title and purpose clearly stated
3. Procedure described clearly and succinctly, including errors and the steps taken to correct them
4. Computations performed neatly showing intermediate steps
5. Errors crossed out with a single line and explained
6. Important observations clearly visible for ease of later retrieval, either by using boxes around results or using a clear and uncluttered format
7. All pages dated at the top and signed by lab instructor on the same date