Physics 401. Classical Physics Laboratory.

Spring 2017
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 resonance curve with f_0 = 0.495 Hz](image.png)
Course Objective. Lab section.

...carry out preliminary data analysis...
Course Objective. Lab section.

...carry out preliminary data analysis...
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.
Introduction

Electromagnetism comprises one of the four fundamental forces of nature, and although the applications of electricity are more apparent in the layman’s everyday life, the effects of magnetic fields, although more subtle, are no less profound nor less important. Pioneering 19th Century work conducted by experimentalists such as Michael Faraday and theoreticians including James Clerk Maxwell underpin the classical electromagnetic theory still widely used in several applications today, ranging from the spinning turbines in every electrical power station to the MRI scanners in all major hospitals. As such they remain an integral cornerstone of modern physical theory, hence the motivation for conducting this experiment.
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

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**Figure caption?**

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**Units?**
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:

An example of P401 good written report

An example of P403 good report
Graphs, graphical software

Origin can be used for data analysis and data presentation. There is 2017 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:
Course Objective. **Lab report**

Graphs, graphical software

http://www.originlab.com/
Graphs, graphical software

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!
Course Objective. Lab report. Submission

The reports should be uploaded to the server:

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

In a case if you have problems with electronic submission you can send the report file by e-mail as an attachment to your section TA and Eugene Colla (kolla@illinois.edu), but this is exceptional case but not a regular rule!
Course Objective. *Lab report*

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. Each *unused voucher* will give 5 *points* to your final score.

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

Date: 
Experiment No.: 
Student Name: 
Signature: 

*void after May 10 2017*

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

Date: 
Experiment No.: 
Student Name: 
Signature: 

*void after May 10 2017*
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.
- May 10\textsuperscript{th} 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:

- engr-file-03\phyinst\APL Courses\PHYCS401\Students
- Millikan Oil Drop experiment
- 7.Hallbach
- Student#1
- Student#2
- Student#3

1/23/2017
Safety is your responsibility!

Hazards: *high voltage, chemical materials, hot equipment*

In class work requires responsible conduct with regards to

(I) safety/hazards and with

(II) equipment

Discuss potential hazards at the beginning of each experiment with an instructor or TA

When in doubt stop and ask
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>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Lecture</td>
<td>03:30 PM - 04:20 PM</td>
<td>Monday</td>
<td>144 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>L5</td>
<td>Lab</td>
<td>01:00 PM - 04:50 PM</td>
<td>Thursday</td>
<td>6103 ESB</td>
</tr>
</tbody>
</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 V 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>Charles Matthew Steiner</td>
<td>Tuesday 12.00-1.00pm ESB 6101</td>
<td>217-979-3863</td>
<td><a href="mailto:csteine2@illinois.edu">csteine2@illinois.edu</a></td>
</tr>
<tr>
<td>Laboratory Instructor</td>
<td>Kenneth W Schlax</td>
<td>Wednesday 12.00-1.00pm ESB 6101</td>
<td>217-840-0315</td>
<td><a href="mailto:schlax2@illinois.edu">schlax2@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>

1/23/2017
<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>January 17</td>
<td>1</td>
<td>Introduction to oscilloscope, function generator, digital multi-meter (DMM), and curve fitting.</td>
<td>---</td>
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<tr>
<td>January 23</td>
<td>1</td>
<td>Transients in RLC circuits</td>
<td>50</td>
</tr>
<tr>
<td>January 30</td>
<td>1</td>
<td>Frequency domain analysis of linear circuits using synchronous detection</td>
<td>100</td>
</tr>
<tr>
<td>February 6</td>
<td>1</td>
<td>Pulses in transmission lines</td>
<td>100</td>
</tr>
<tr>
<td>February 13</td>
<td>1 of 2</td>
<td>Millikan Oil Drop Experiment / Week 1</td>
<td>---</td>
</tr>
<tr>
<td>February 20</td>
<td>2 of 2</td>
<td>Millikan Oil Drop Experiment / Week 2</td>
<td>100</td>
</tr>
<tr>
<td>February 27</td>
<td>1 of 2</td>
<td>Torsion Oscillator / Week 1</td>
<td>---</td>
</tr>
<tr>
<td>March 6</td>
<td>2 of 2</td>
<td>Torsion Oscillator / Week 2</td>
<td>100</td>
</tr>
<tr>
<td>March 13</td>
<td>1 of 2</td>
<td>Hall Probe Measurement of Magnetic Fields</td>
<td>100</td>
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<tr>
<td>March 20</td>
<td></td>
<td>Spring Break</td>
<td></td>
</tr>
<tr>
<td>March 27</td>
<td>2 of 2</td>
<td>Qualitative Studies with Microwaves / Week 1</td>
<td>150</td>
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<tr>
<td>April 3</td>
<td></td>
<td>Microwave Cavities / Week 2</td>
<td></td>
</tr>
<tr>
<td>April 10</td>
<td>1 of 3</td>
<td>Final Project – AC Measurement of Magnetic Susceptibility / Week 1</td>
<td>300</td>
</tr>
<tr>
<td>April 17</td>
<td>2 of 3</td>
<td>Final Project – AC Measurement of Magnetic Susceptibility / Week 2</td>
<td></td>
</tr>
<tr>
<td>April 24</td>
<td>3 of 3</td>
<td>Final Project – AC Measurement of Magnetic Susceptibility / Week 3.</td>
<td></td>
</tr>
<tr>
<td>May 10</td>
<td></td>
<td>Final week: Final Project Reports due on May 10th at 11:59 PM. Reports should be submitted by uploading.</td>
<td>Total 1000</td>
</tr>
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</table>

Total: 1000
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-