Physics 401. Classical Physics Laboratory.

Fall 2016.

Eugene V. Colla
Course Objective

Organization
- Times and locations
- Physics 401 staff

Semester Schedule

Laboratory routine

Grading scheme

Section assignments

Comments
Classical Physics Lab.
Main Goals of the Course.

✔ Taking Data using modern equipment

✔ Data analysis

✔ Documenting of the experiment

✔ Presenting the results
Course Objective.

✓ Lectures

✓ Laboratory section

✓ Laboratory notebook

✓ Laboratory report
Lecture attendance is not an optional part of the course but a sort of assignment - each lecture corresponds to 5 credit points.
Lectures: Lectures will cover the idea of experiment, measuring approach, used equipment, possible analysis of the results, presentation of data, error analysis.

Typical lecture plan:
- briefly about physics of the experiment
- Experimental setup and equipment
- How to do the experiment, possible problems and difficulties
- Data analysis using Origin and data presentation
- Error analysis
- Questions, discussion
Laboratory section:

Carry out experiment, briefly summarize experimental procedures and record observations and results in your laboratory notebook, carry out preliminary data analysis (see comments in next slide!).
Course Objective. *Lab section.*

...carry out preliminary data analysis... do it in the Lab

![Graph showing frequency response with a peak at f₀ = 0.495 Hz]
Course Objective. Lab section.

...carry out preliminary data analysis...

\[ f_0 = 0.495 \text{Hz} \]

- actual resonance curve
- data point \( \Delta f \approx 0.18 \text{Hz} \) (51 points)
Course Objective. Lab section.

...carry out preliminary data analysis...

![Graph showing resonance curve and data points]

- Actual resonance curve
- Data points, $\Delta f\sim0.18$Hz (51 points)
- Data points, $\Delta f$ variable (34 points)
Laboratory notebook:

You should have *two* notebooks. Both are identical. One will be submitted with report and the second will be with you to work on next experiment.
Your laboratory notebook is the scientific record of your experiment. It needs to contain in brief all information required to solidly connect the experimental data with physics observables in the data analysis:

- drawing of the setup,
- environment conditions (as needed)
- dimensions or other characteristics of experimental equipment relevant to later analysis
- results from calibration procedures
- data and error estimate
- some preliminary results and graphs
The main goal of the Lab report is to show the main results and findings of the experiment and how these results were obtained.

**Laboratory report:**

Report should be submitted electronically not later than a week after the Lab was done. Despite you doing experiments in team of two each student should write a personal report.
Measurement of the Electronic Charge by the Oil Drop Method

Excellent Student

TA: TA's name
Department of Physics, University of Illinois Urbana-Champaign
September 27 and October 4, 2012
Lab Notebook #1 Pages 10-12

Abstract

The Millikan oil drop method is used to determine the electron charge. Using a special scope aligned with a capacitor, the response of charged oil drops introduced into the capacitor through an atomizer is studied for each drop's rise in the presence of an electric field and fall without the field. The rise and fall times, when applied to several equations along with various environmental constants, give the total charge on the drop. These charge values are then studied using a histogram, and by analyzing fit peaks, mean charge values for the distribution are obtained. These mean values, compared to the previously obtained total charges, allow the estimated charge of the electron to be found. This process is completed for both an individual set of data and data collected by the whole section, the accuracy of the final results is then compared with each other and the theoretical charge on the electron.
Abstract

Several ferromagnetic samples were examined by probing with an external magnetic field to observe their susceptibility and phase change as we reoriented their magnetic spin. For each sample we recorded its behavior between its permeability and current driving the external field, the samples magnetic field and the external magnetic field, and the energy dissipated per cycle of reorientation. Further, the behavior or ferromagnetic samples under varying temperature was observed and through experimentation we derived one samples Curie temperature. For accuracy, we compared each sample to provided material for each species of magnet generally found from manufactures websites.
3. Introduction (Theory, motivation)

Introduction

Liquid Helium has very unique properties when cooled to temperatures below 2.17K and the pressure is lowered below 37.77 torr, which is known as the lambda point. It changes to a new phase of matter called He II. He II has several unique properties that distinguish it from normal liquid Helium or He I. These properties include zero viscosity while flowing through very small tubes, flowing without friction up containers walls and a thermal resistivity that goes to zero as the temperature goes to zero. All of this results in heat traveling in high speed waves, in contrast to ordinary heat travel through diffusion. The speed of these waves is called second sound, the name will become more apparent shortly. It also exhibits He I properties as a torsion pendulum with slowly decay showing the viscosity is about one-tenth of air. This viscosity paradox would be explained by Lazlo Tisza in 1938 with the formation of the two-fluid model. This model explains the properties of He II by letting the He II be a mixture of both normal liquid helium and superfluid helium.
4. Procedure (Setup, Measuring technique, Object of study)
5. Results (main finding, analysis, errors)

Figure 4. Graph of X vs Frequency over a wide range of frequencies in circuit A.
6. Conclusions

In conclusion, a number of results were confirmed by oscillating a copper disk with different damping forces as well as different driving forces. The K value for static measurements produced a sheer modulus value within 3% of the handbook value. Using dynamic measurements the same k was calculated but there was a 17% error between the two, which was most likely due to human error in the static measurements experiment because there was so much hands on activity. No linear correlation for amplitude vs. log decrement for turbulent damping was found, which is due to the fact that the starting position of the disk was not far back enough. Using driven oscillation beats were observed. The amplitude and phase of damped, driven oscillator vs. frequency were also graphed.
Course Objective. Lab report

Some examples of reports from P401 and P403 could be found in:

\`\text{\textbackslash engr\textbackslash file\textbackslash 03\textbackslash PHYINST\textbackslash APL Courses\textbackslash PHYCS401\textbackslash Common\textbackslash Sample reports - DO NOT DISTRIBUTE}\`
Graphs, graphical software

Origin can be used for data analysis and data presentation. There is 2016 version available on all Lab computers.

https://webstore.illinois.edu/Shop/product.aspx?zpid=1311
OriginLab has put together a handy multi-page booklet highlighting key features of Origin and OriginPro. An online version of this booklet is available here: http://www.originlab.com/Booklet/
**Course Objective. Lab report**

**Graphs, graphical software**

http://www.originlab.com/
Working with Origin you can use the templates

Simply plotting the data

Open the template

\engr-file-03\phyinst\APL Courses\PHYCS401\Common\Origin templates
Course Objective. Lab report. Submission

The reports should be uploaded to the server:

https://my.physics.illinois.edu/courses/upload/

All assignments have the names close to the Lab Title

Frequency Domain Analysis Report_L1

Your Lab section

The acceptable file formats are: doc, docx, pdf

Be careful with assignment name and your Lab section selection!
Deadline for notebook and lab-reports is the day (up to midnight) of each lab-section one week later. You have two vouchers to return the report by one week later with no penalty.

Voucher I to turn in notebook + report one week late.

Date:
Experiment No.:
Student Name:
Signature:

void after December 10 2015

Voucher I to turn in notebook + report one week late.

Date:
Experiment No.:
Student Name:
Signature:

void after December 10 2015
All experiments will be performed in team of two, but the report should be written by each student personally using results of personal analysis of data and personal graphs.
In the case if you have acceptable reason for absence of the Lab section you have to contact Eugene Colla and we will try to figure out how to make up the Lab.

The rules for late reports:

- 5% of total score for report for up to 1 week late.
- 10% - for up to 2 weeks late.
- After that, it’s too late.
- December 14th is the final deadline for everything.
Computer Access in P401

All P401 students should have access to the Lab network. Try it and if it does not work report to your TA and/or Jack Boparai.

User: NetID
Password: Active Directory Password
Domain: UOFI

There is a server where you can find some useful information and where you have to store your data and Origin projects:

1. Millikan Oil Drop experiment
7. Hallbach
Student#1
Student#2
Student#3

8/22/2016 Physics 401
Typical Lab Routine

1. **Reading the write-up** *(better before the Lab session)*

2. **Assembling the experimental setup.** Drawing the diagram if it is necessary.

3. **Taking data.** Saving data using DAQ or writing manually the numbers in the notebook. In the case if data was obtained automatically you have to write in logbook the filename and its location.

4. **Preliminary analyzing the data.** Correcting the experiment settings if it is necessary.

5. **Writing the report.**
<table>
<thead>
<tr>
<th>Section</th>
<th>Type</th>
<th>Times</th>
<th>Days</th>
<th>Location</th>
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<tbody>
<tr>
<td>A</td>
<td>Lecture</td>
<td>03:30 PM - 04:20 PM</td>
<td>Monday</td>
<td>276 Loomis Laboratory</td>
</tr>
<tr>
<td>L1</td>
<td>Lab</td>
<td>01:00 PM - 04:50 PM</td>
<td>Tuesday</td>
<td>6103 ESB</td>
</tr>
<tr>
<td>L3</td>
<td>Lab</td>
<td>01:00 PM - 04:50 PM</td>
<td>Wednesday</td>
<td>6103 ESB</td>
</tr>
<tr>
<td>L3</td>
<td>Lab</td>
<td>08:00 AM - 11:50 AM</td>
<td>Thursday</td>
<td>6103 ESB</td>
</tr>
<tr>
<td>L4</td>
<td>Lab</td>
<td>01:00 PM - 04:50 PM</td>
<td>Thursday</td>
<td>6103 ESB</td>
</tr>
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</table>
# Physics 401 staff

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
<th>Office Hours</th>
<th>Phone</th>
<th>e-mail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecturer</td>
<td>Prof. Eugene Colla</td>
<td>Monday 4:30-5:30 pm ESB 4137</td>
<td>office: 333-5772</td>
<td><a href="mailto:kolla@illinois.edu">kolla@illinois.edu</a></td>
</tr>
<tr>
<td>Laboratory Instructor</td>
<td>Hryhoriy Polshyn</td>
<td>Tuesday 12pm-1pm ESB 6103</td>
<td></td>
<td><a href="mailto:polshyn1@illinois.edu">polshyn1@illinois.edu</a></td>
</tr>
<tr>
<td>Laboratory Instructor</td>
<td>Chong Han</td>
<td>Friday 10am-11am ESB 6103</td>
<td></td>
<td><a href="mailto:chan104@illinois.edu">chan104@illinois.edu</a></td>
</tr>
<tr>
<td>Laboratory Instructor</td>
<td>Abid Khan</td>
<td>Wednesday 10am-11am ESB 6103</td>
<td></td>
<td><a href="mailto:aakhan3@illinois.edu">aakhan3@illinois.edu</a></td>
</tr>
<tr>
<td>Laboratory Technician</td>
<td>Jack Boparai</td>
<td>None</td>
<td>office: 333-2208</td>
<td><a href="mailto:jboparai@illinois.edu">jboparai@illinois.edu</a></td>
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</table>

8/22/2016 Physics 401
<table>
<thead>
<tr>
<th>Week of</th>
<th>No. Weeks</th>
<th>Lab Title</th>
<th>Point Value</th>
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<tbody>
<tr>
<td>August 22</td>
<td>1</td>
<td>Introduction to Classical Physics (P401) Course.</td>
<td>---</td>
</tr>
<tr>
<td>August 29</td>
<td>1</td>
<td>Transients in RLC circuits</td>
<td>50</td>
</tr>
<tr>
<td>September 5</td>
<td>1</td>
<td>Frequency domain analysis of linear circuits using synchronous detection. (No Lecture this week - Labor Day Holiday)</td>
<td>100</td>
</tr>
<tr>
<td>September 12</td>
<td>1</td>
<td>Pulses in transmission lines</td>
<td>100</td>
</tr>
<tr>
<td>September 19</td>
<td>1 of 2</td>
<td>Millikan Oil Drop Experiment / Week 1</td>
<td>---</td>
</tr>
<tr>
<td>September 26</td>
<td>2 of 2</td>
<td>Millikan Oil Drop Experiment / Week 2</td>
<td>100</td>
</tr>
<tr>
<td>October 3</td>
<td>1 of 2</td>
<td>Torsion Oscillator / Week 1</td>
<td>---</td>
</tr>
<tr>
<td>October 10</td>
<td>2 of 2</td>
<td>Torsion Oscillator / Week 2</td>
<td>100</td>
</tr>
<tr>
<td>October 17</td>
<td>1</td>
<td>Hall Probe Measurement of Magnetic Fields</td>
<td>100</td>
</tr>
<tr>
<td>October 24</td>
<td>1 of 2</td>
<td>Qualitative Studies with Microwaves / Week 1</td>
<td>---</td>
</tr>
<tr>
<td>October 31</td>
<td>2 of 2</td>
<td>Microwave Cavities / Week 2</td>
<td>150</td>
</tr>
<tr>
<td>November 7</td>
<td>1 of 3</td>
<td>Final Project - AC Measurement of Magnetic Susceptibility / Week 1</td>
<td>---</td>
</tr>
<tr>
<td>November 14</td>
<td>2 of 3</td>
<td>Final Project - AC Measurement of Magnetic Susceptibility / Week 2</td>
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<tr>
<td>November 21</td>
<td></td>
<td>Thanksgiving break</td>
<td></td>
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<tr>
<td>November 28</td>
<td>3 of 3</td>
<td>Final Project - AC Measurement of Magnetic Susceptibility / Week 3.</td>
<td>300</td>
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<tr>
<td>December 5</td>
<td></td>
<td>No lab.</td>
<td></td>
</tr>
<tr>
<td>December 12</td>
<td></td>
<td>Final week: Final Project Reports due on December 14th at 11:59 PM.</td>
<td>Total 1000</td>
</tr>
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</table>
Grading

Total Points (max) =

1000 (reports) +

60 (Lectures attendance)

Letter grading scale is approximately: 97% = A+, 93% = A, 90% = A-, 87% = B+, 83% = B, 80% = B-, 77% = C+, 73% = C, 70% = C-, 67% = D+, 63% = D, 60% = D-