111 A Syllabus

University of California at Berkeley
Donald A. Glaser Physics 111A
Instrumentation Laboratory

Syllabus

The 111A Instrumentation Laboratory Workstation

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General Information: Come to first (1st) day of classes in room 282 LeConte at 1:00PM

Spring 2016 Instructor:

William Holzapfel
433 LeConte Hall
Phone: 510-642-5036
Email: swlh@cosmology.berkeley.edu
BSL Lectures are on Tuesdays and Thursdays from 5:00-6:30pm in room 3 LeConte Hall

Graduate Student Instructors

<table>
<thead>
<tr>
<th>Name</th>
<th>Email</th>
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<tbody>
<tr>
<td>Juan Camilo Buitrago-Casas</td>
<td><a href="mailto:juan@berkeley.edu">juan@berkeley.edu</a></td>
</tr>
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<td>Dylan Rees (20)</td>
<td><a href="mailto:rees@berkeley.edu">rees@berkeley.edu</a></td>
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<tr>
<td>Samuel Ciocys (20)</td>
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<td>Joseph Broz (20)</td>
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</tbody>
</table>

Office hours and schedules for the GSIs and professors will be posted outside 275 LeConte after the second week of classes.

111 Laboratory Staff  Research Engineer 3 and 111-Lab Manager

<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
<th>Phone</th>
<th>Email</th>
</tr>
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<tbody>
<tr>
<td>Donald Orlando</td>
<td>282E LeConte</td>
<td>642-5328</td>
<td><a href="mailto:phylabs@berkeley.edu">phylabs@berkeley.edu</a></td>
</tr>
</tbody>
</table>

Lab Information

Laboratory Phone: 624-1937

Lab hours: Mondays 12-4 pm and Tuesday-Friday 1-5 pm

The Physics Department Colloquium is on Mondays from 4:15-5:30 pm in 1 LeConte Hall, all students are strongly encouraged to attend. Also, tea and cookies are served (for a small fee) at 4pm every day in 375 LeConte Hall.

Course web site: Instrumentation Lab, then click on Instrumentation Lab picture

Course Checklist

Before The 1st Day of Class

- Fill out the Signature Card, located on the class bCourses[18] web site on the home page and press the submit button.
- Fill out the Background Survey[19] here.
- Make sure your picture is available on the bCourses web site; If NOT bring a passport-sized photo of yourself to the first class meeting.
- Think about finding a lab partner in advance.
- Purchase your lab notebook. You'll need this for the 1st lab, which starts on the 1st day.
- Make sure TeleBears thinks you're enrolled in the class. You can't do the labs without access to the lab computers, and you can't get that without being enrolled.
- Read the University of California and Physics computer policy[20].

There will be a mandatory first class meeting in the 111-lab at 1 PM on the 1st day of classes in 282 LeConte Hall.

- We'll give you important information.
- If you need a lab partner, you'll find one.
- You'll sign up to use an experiment workstation for minimum of two afternoons a week. There are 22 workstations. One workstation 23 for soldering, remember that workstations 20, 21, and 22 during Lab 3 week will be used for Curve Tracer labs.
- Look at the Glossary[10], of terms.
- Check out the new digital equipment; Tektronix Scope[21], Keithley DMM[22], and the Tektronix ARB Function generator[23].

Lectures start the first Tuesday of classes.

- Lectures are 5PM to 6:30PM Tuesdays and Thursdays starting the first (1st) Tuesday of classes.
- You should have done the reading assignment by the start of lecture, including the first one.

Before you start each lab

- Download the manual for each lab from the Lab Assignments[24] tab above.
- Read it and do the pre-lab questions before coming to the lab.
- Before your first lab, watch the Introduction videos on the Instrumentation web site.

Instrumentation Lab COURSE INFORMATION

Welcome to the Physics 111 Lab—Instrumentation Lab (Previously BSC) course! The Instrumentation Lab is a 3-unit, fifteen-week course that requires two to three, 4-hour afternoons of lab time and two, 1.5-hour lectures twice a week, on average, in addition to outside reading, analysis and writing. The course covers basic electronics (filters, diodes, transistors, op-amps, analog & digital circuits, D/A conversion, and LabView Programming, etc.) and measurement techniques with an approved Final Project of your choice. It will also teach you how to use equipment found in a typical physics research laboratory and how to write scientific reports.

Before taking advanced laboratory section of the 111 Lab, you must take Instrumentation Lab (physics 111A) unless you have taken an equivalent electronic course (e.g. from the EECS department or physics 111 professor approval).
Some students find that the 3-unit Instrumentation course takes more time than two 4-hour afternoons. This is an upper division physics Lab course and moves very quickly! Students completing Instrumentation Lab last semester estimated that the course takes between 12 and 15 hours each week total. **Please plan your time accordingly.**

**Course Structure:**

The course is organized around the lab assignments. You'll be doing them continuously. Each lab has a write-up that you work through with a partner. See below for more hints on how to do that and how to get the most out of it. At the end of each lab, there's an assignment to be turned in. Some of these are formal lab reports, some are informal (shorter reports). **All reports are submitted online through Bcourses.**

Pre-labs must be done in advance. They should be at the front of that week’s section in your lab notebook. You need to show them to a GSI and get them signed off before the start of your reserved lab period.

Assignments are due by 11 pm on the due date online uploaded to Bcourses. **Procedure for reports; Scan in report at the Library and make a PDF format file or Format a PDF from one of the 111-Lab computers. Then upload into Bcourses.** Note that it's not appropriate to be in the lab trying to finish it right before the deadline. It's OK to print your report on the lab printers, but note that they're not entirely reliable and there might be 80 other people trying to do that at the last minute.

Late assignments will be subject to a penalty per day late. Extending your assignment due dates without penalty would require exceptional circumstances. On those occasions, approval must be in advance and via email from the Professor and must be included in your report. Past one week, if the lab has already been graded it will receive a grade of 'F' equal to zero. You must still submit ALL assignments in order to pass this course.

Students must complete all required work and turn it into the 111 Lab in order to pass the course. Any missing work will result in a final grade of "F" for the semester. You must turn in all labs, even if they're late, to pass this course.

Plagiarism will result in a final grade of "F" for the course. For guidelines on working with a lab partner, please see "On Working Together" later in this manual.

The last assignment is a project of your own development. We'll provide more information on that as the course goes along. You'll submit a proposal, discuss it with the instructor, then build and debug your project. At the end of the course, you'll demonstrate it and write a typed written final lab report.

**Computers in the Physics 111 Lab:**

- **Read the University of California computer policy.**

You must be enrolled in the course and have a valid CalNet ID Login name to log into the computers. Save all of your data and files to the DeskTop or My Documents Folder; everything else will not be saved or backed up. You also want to save your files & data to your own 8GB USB thumb drive. Experiment and equipment information is located on the 111-Lab Share folder on your network drive from within the 111-Lab in "My Computer" on each computer or from the Physics 111-Lab Library site.

**Academic Honesty**

Both the University and the 111 Lab staff take the subject of academic honesty very seriously. Please make sure you understand completely the following and ask questions if ever in doubt:

"All data that you present in your reports must be your own. All written work that you submit, except for acknowledged quotations, is to be in your own words. Work copied from a book, from another student's report, or from any other source will, under University rules, earn the student a grade of 'F' for the semester, and possible disciplinary action by the Student Conduct Committee."

**Note on Working Together**

Research in physics is facilitated by close cooperation and collaboration among those involved. Indeed, if scientists did not share results and argue over interpretations, new discoveries and insights would be much fewer and further between. You will find in the 111 Lab that you learn a great deal from working and talking with your classmates, especially your lab partner. However, as in other courses, each student will be given a grade based solely on his or her individual achievements. Each student must turn in his/her own lab report, in his/her own words. This requirement is not intended to reduce cooperation or discussion in or out of the lab. On the contrary, we encourage you to discuss your results with other students and to try to make sense of them together. The final product, however, must be your own work.

What is not acceptable? In general, use common sense. Raw data and good ideas should be shared with your classmates, but text, analysis, graphs, figures, and derivations of equations should be completed alone. If you have any questions, please ask the lab staff.

In summary, each student must do his or her own work. **Failure to do so will result in an "F" for the course.**
Physics 111A Instrumentation students are assessed a Course Materials and Service Fee (CMSF) of $175 to cover the cost of expendable supplies and materials used in the course. These fees are collected after the fifth (5th) week of classes and will be included in each students' CARS (Campus Accounts Receivables System) statement. Income from the CMFS is kept in a separate account that is used only for the purchase of supplies and expendable materials for Physics 111. Equipment purchase and repair, computers, and staff salaries are paid for by the Physics Department, not by student CMSF.

You can sign out a VB-108 type breadboard and keep it for your own use from the back wall of the lab. That lets you build a circuit one day, and still work on later days. You can keep the breadboard in a slot in the lab (recommended; pieces tend to fall out when you transport them) or take it with you.

**Assignment Due Dates:** Turn assignments into Physics 111A Bcourses online see due dates below by 11:00PM.

<table>
<thead>
<tr>
<th>LAB #</th>
<th>Lab Title</th>
<th>Lab Start Date</th>
<th>Report Due Date</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introductory &amp; Linear Circuits I (longer lab)</td>
<td>Tues. Jan. 19</td>
<td>Mon. Feb. 1</td>
<td>Full Report for Full Grading online turn in through Bcourses 100pts</td>
</tr>
<tr>
<td>2</td>
<td>Linear Circuits II</td>
<td>Fri. Jan. 29</td>
<td>Fri. Feb. 5</td>
<td>Type up Notebook online turn in through Bcourses 100pts</td>
</tr>
<tr>
<td>4</td>
<td>JFET Circuits I</td>
<td>Thurs. Feb. 11</td>
<td>Mon. Feb. 22</td>
<td>Type up Notebook online turn in through Bcourses 100pts</td>
</tr>
<tr>
<td>5</td>
<td>JFET Circuits II</td>
<td>Thurs. Feb. 18</td>
<td>Mon. Feb. 29</td>
<td>Full Report for Full Grading</td>
</tr>
<tr>
<td>6</td>
<td>Op Amps I</td>
<td>Thurs. Feb. 25</td>
<td>Mon. March 7</td>
<td>Type up Notebook online turn in through Bcourses 100pts</td>
</tr>
<tr>
<td>7</td>
<td>Op Amps II (longer lab)</td>
<td>Thurs. March 3</td>
<td>Fri. March 18</td>
<td>Type up Notebook online turn in through Bcourses 100pts</td>
</tr>
<tr>
<td>9</td>
<td>LabView Programming</td>
<td>Mon. March 28</td>
<td>Fri. April 8</td>
<td>Type up Notebook online turn in through Bcourses 100pts</td>
</tr>
<tr>
<td>10</td>
<td>ADC’s &amp; DAC’s</td>
<td>Mon. April 4</td>
<td>Fri. April 15</td>
<td>Type up Notebook online turn in through Bcourses 100pts</td>
</tr>
<tr>
<td>11</td>
<td>Feedback Control</td>
<td>Mon. April 11</td>
<td>Fri. April 22</td>
<td>Type up Notebook online turn in through Bcourses 100pts</td>
</tr>
<tr>
<td>12</td>
<td>Final Project ***</td>
<td>Mon. April 18</td>
<td>Mon. May 9**</td>
<td>Final Full Report for Full Grading 330 Pts</td>
</tr>
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**Full Report** = Includes Introduction and Conclusion. Re-write experiments, integrate graphs, analysis, and comments to make a clean easy to read report. Your report must include carbonless copies of in-lab notes. Type written reports.

**Notebook Turn in** = Type up this report, Short (paragraph) answers to specific questions, plus carbonless copies of lab notes with attached graphs or other analysis. Clarity and neatness still count! Late reports scored as zero.

**Full Grading** = Detailed grading of content and presentation. It must be understandable and persuasive, so your writing counts! Late reports accepted at -10% per day, up to 5 days, then score equals zero.

**Peer Grading** = Each student will provide comments on another student’s lab report. The report and the comments will be
reviewed for the recorded grade.

**Notes:**
1) ALL lab assignments must be turned in to pass the class.
2) Scoring a zero (perhaps by turning in a short report late) means lost points, but not turning in a lab means automatic F for the course.
3) All questions on grading should be addressed to the Professor, not to the GSIs.
4) You shouldn't waste precious lab time on lab write-ups. Get it done outside of class.
5) Exceptions may be made for extraordinary circumstances at the Professor's discretion. This is much more likely if you contact him before the deadline rather than after.

*** Final Project NOTE: *** Submit online or (in PDF or Doc format) file via Email to the Professor of this course a 2 page or less proposal for your final project with a Circuit Diagrams and Block Diagrams on or before ** Friday March 18.**

Your professor will contact you to approve your proposal, request clarification, or suggest improvements. Each group will have the opportunity to meet with the professor to develop and refine your proposed project. A schedule for these meetings will be posted in lab. Revised proposals are due on April 4th. The final project proposal is the only instance in this course where you will submit identical work. For both the initial and revised proposals, please coordinate with your partner to submit duplicate proposals that clearly display your project title and lab partner's name.

*Note: Purchase your final project parts ahead of time including any other breadboards you will need. Ask professor if you need help. Some Sources include;*

**NOTE: You can check out and keep the portable breadboards, VB-106 or VB-108, from the 111-Lab for yourself (Only one each please)***

- Mouser.com, Digi-key Electronics, Newark Electronics, Jameco, Al Lashers in Berkeley at 510-843-5915, etc;
- Ask the GSIs or Professor for others if needed. Plan ahead!

**Inspection of physical Final Projects will be on or before the last four days of classes. See Professor for Details.**

=> Every student must complete their own final lab write-up. (Reports are submitted online at Bcourses see due dates above)**

Final Project Information:

The last assignment is a project of your own development. We'll provide more information on that as the course goes along. You'll submit a proposal, revise as needed, then build and debug your project. At the end of the course, you'll demonstrate it and submit a written final lab report.

Proposal Process:
- Turn in a 2 page or less proposal for your final project with a block diagram and schematics of key parts. The idea is to focus on what you're going to build, and show you've started thinking about how to build it.
- The professor will approve your final project proposals or engage you in a dialogue about how to improve them if needed.

There should be only one proposal per lab team. You will write it together, with everybody's name on it.

Note: Purchase your final project parts ahead of time including any other breadboards you will need. Some Sources include Mouser.com, Digi-key Electronics, Newark Electronics, Jameco, Al Lashers in Berkeley at 510-843-5915, etc. Ask the GSIs, Don, or the Instructor for others if needed. Plan ahead!

End-of-Semester Process:

The lab is open its regular hours through the end of RRR week, Friday. No lab work will be allowed in the 111 lab rooms after the end of Lab classes. Please work on your project early, in case of unexpected delays.

There are three parts to the end of semester process. You must do all three!

- Your project will be evaluated at a scheduled time on Monday through Thursday last days of class.
- This is similar to being quizzed about a lab section to get a sign off, except it'll be more thorough and be specifically about your project. Sign-ups for evaluations times will be done via bCourse starting a week before. All team members must be there, so pick a time that works for all.
- You will individually write your own final lab write-ups. (Everything else on the final project is joint, but the final write-up is done individually like all the other lab reports). The final lab report is due online at Bcourses see due dates.

**Required text:**

Horowitz and Hill, [22] The Art of Electronics, 2nd Ed. (Cambridge)

**Recommended for Reference:**

Hayes and Horowitz, Student Manual for the Art of Electronics, (Cambridge)

Other references: Physics 111-Library Site  

Other useful texts (on reserve in the Physics Department Library)  

- Senturia & Wedlock, Electronic Circuits and Applications (Wiley)  
- Schwarz & Oldham, Electrical Engineering: An Introduction (Saunders)  
- Millman & Grabel, Microelectronics, 2nd Ed. (McGraw Hill)  

Required Lab Notebook: Student Lab Notebook (Haden McNeil); 100 pages or type up your own documents (since they are submitted online)  

You are required to keep a lab notebook for this course. The one listed above has perforated pages and a carbonless copy. That makes it easy to turn in copies of your notebook. If you want to use some other form of bound notebook, that’s OK but you’ll have to make a copy of your notebook to turn it in. Remember that your lab book should be a self-contained, stand-alone description of your laboratory experiments: when you look it over, say a year from now as you fondly remember your undergraduate days, it should make sense to you!  

NOTE: You will probably need more than one of these lab books.  

- To do calculations use MatLab or use outside the lab R-Studio (freeware)  
- When writing in your Instrumentation Lab Notebook: You need to type up all data and text. insert pictures as needed.  

Then upload your documents to Bcourses.  

- Give the following information at the top of the lab write-up:  
  Your name                                         Date  
  Your partner’s name                         Station number  
  Week number and title of lab  

- Record all of your data and observations in your notebook; don’t use “scratch paper.” Type them up  
- Record the settings and conditions under which the data was taken.  
- Be as neat as possible. (Sections that cannot be EASILY read will not be graded.)  
- Line out with a single line (e.g. Ooops) anything written in error (data or text).  
- Use a single large "X" to indicate any sections that you do not wish to be read.  
- Use a straight edge to draw lines that are supposed to be straight (graph axes, column lines, etc.).  
- Attach any loose sheets (e.g. semi-log graph paper) with your assignment.  
- Pre-lab questions must be signed off by TA’s by each Friday  
- Your logbook should show a clear understanding of the Lab and the work that you did in the laboratory. It should not be longwinded, it should not include all possible details, and it should not be a scattergun approach.  
- P/MF Graded labs: please just tear out the copy pages from your LAB NOTEBOOK for the Lab and turn them in. Do not include introduction or conclusion. DO include Pre-Lab Questions, in Lab Work and Diagrams, etc.  

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THE LAB REPORT  

Overview  

Ten pages are a reasonable upper limit on length for a full lab report. (Please note, however, that this “upper limit” does not mean that your report should stop just because you have hit page 10.) Your report should concentrate on the essentials, and should show that you know what you are doing and that you can pick out the significant details. It should also show that you know how to organize a report—each Lab write-up will give you some guidelines, but we want you to exercise your judgment. You should compromise between telling so little, as to be not understandable, and telling so much that you are following a cookbook. These reports should be halfway between a Physics 7 report and a research report; they should not read like problem sets. They must be type written.  

Record all your data and take the time to write comments and coherent explanations, draw neat graphs and tables, and clearly derive quantities that are not directly measured. For each assignment you will type everything in your lab notebook document. You should have the following sections:  

Sample Lab write-ups  

Introduction  

NOTE: You do not have to include the Intro/Conclusion in your lab notebooks—they are however required to be included in the final drafts of your Formal Reports. This should describe the Lab and give an overview of what you are going to do. Aim to answer the questions: Why would someone want to do this Lab? What is gained?  

Pre-lab questions  

Before each week’s lab you should do the recommended reading, attend the lecture, read through the lab manual, and think about what it is that you are going to do in lab and why you are doing it. The “Pre-lab Questions” that are given at the beginning of each week’s lab are intended to guide you. These are to be answered before you come to lab. Lab time is valuable, and the goal of all this is to make sure you can use it effectively.  

The pre-lab needs to be signed off by a GSI. It should be signed at the beginning of your first day in the lab before you start. If a GSI is unavailable, you may begin the lab, however it should be signed ASAP and by the end of the day at the very latest. After the your first day, you will not receive credit for the prelab. The prelab needs to be correct as well. If you need help or are worried about the correctness, feel free to come in before your first lab afternoon and discuss it with the GSIs.
In the lab

After the Pre-lab, you take data for that week's lab. You then present that in your report. Make sure that you:

- number the sections of your data so they correspond to the numbers in the lab manual.
- make tables clear and neat, and be sure to always label columns and include units and some estimate of uncertainties.
- answer questions posed in the "In the lab" section in the same section as your data.

- include circuit diagrams and figures showing the set-up. Any circuits analyzed, built or used should be diagrammed. If you have a digital camera, take lots of pictures, but you should still make diagrams in your lab notebook.

Signatures

There are places marked in the lab where you are supposed to get a GSI signature. These are meant to let the GSIs check up on your progress throughout the lab. Therefore, you need to get your lab questions signed as you complete them. GSIs expect to see your circuits and signals so we can test them, not just your recordings in your notebook. Also, signatures are not an answer, they are just an acknowledgement that you completed the section. Explanations are still required.

Please start each lab with a section for the GSIs to sign all in one place.

Questions

Each lab contains "Questions" which refer to the data which you have taken in lab. Please number your answers. Extra information is fine, but don't bury your answer where it can't be found. Clearly set off the final results (e.g., box numerical answers) and, of course, always include units and error estimates. Compare your results with your expectations whenever possible.

You may wish to complete some of the questions while in the lab, rather than waiting until later (e.g. calculating amplifier gains, making plots, etc.). This is often a good idea but please indicate where you are completing one of the "Questions" by labeling it.

Graphs, tables and scope traces

Data plots and tables are often the easiest ways to convey information. All graphs must have a title and labeled axes showing quantities and units. Make all graphs large enough so that they may be easily understood. Graph families of curves or related functions on a single set of axes. Error bars are almost always required. Number all figures and graphs and include legends. If there are a lot of points, or if you need to fit the data to a theoretical curve, it is usually best to use a computer-plotting program to prepare the graph.

Axes should also be labeled on scope trace sketches, as should the heights and widths of its features. Basically, a sketch should contain enough information so that it can be used to reconstruct what is important in a trace. You may not know at the time what is important, so you'll have to use your best judgment. It's usually best to err on the side of completeness.

Uncertainties (errors)

As this class is focused on getting experience building circuits and analyzing circuits, you do not need to do formal error analysis. Still, this is a physics lab, and some attention must be paid to the uncertainties in your data and analysis. Uncertainty estimates come from consideration of the measurement itself, not from the comparison of theory and experiment. In each case you want to ask yourself the following two questions:

- "What is the range of values for my measurement over which I can't reliably state that one answer is better than the others?" This is roughly the statistical uncertainty (error), and it can always be easily assigned.

- "By how much might I actually be measuring something different from what I'm intending?" This is roughly the systematic uncertainty (error), and it may require more thought to quantify.

Only the dominant source or sources of error are important. One can only make a reasonable comparison between theory and experiment if the uncertainty in the result is known.

Conclusions

NOTE: You do not have to include the Intro/Conclusion in your lab notebooks—they are however required to be included in the final drafts of your Formal Reports! The conclusion should be written once the lab is completed. A few sentences should indicate what was accomplished, what was learned in the process, and any comments. This is an important part of each week's lab, so take some time to think about what it is you have learned!

Acknowledgments and References

Indicate who your partner is and indicate which parts of the lab you did together and which you did separately. Reference any outside sources you used (text, friends, etc.); give credit where credit is due.

Supplementary problems

If there are any then the points for these are kept track of separately from the rest of the lab. In cases where your grade is just below a grading boundary, having done this extra work may boost you up to the next grade. The supplementary problems are often among the most interesting exercises, and they are not in general more difficult. If you do not have time to do them, you should at least read them over.

Level

Your report should be type written at a level such that one of your classmates with the level of understanding that you had before you started the Lab could pick up your report and understand what you did, what electronics is illustrated, and how good your results are.

Pass/Medium/Fail (P/M/F)

For your P/M/F reports, you should only have to tear out the pages from your lab notebook and staple them together. Then turn them in with your name, your partner's name, the title of the lab, and the date on the first (1st) page. Include the pre-lab questions, questions in the lab, in-lab work, diagrams, graphs, analysis and questions, etc. DO NOT include an Introduction or a Conclusion. You must turn in P/M/F reports on time.
Format

For all typed portions of your report, they should be printed on blank white paper. Please DO NOT use recycled paper that has writing on the other side.

TIPS FOR SUCCESS

- **Get started early.** Reports always take longer to complete than one expects.
- **During the lab session, make estimates** for measured quantities to see if what you are doing makes sense. This will save you return trips to the lab!
- **Be neat.** Understanding the material is only half your task. Your presentation must be clear enough and easy enough to read that the reader can be convinced of your mastery.
- **Watch your units.** Confirm that measured quantities have the appropriate units. A unit-less answer is meaningless.
- **Define variables in equations.** What is obvious to you may not be to the reader.
- **Locate experimental uncertainty.** Nothing elaborate is expected but be aware that errors (uncertainties) do exist. Identify sources and estimate magnitudes of error.
- **Proofread.** Check for both simple and conceptual typos. Compare your results to theoretical predictions and to the component specifications. Order of magnitude estimates are often sufficient for checking results.
- **Ask questions!** The only dumb questions are the ones that aren’t asked.
- **Don’t waste time in the lab.** Time management will be crucial in the lab and if you are getting ahead, stay ahead. If you are done with the lab 2 hours early, start the next one. Holidays and sickness can throw you off permanently if you don’t take advantage of all the time you have.

HELPFUL HINTS FROM GSI’s: How to ace your lab report.

- You need to get a signature from your GSI for the Pre-Lab questions before you can get a signature for any questions marked with a pen.
- You also need to get GSI’s to sign the problems that are marked with a pen.
- On your Lab report, you need to attach an original or copy of these signatures.
- Without these signatures, you will not get credit for these problems.

- Try to do all the problems in the Lab write-up.
- GSI’s are not going to grade all of the problems.
  
  Part of the problem sets will be chosen for grading. You will not know in advance which problems are graded or not.

**Formal** = Includes Introduction and Conclusion. Re-write experiments, integrate graphs, analysis, and comments to make a clean easy to read report. Your typed report must include carbonless copies of in-lab notes.

- The first week is a ‘full’ lab. This means we will be looking for a little bit extra. First off, we will be tougher in evaluating your responses, so give us a little discussion with each question (Prove that you know what’s going on!)
  
  - Also, you need to write an Introduction and Conclusion. These should give some general discussion of the lab as a whole, though the desired content of each is slightly different.
  
  - Your **Introduction** should discuss the things a student should learn from this lab. (Imagine you are presenting this to a Instrumentation student a year from now.) Your introduction should try to answer the following questions:
    
    - Was there anything in this lab that you did not understand before coming to lab?
    
    - How were the lab experiments designed to teach you these things? Please provide 3-4 concrete examples here.
    
    - What were the main goals of this week’s lab?
    
    - How does the lab introduce and achieve these goals? (3-4 examples)
    
    - Why should anyone want to learn about any of this?

    - Try to be creative; do not simply itemize your examples. Imagine that you are submitting this lab report to a scientific journal; your introduction should clearly state what your report is about and try to convince people that it is useful. You may also discuss potential applications of the lab content to Experimental Physics, but be specific.

    - In the **Conclusion**, give us 3 or 4 examples of things you actually observed. This section can be some follow-up discussion to the intro or it can be some discussion of some observations you found particularly interesting or unexpected. Also try to include insights and things to keep in mind for the rest of the semester.

    - Neither section need be very formal; however concrete examples are definitely a plus. Each should be at least 1/2 page in length, but please no more than 2 pages.

**Informal** = No Intro or Conclusion, just turn in carbonless copies of lab notes with attached graphs or other analysis. Clarity and neatness still count, but not as critical as formal write-up.
Full Grading = Score will range from 0 to max point value, detailed grading. Late reports accepted at -10% per day, up to 5 days, then score equals zero.

P/M/F Grading = Pass/Medium/No Pass. Scores will be either Max, 75% of Max, or zero point value. Late reports scored as zero.

Notes: 1) ALL labs must be turned in to pass the class.

- This report is fairly straightforward. Complete the lab exercises, writing the results in your bound lab notebook. Before you leave on your last day, briefly look over your notes to make sure that you have answered all of the questions for each exercise. Leave the originals in your notebook and submit the copies to the Instrumentation Lab box located in the 251 LeConte.

- Scoring a zero (perhaps by turning in a P/M/F lab late) means lost points, but not turning in a lab means automatic F for the course.

- It is usually better to turn a lab in somewhat incomplete than to turn it in late, losing points and time.

- Labs are due at 11PM, see the due dates. Scan in your reports and then upload submission online at Bcourses.

- Exceptions may be made for extraordinary circumstances at the Professor's discretion.

Evaluations

- Please turn in the evaluation for each lab. Please put at least 10 minutes of thought into it; simple yes or no answers do not help us. (Would the evaluation you turned in help you if you were the one trying to revise the lab write-ups?)

Final Advice: Here are some comments that will make your 111 Instrumentation Lab experience much easier and enjoyable for you (and less time consuming). First of all, do not simply think you do not have homework because this class is a lab.

- Before the lab: It will help you tremendously if you read and understand the lab write-up before you come in to start the lab. Look over all the questions, including the pre-lab questions, and determine anything you do not understand. This would also be a good time to write your introduction since now you know what the lab is about.

- In the lab: When you come in on your first day, you can discuss the pre-lab questions with the GSIs and answer them. This would also be a good time to discuss anything you are not clear about. In addition, try to follow directions; you could lose points by simply not answering the questions fully. Finally, if you have any doubts about anything, please ask a GSI.

How to Use the Lab Write-Ups

Read the write-ups before coming to lecture. The labs are divided into four sections: the Pre-lab questions, which should be completed before coming to the 111-Lab, Background materials, In Lab work, and Analysis. Not all labs have all sections. Be sure you understand the background material and have answered all the pre-lab questions before you come to class. The Analysis questions can be answered at home after you finish the labs. Ask questions if you are confused...electronics is a difficult subject that is new to most students. Don’t be dismayed if some of the other students seem to be faster than you; probably they just have some previous experience.

The write-ups are available from the 111-Lab Instrumentation Lab WEB site at:

http://instrumentationlab.berkeley.edu

Circuit schematics and some analysis programs can also be downloaded from the site.

The lab write-ups are not intended to be used on their own. Make sure you read the assigned reading.

Take a quick look at the glossary before you begin this course. There are too many terms there for you to memorize their meanings all at once, but knowing which terms are defined will help you later in the course.

The labs contain several ideograms:

- Means do this before you come to the Physics Instrumentation Lab.

- This means that you have to have the results of the indicated problem checked and signed off by a T.A. or professor

- Indicates that the adjacent schematic has a Multisim [29] model.

- Denotes an extra credit problem.

Credits

The Instrumentation Laboratory is the first semester of the Physics Departments' advanced laboratory class, Physics 111A and B, required for all physics majors. The class starts with 11 labs, and ends with a final design project. The labs progress from basic instrumentation to frequency dependent components, transistors, op amps,
and digital circuits. Each lab takes approximately two and 1/2 half afternoons to complete; approximately all labs are due each week, submission online to Bcourses, see due dates.

Many faculty and staff members have worked on the lab experiments and manual, including Joel Fajans, Bruce Birkett, Sumner Davis, Roger Falcone, Kam Biu Luk, David Weiss, Bob Jacobsen, Don Orlando, Howard Shugart, Sudeep Dutta, Damon Brown, Nate Belmore, and the Electronic Shop Staff.

In 1996, I started the major revision on the labs and the manual; I am grateful for the patience of the students during the semesters that the lab was being revised. Joel Fajans  (Revision Summer '02, Jim Siegrist)(Revision Spring 14, Bob Jacobsen)

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Outline of Lectures
I. Introduction & Linear Circuits I (Lab 1)
   A. Resistors and Kirchhoff's Laws
   B. Thevenin's Theorem

II. Linear Circuits II (Lab 2)
   A. Capacitors and inductors
   B. Fourier analysis
   C. Linear circuits in the time domain
   D. Resonant circuits

III. Semiconductor Diodes (Lab 3)
   A. Non-linear impedance
   B. The physics of diodes
   C. Load lines
   D. Rectifiers
   E. Special Diodes (Zener Diodes, LEDs, Photodiodes and Laser Diodes)

IV. Transistors (Labs 4 & 5)
   A. Types of Transistors
   B. The transconductance model
   C. The physics of JFETs
   D. Self-biasing
   E. Voltage amplifiers
   F. Differential amplifiers

V. Op-amps (Labs 6, 7, 8)
   A. What is an op-amp?
   B. Op-amp golden rules
   C. Op-amp amplifiers
   D. More on feedback
   E. Oscillators, filters and other devices
   F. Real op-amps

G. Noise

H. Bipolar junctions transistors

VI. LabView Programming (Labs 9, 10, 11)
   What is LabView
   ADC’s and DAC’s using LabView
   Feedback Control using LabView and computers
   LabView Interface Programming used in Research Laboratories.
   Control of Equipment & taking of data.

VII. Final Projects of your choice with approval (Lab 12)

VIII. Digital Electronics (Supplemental Information)

No Lecture on Digital Circuit but information is still online for your viewing.
A. Digital: what and why?

B. Digital logic and gates, Timers

C. Flip-flops: Counters, and oscillators

D. Analog-Digital Converters

Source URL: http://instrumentationlab.berkeley.edu/syllabus

Links
[2] mailto:swlh@cosmology.berkeley.edu
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