

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Physics 401. Classical Physics Laboratory.

Spring 2019
Eugene V Colla



illinois.edu

Physics 401. Spring 2017

- **Course Objective**
- **Organization:**
 - **Times and locations**
 - **Physics 401 staff**
- **Semester Schedule**
- **Laboratory routine**
- **Grading scheme**
- **Section assignments**
- **Comments**

Classical Physics Lab.

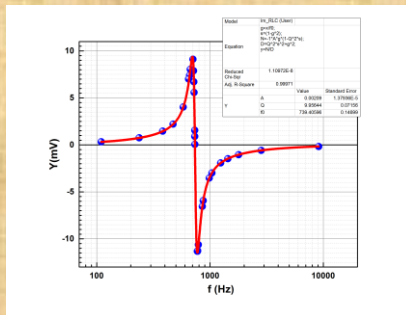
Main Goals of the Course.

✓ Taking Data using modern equipment

✓ Data analysis

✓ Documenting of the experiment

✓ Presenting the results



Course Objective

✓ Lectures

✓ Laboratory section

✓ Laboratory notebook

✓ Laboratory report

Course Objective. *Lectures*

Lecture attendance is not an optional part of the course but a sort of assignment - each lecture corresponds to *5 credit points*.



Course Objective. *Lectures*

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

Course Objective. *Lab section*

Laboratory section:

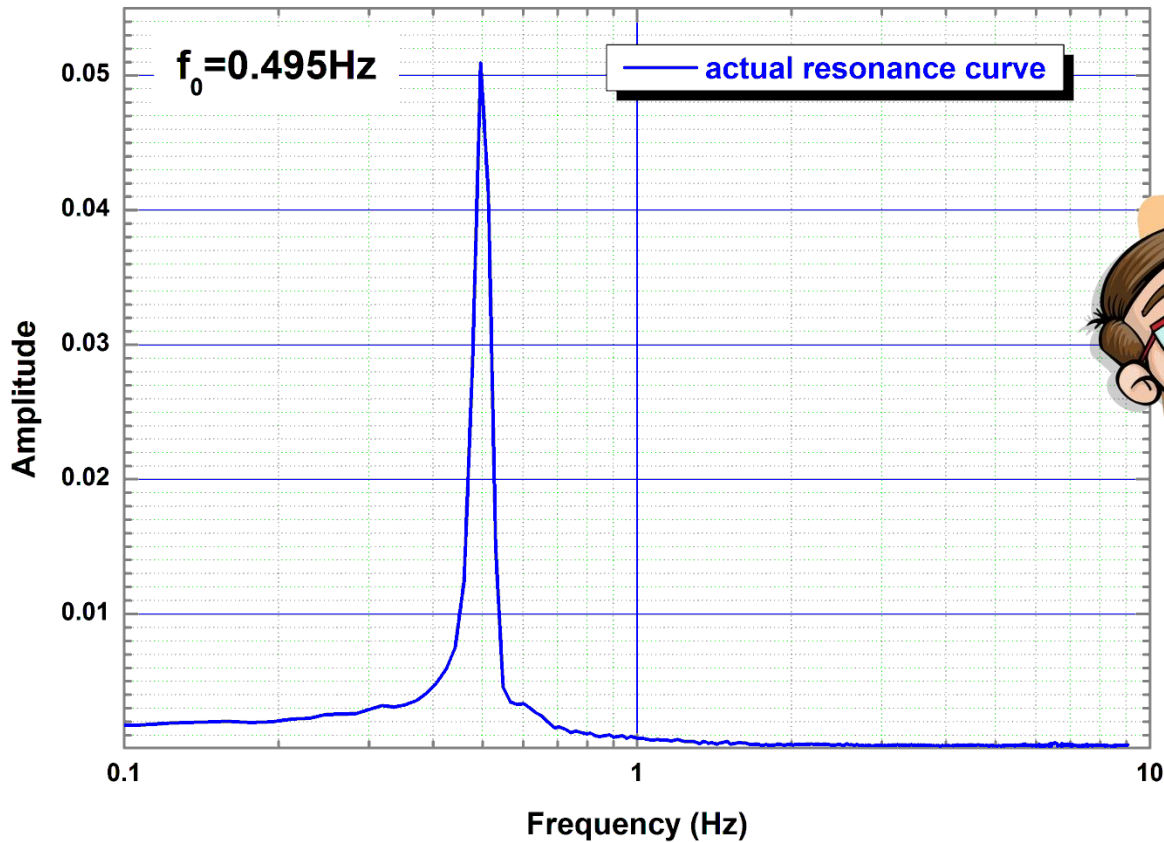


Carry out experiment, briefly summarize experimental procedures and record observations and results in your laboratory notebook, *carry out preliminary data analysis (see comments in next slide!).*



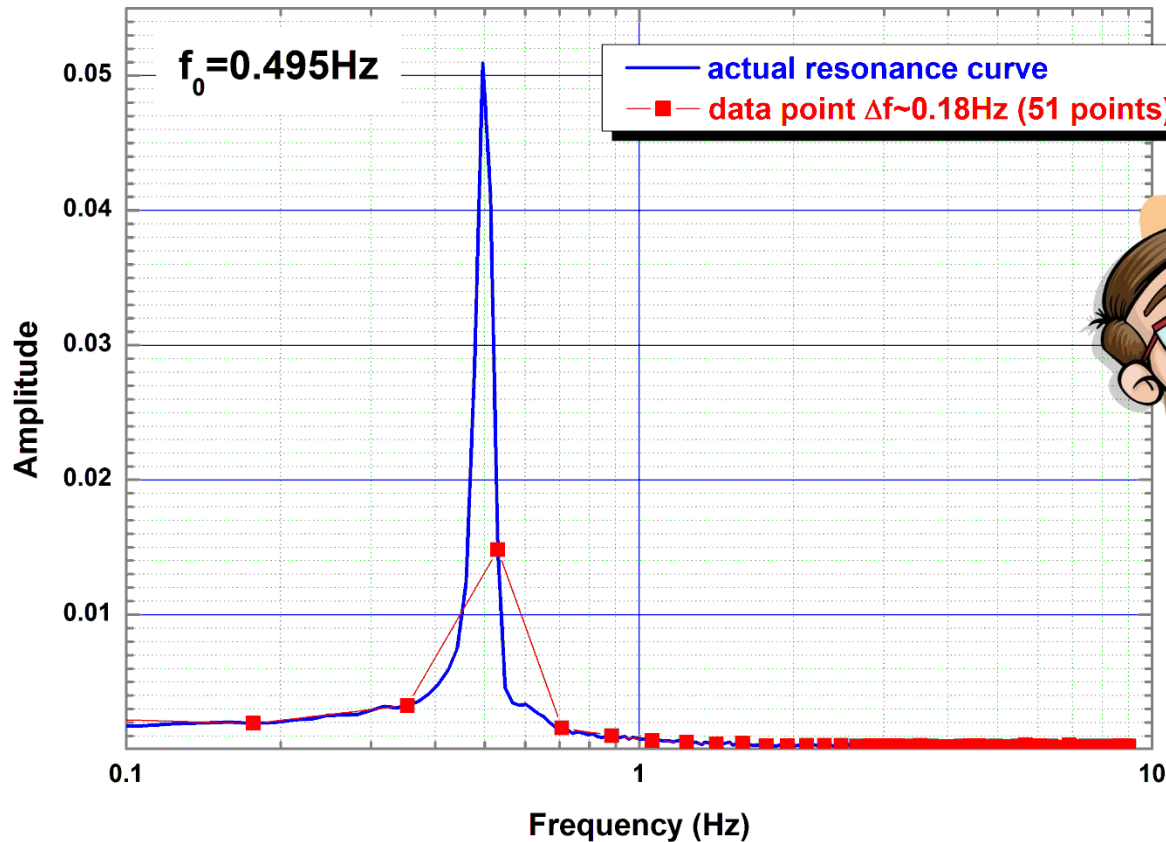
Course Objective. *Lab section.*

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



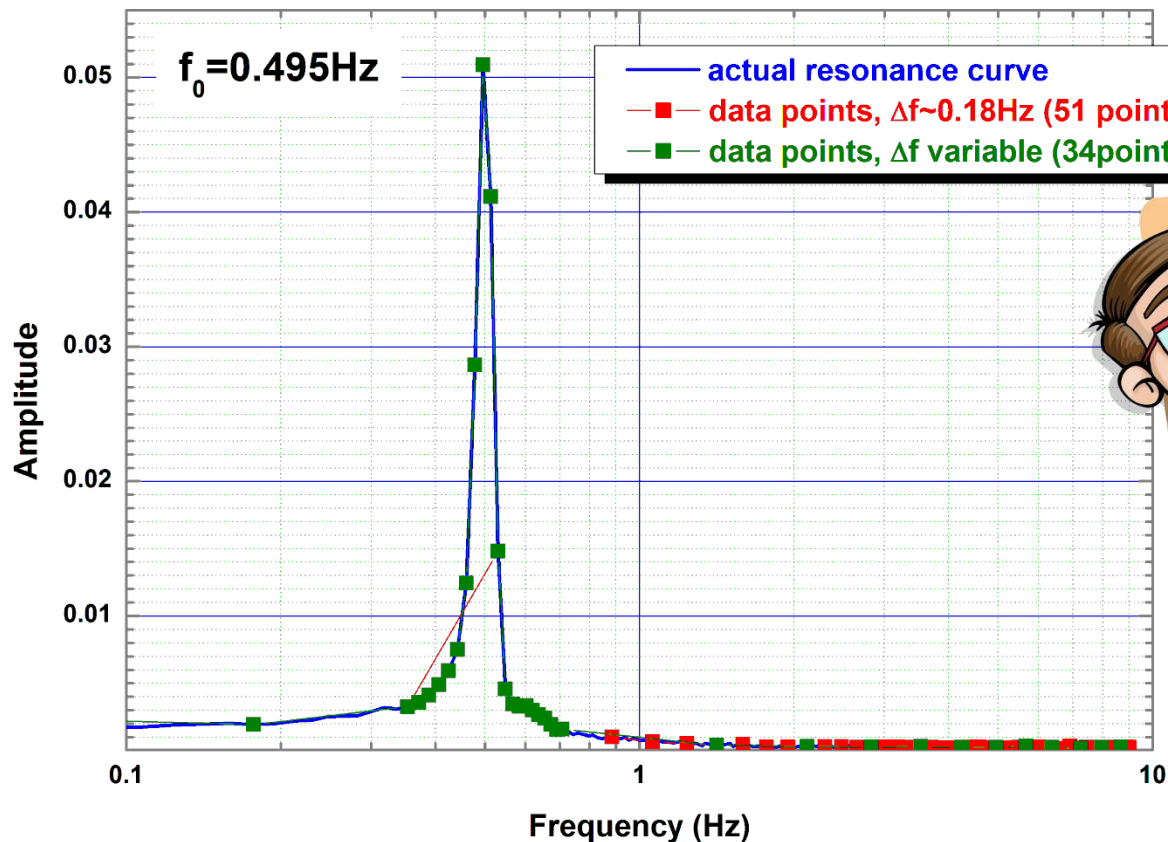
Course Objective. *Lab section.*

...carry out preliminary data analysis...



Course Objective. *Lab section.*

...carry out preliminary data analysis...



Course Objective. *Lab notebook*

Laboratory notebook:

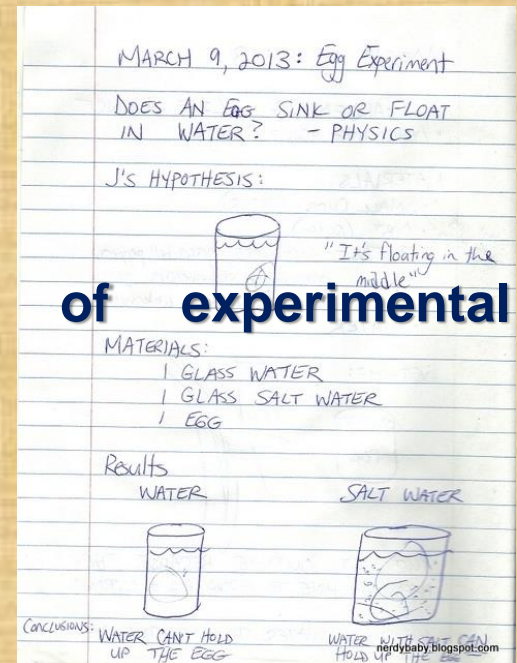
You should have **two** notebooks. Both are identical. One will be submitted with report and the second will be with you to work on next experiment.



Course Objective. *Lab notebook*

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



Course Objective. *Lab report*

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*.

Course Objective. *Lab report*

The components of the report. Title etc.

Measurement of the Electronic Charge by the Oil Drop Method

Title

Excellent Student

Name

TA: TA's name

Department of Physics, University of Illinois Urbana-Champaign

**Affiliation,
date etc.**

September 27 and October 4, 2012

Lab Notebook #1 Pages 10-12

Abstract

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.

Course Objective. *Lab report*

The components of the report. *Abstract*

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 of 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.

Course Objective. *Lab report*

The components of the report.

Abstract

- ***Celia's foolproof abstract recipe:***

Answer the following questions, in this order, in one or two sentences each:

- **What problem did you study and why is it important?**
- **What methods did you use?**
- **What were your principal results?**
- **What did you learn? What have you contributed?**

courtesy of Cilia Elliot

Course Objective. *Lab report*

The components of the report. Introduction

3. Introduction (Theory, motivation)

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.

Course Objective. *Lab report*

The components of the report. Introduction

3. Introduction (Theory, motivation)

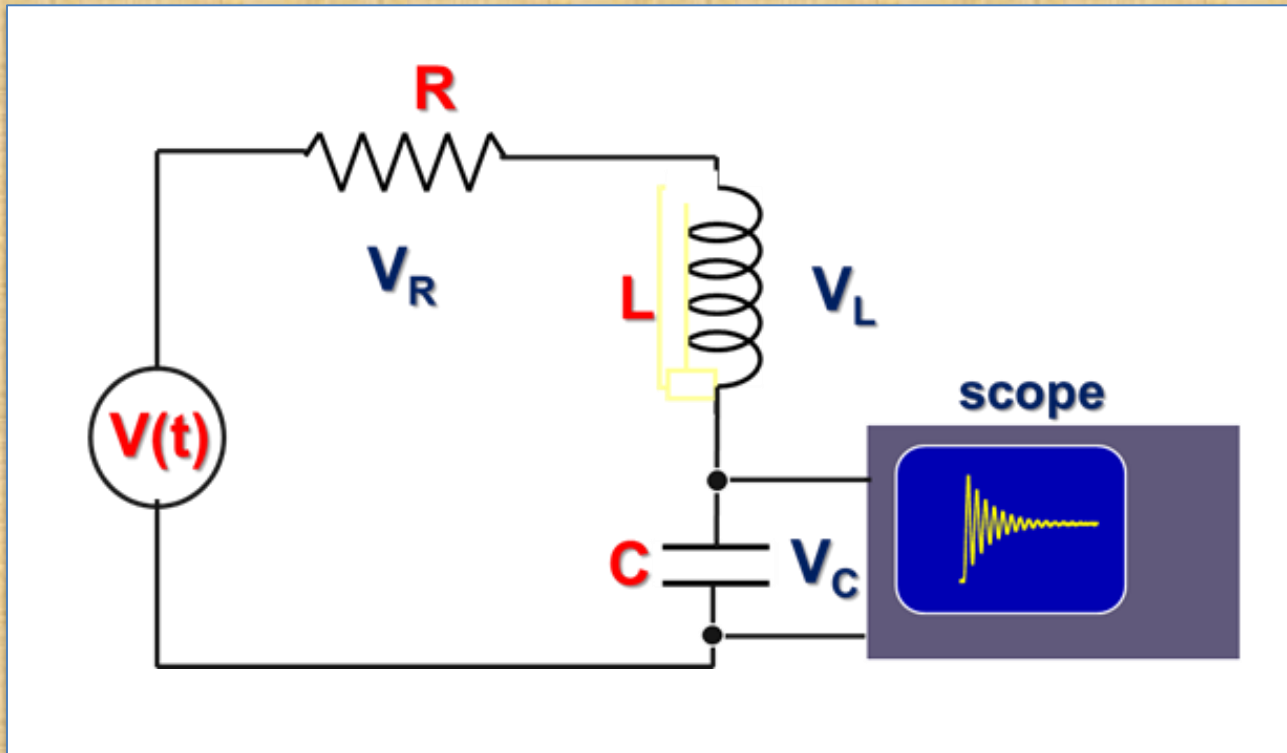
- **What Physics did you touch**
- **Historical excursion. Short and only if it is necessary**
- **From physics to measurable parameters.**

Course Objective. *Lab report*

The components of the report.

Procedure

4. Procedure (Setup, Measuring technique, Object of study)



Course Objective. *Lab report*

The components of the report.

Procedure

4. Procedure (Setup, Measuring technique, Object of study)

- **Measuring idea**
- **Experimental setup. Show the diagram of the setup**
- **Used equipment**
- **Used DAQ software**

Course Objective. *Lab report* The components of the report. Results

5. Results (main finding, analysis, errors)

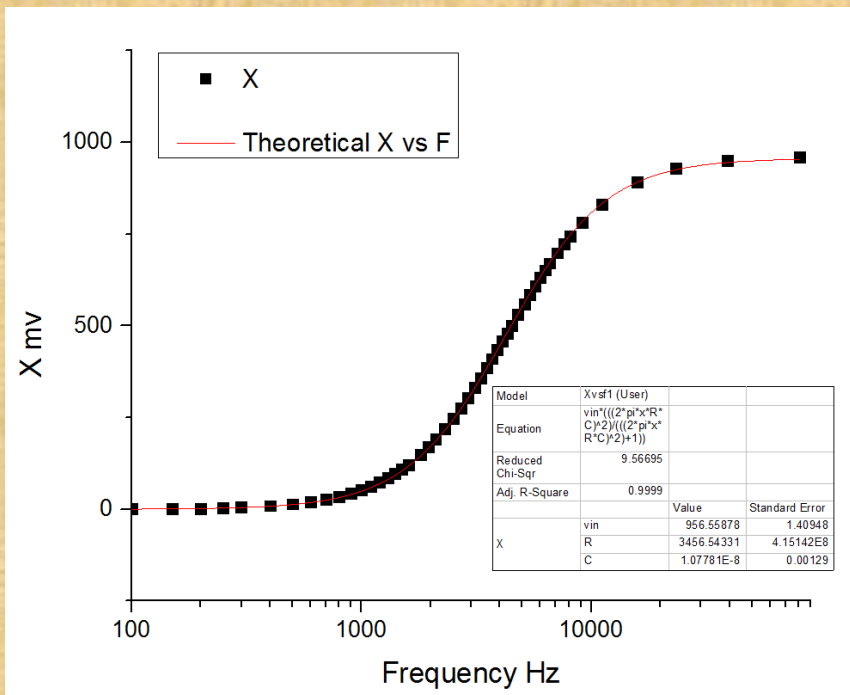


Figure 4. Graph of X vs Frequency over a wide range of frequencies in circuit A

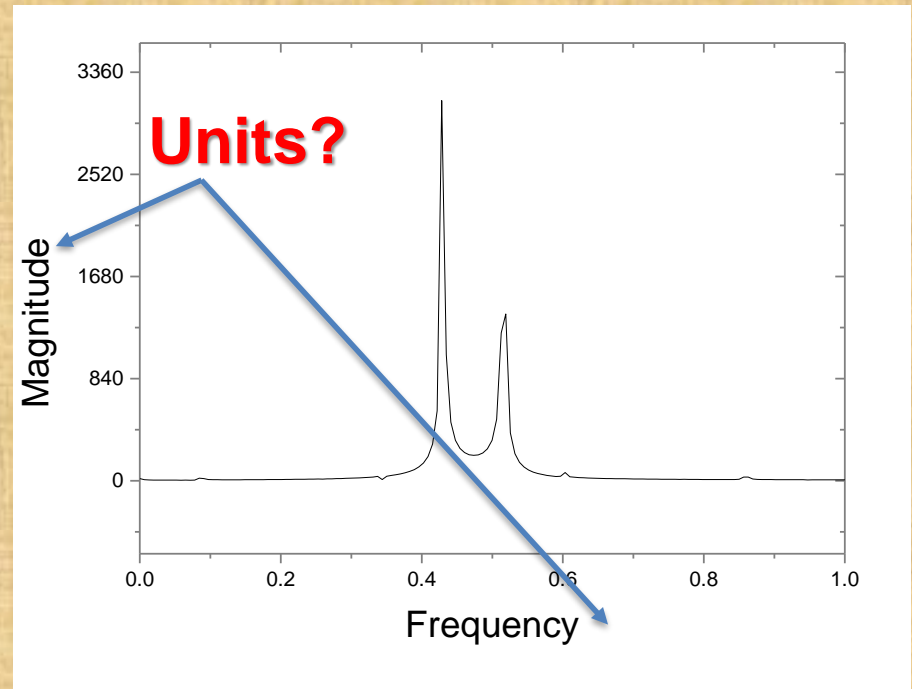


Figure caption ?

Course Objective. *Lab report*

The components of the report.

Results

- **Show some raw results if it is appropriate**
- **From raw data obtained in experiment to physical parameters**
- **Errors, uncertainties, problems**

Course Objective. *Lab report*

The components of the report.

Conclusions

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 shear 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*

The components of the report.

Conclusions

- **Main findings obtained in experiment
and after the data analysis**
- **Compare the obtained results with
published/known ones.**

Course Objective. *Lab report*

Main suggestions how to prepare a good report:

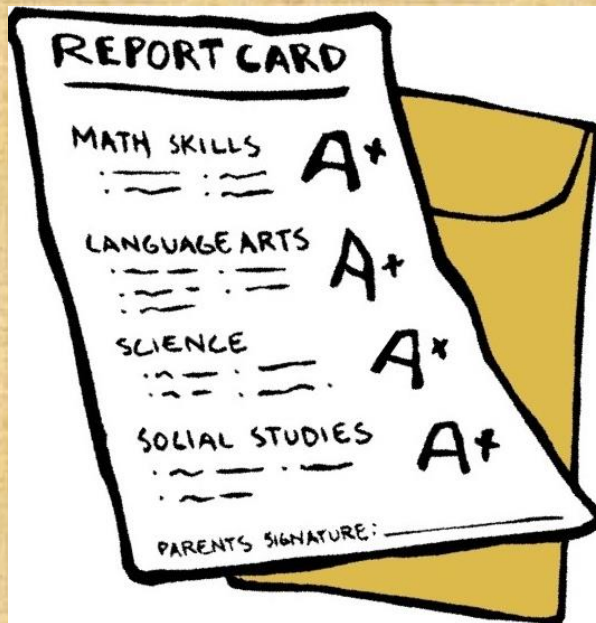
- **Proofreading and check spelling.**
- **Prepare the well “polished” graphs**
- **All graphs pictures and tables should be supplied by captions.**
- **Equations should be numbered**
- **All found physical parameters/results should be given with estimated errors.**
- **Take care about reasonable number of significant digits in all numerical results.**

Course Objective. *Lab report*

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

[An example of P401 good written report](#)

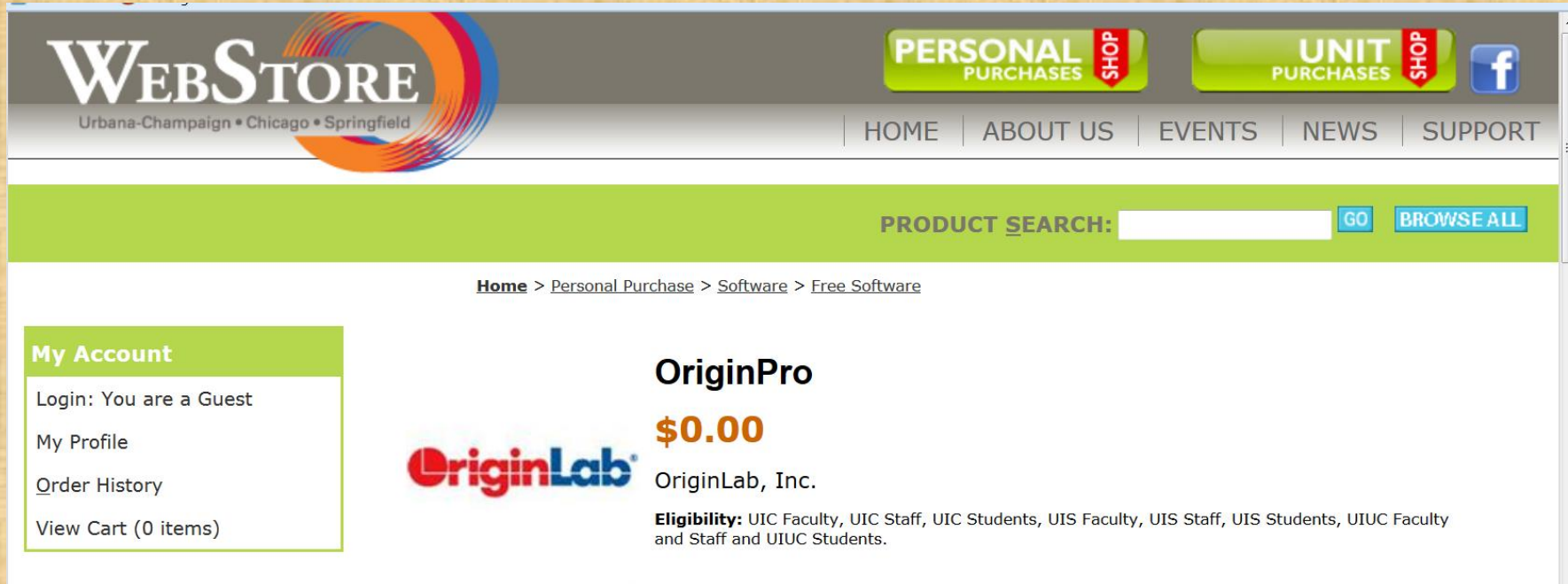
[An example of P403 good report](#)



Course Objective. *Lab report*

Graphs, graphical software

*Origin can be used for data analysis and data presentation.
There is 2018 version available on all Lab computers*



The screenshot shows the WebStore website interface. At the top, there is a navigation bar with the WebStore logo (Urbana-Champaign • Chicago • Springfield) and buttons for 'PERSONAL PURCHASES SHOP' and 'UNIT PURCHASES SHOP'. A Facebook icon is also present. Below the navigation bar are links for HOME, ABOUT US, EVENTS, NEWS, and SUPPORT. A search bar is located below the navigation bar with the text 'PRODUCT SEARCH:' and buttons for 'GO' and 'BROWSE ALL'. The main content area shows a breadcrumb trail: Home > Personal Purchase > Software > Free Software. On the left, there is a 'My Account' sidebar with links for 'Login: You are a Guest', 'My Profile', 'Order History', and 'View Cart (0 items)'. The main product listing for 'OriginPro' is displayed, showing the price as '\$0.00' and the company name 'OriginLab, Inc.'. Below the company name, there is an 'Eligibility' section: 'Eligibility: UIC Faculty, UIC Staff, UIC Students, UIS Faculty, UIS Staff, UIS Students, UIUC Faculty and Staff and UIUC Students.'

<https://webstore.illinois.edu/Shop/product.aspx?zpid=1311>

WebStore offers two versions: 2018 and 2019

Course Objective. *Lab report*

Graphs, graphical software

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://cloud.originlab.com/pdfs/Booklet2017.pdf>

ORIGIN® 2017
Graphing & Analysis



Introduction to Origin and OriginPro 2
What's New in Origin 2017 4-5
2D Graphing 6-11
3D Graphing 12
Database Access 14
Data Processing 16
Gadgets 18
Apps in Origin 19
Curve Fitting 20
Peak Analysis 22
Signal Processing 24
Statistics 26
Handling Repetitive Tasks 28-31
Custom Reports 32
Publishing 33
Working with Excel®, MATLAB® Connectivity 34
LabVIEW™ Connectivity 35
Programming 36-39
User Case Studies 40
Comparison of Origin and OriginPro 42
Key Features by Version 44
Licensing 48
Product Support 50
About OriginLab 51

Course Objective. *Lab report*

Graphs, graphical software

OriginLab 25+ years serving the scientific and engineering community

Log In
Chat Try Buy English

Products Purchase Support Communities About Us Search

Publication-quality Graphing for Scientists and Engineers

- ✓ Over 100 Built-in Graph Templates
- ✓ Point-and-click Customization of All Elements
- ✓ Create Custom Graph Templates & Themes
- ✓ Push to PowerPoint or Copy-Paste to Word
- ✓ Export Image to 12+ Vector and Raster Formats
- ✓ Perform Batch Plotting Across Columns/Sheets/Books

Support Communities About Us Search

SERVICES

- Transfer Origin to new PC
- License/Register Origin
- Consulting
- Training
- Webinar/Online Trainings

SUPPORT

- Newsletter
- Support FAQ
- Help Center
- Contact Support
- Support Policy

DOWNLOADS

- Service Releases
- Origin Viewer
- Orglab Module
- Product Literature
- Origin Evaluation
- All downloads

VIDEOS

- Installation and Licensing
- Introduction to Origin
- All video tutorials

DOCUMENTATION

- User Guide
- Tutorials
- OriginC Programming
- LabTalk Programming
- All documentation

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Graphing & Analysis

<http://www.originlab.com/>

News items:
Apr.02.2007 New Century Financial Corporation
Sep.15.2008 Lehman Brothers Files for Bankruptcy
Sep.21.2011 Fed launches Operation Twist
Jun.26.2012 Fed expands Operation Twist

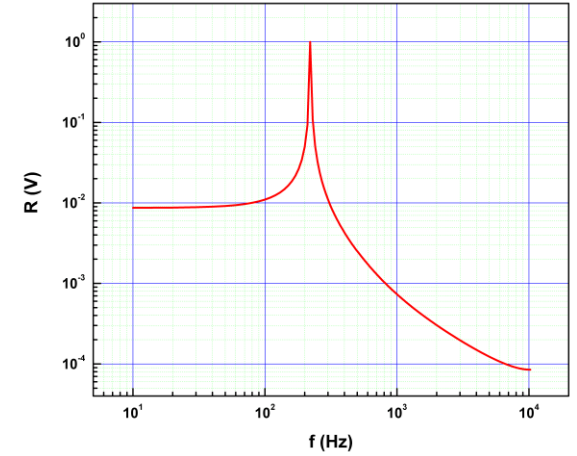
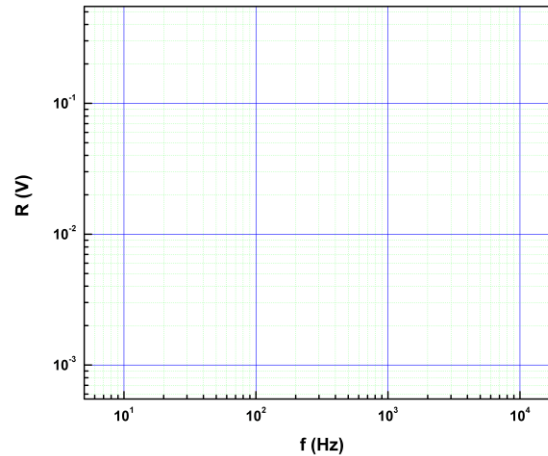
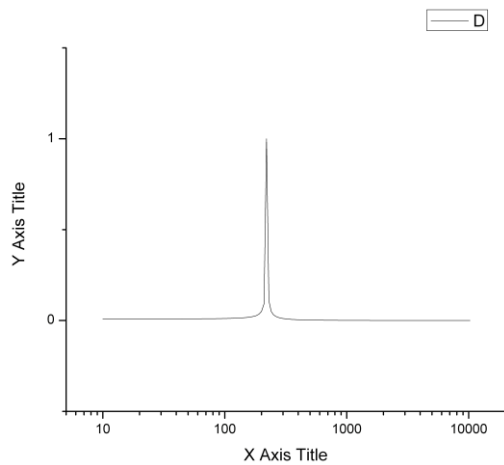
Wurtzite Gali Fitted Measured
Particle Number and Volume Concentrations in a Closed Photochemical System
Control of Electricity (AFI)

Origin 2017 SR2 is now available!
Free Origin Viewer 9.4.1, Updated for both Windows and Mac versions!
Upcoming Trade Shows: ACS Fall Neuroscience
New Apps: OPJ Examiner, Data Slicer, Equivalence Test

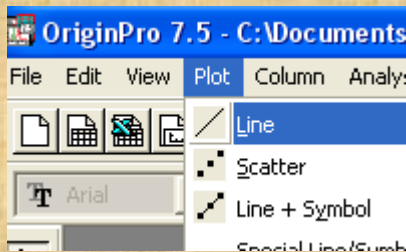
Course Objective. *Lab report*

Graphs, graphical software

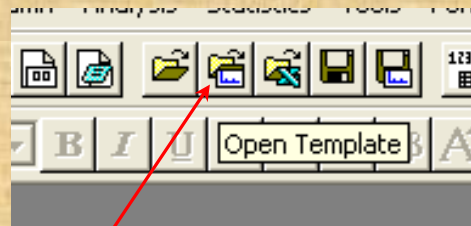
Working with Origin you can use the templates



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/>

ASSIGNMENT UPLOAD

Student Assignment Upload

Admin Assignment Upload

Admin Upload Log

Term Code

Fall 2017

Course Subject

PHYS

Course Number

401

1GB maximum file size allowed.

Please ensure the paper you're uploading has one of the following file extensions (.doc .docx .pdf):

Assignment

Transients and Oscillations in RLC Circuits_L1 (due on 9/6/2017 1:00 AM)

Upload your assignment

Browse...

No file selected.

Upload

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 you **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 9 2018

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

Date:
Experiment No.:
Student Name:
Signature:

void after May 9 2018

Course Objective. *Lab report*

Vouchers. The main rules:

- **Vouchers can not be used both together for the same report.**
- **Voucher can not be used after more week from the day of regular submission**
- **You have to inform your TA if you are going to use the voucher and preferably beforehand.**
- **Voucher can not be used for the final report.**
- **Credit for unused voucher/s will be added to the final report score or to any other one.**

Course Objective. *Lab report*

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*.



Course Objective. *Lab report.* ***Resubmission .***

You have a right to resubmit during the semester one report. The rules for resubmission are:

- 1. *Original report should be submitted in time or with using a voucher***
- 2. *Original report should be a real report but not a title page with author name***
- 3. *The final report is not a subject for resubmission***
- 4. *The deadline for resubmission is the same as for final report – May 5th 2019***

Course Objective.

Late reports

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 5th 2019 is the final deadline for everything



Course Objective.

Absences/Excuse policy

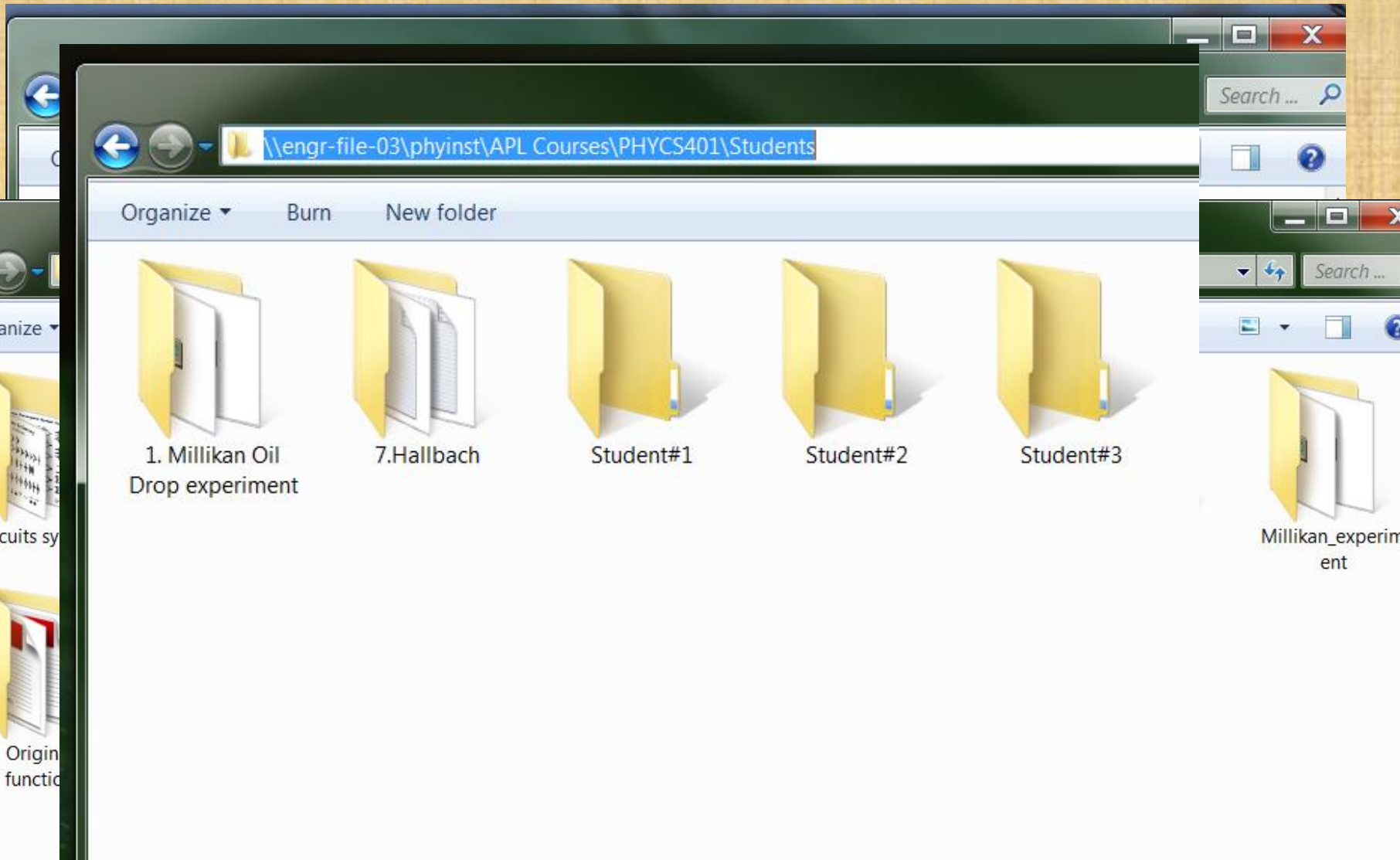
In the case if you have acceptable reason for absence of the Lab section you have to contact Eugene Colla and we will try to figure out how to make up the Lab

- *You can be excused from only one missed assignment, and only if you provide medical or equivalent documentation.*



- *The Final Experiment cannot be excused, as it is equivalent to a final exam. You cannot pass the course without credit for this assignment (see Student Code)*

Computer Access in P401



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.

Times and Locations

Section	Type	Times	Days	Location
A	Lecture	03:30 PM - 04:20 PM	Monday	276 Loomis Laboratory
L1	Lab	01:00 PM - 04:50 PM	Tuesday	6103 ESB
L3	Lab	01:00 PM - 04:50 PM	Wednesday	6103 ESB
L4	Lab	08:00 AM - 11:50 AM	Thursday	6103 ESB

Physics 401 staff



	Name	Office Hours	Phone	e-mail
Lecturer	Prof. Eugene V Colla	Monday 4:30-5:30 pm ESB 4137	333-5772	kolla@illinois.edu
Laboratory Instructor	Lucas Slattery	Tuesday 12pm-1pm ESB 6103		lslatte2@illinois.edu
Laboratory Instructor	Lazar Laszlo Kish	Wednesday 12pm-1pm ESB 6103		lazark2@illinois.edu
Laboratory Instructor	Jordan J Sickle	Thursday 1pm-2pm ESB 6103		sickle2@illinois.edu
Laboratory Technician	Jack Boparai ESB 6101	None	333-2208	jboparai@illinois.edu

Semester Schedule

<i>Week of</i>	<i>No. Weeks</i>	<i>Lab Title</i>
January 14	1	Introduction to oscilloscope, function generator, digital multi-meter (DMM), and curve fitting.
January 21	1	<i>Transients in RLC circuits</i>
January 28	1	<i>Frequency domain analysis of linear circuits using synchronous detection</i>
February 4	1	<i>Pulses in transmission lines</i>
February 11	1 of 2	<i>Millikan Oil Drop Experiment / Week 1</i>
February 18	2 of 2	<i>Millikan Oil Drop Experiment / Week 2</i>
February 25	1 of 2	<i>Torsion Oscillator / Week 1</i>
March 4	2 of 2	<i>Torsion Oscillator / Week 2</i>
March 11	1 of 2	<i>Hall Probe Measurement of Magnetic Fields</i>
March 18		Spring Break
March 25	2 of 2	<i>Qualitative Studies with Microwaves / Week 1</i>
April 1		<i>Microwave Cavities / Week 2</i>
April 8	1 of 3	<i>Final Project – AC Measurement of Magnetic Susceptibility / Week 1</i>
April 15	2 of 3	<i>Final Project – AC Measurement of Magnetic Susceptibility / Week 2</i>
April 22	3 of 3	<i>Final Project – AC Measurement of Magnetic Susceptibility / Week 3.</i>
		<i>Final week: Final Project Reports due on May 5th at 11:59 PM. Reports should be submitted by uploading.</i>

Grading

Total Points(max) =

1000(reports) +

60(Lectures attendance)

Total number of scaling points is 1060!

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-