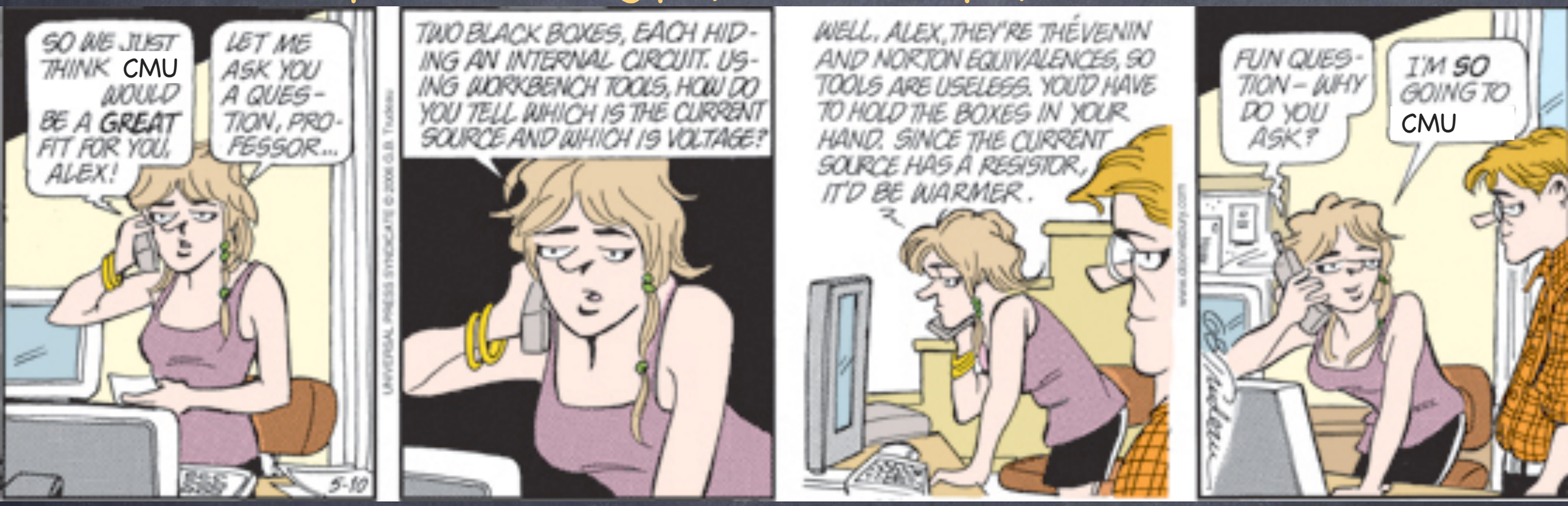
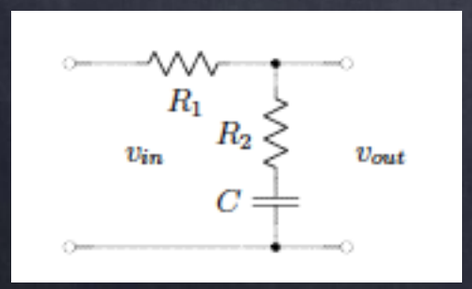
Electronics - Physics 33228

http://www-meg.phys.cmu.edu/physics_33228



Doherty Hall A324



Electronics - Physics 33228

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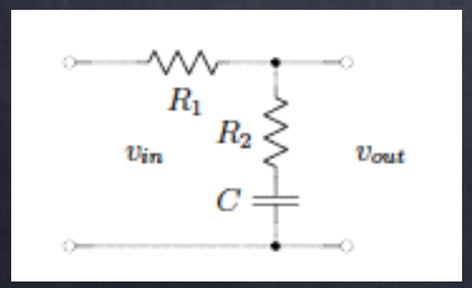
Spring Semester, 2016

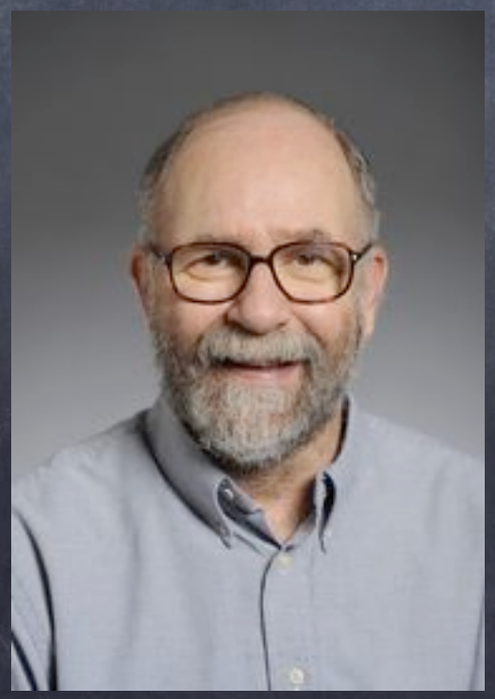
Lecture: Tues. & Thurs. 9:30 to 10:20
Wean Hall 5403

Lab Sec. A Mon. & Wed. 1:30pm-4:20pm
Lab Sec. B Tues. & Thurs. 1:30pm-4:20pm
Doherty Hall A324



Instructors

Professor Curtis A. Meyer
Wean Hall 8414
268-2745
cmeyer@cmu.edu



Professor Tom Ferguson
Wean Hall 7402
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tf0s@andrew.cmu.edu

Professor Curtis Meyer

Ph.D. University of California, Berkeley

Wean Hall 8414

cmeyer@cmu.edu

(412) 268-2745

www.curtismeyer.com

Experimental Nuclear and Particle Physics

Quark Interactions

My research is carried out at the Thomas Jefferson National Accelerator Laboratory (Jefferson Lab) in Newport, News, VA.

"Why are quarks forever trapped inside protons and neutrons?"

The GlueX Experiment: www.gluex.org

Professor Tom Ferguson

Ph.D., University of California, Los Angeles

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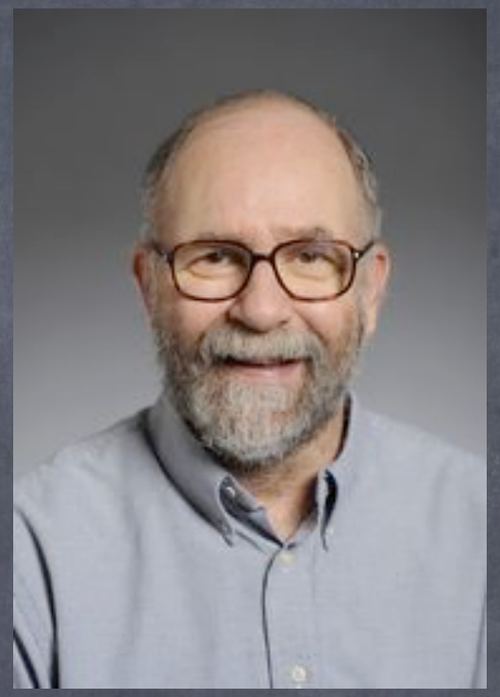
tf0s@andrew.cmu.edu
(412) 268-2744



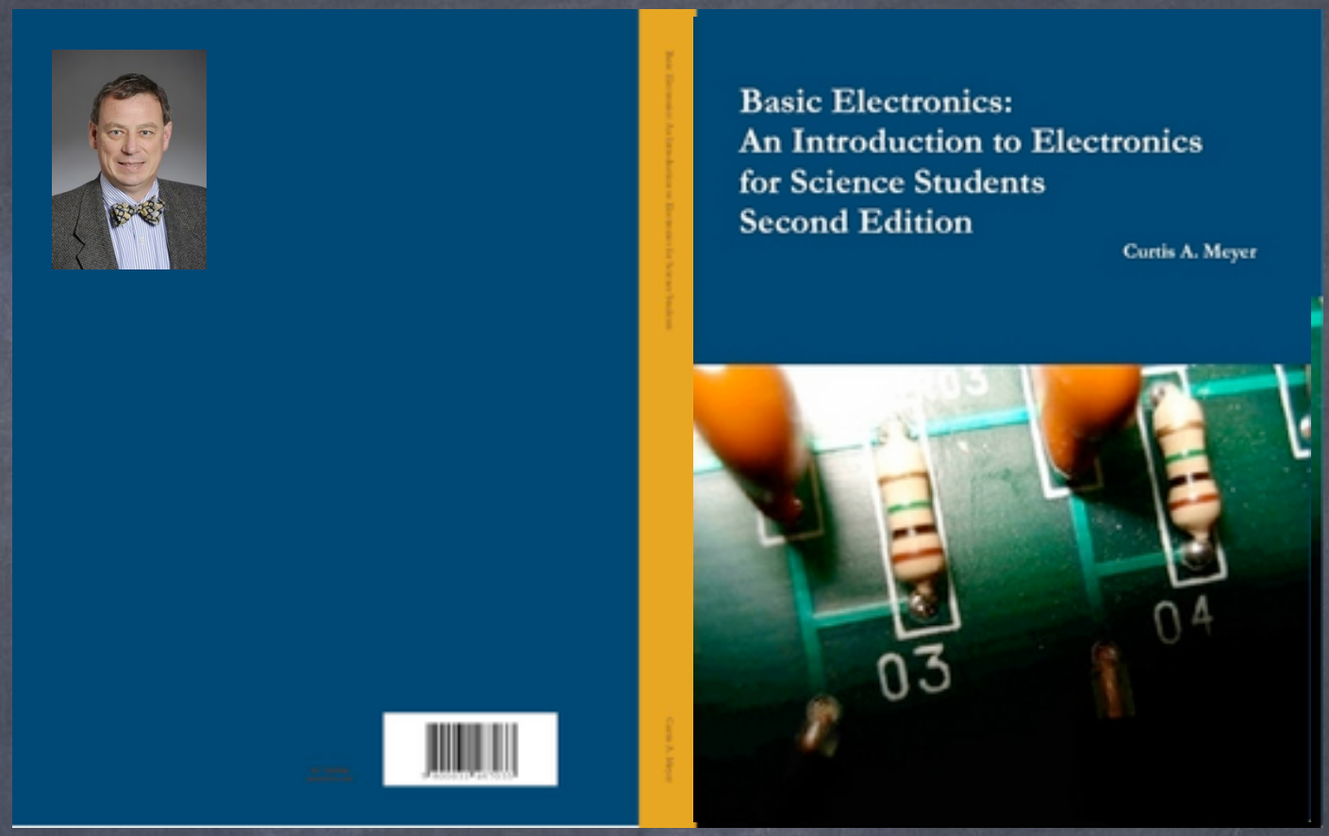
High Energy Particle Physics

My research is carried out at the European Reseach Accelerator Center (CERN) outside Geneva, Switzerland, using the Large Hadron Collider (LHC).

Why do elementary particles have the properties that they do, and are they the ultimate constituents of matter?
CMS Experiment, http://cms.web.cern.ch/

Textbook

Basic Electronics:
An Introduction to Electronics
for Science Students
Second Edition
by Curtis A. Meyer



You will need to purchase the book from the on-demand publisher, lulu.com
http://www.lulu.com/spotlight/curtisameyer

Reading and homework assignments are listed on the course web site. Labs will also refer directly to the textbook.

You will find it very useful to bring your textbook to lab with you.

Course Grade

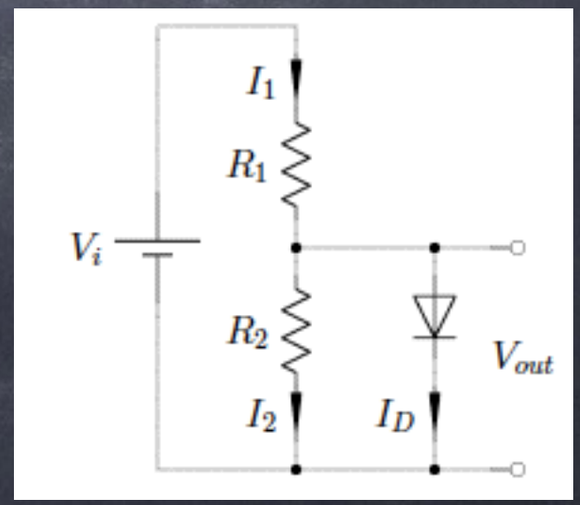
Grade Weighting:

Laboratory Notebooks	55 %
Laboratory Participation	10 %
Lab Quizzes	20%
Homework + Pop Quizzes	15%

Grade Cutoffs:

Between 89% and 100%	A
Between 79% and 88%	B
Between 69% and 78%	C
Between 56% and 68%	D
Below 56%	R

(cutoffs can be lowered)

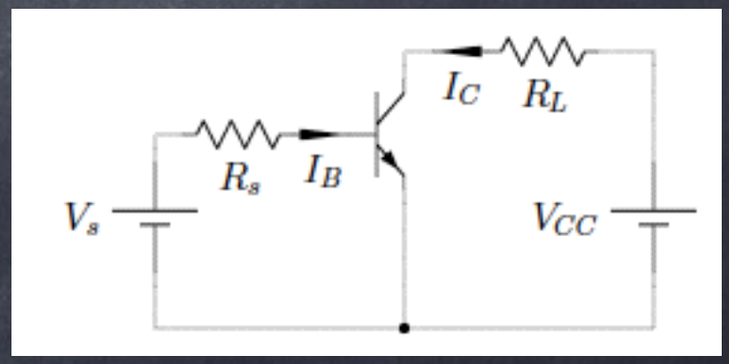


Homework

Homework assignments are listed in the weekly activities on the course web site. The assignments tend to be longer at the start of the semester when labs are easier. As the labs get harder, we will have less homework. All problems are from the text book.

We encourage you to work together on the homework, but you are required to turn in your own work.

No late assignments will be accepted without the prior approval of an instructor.

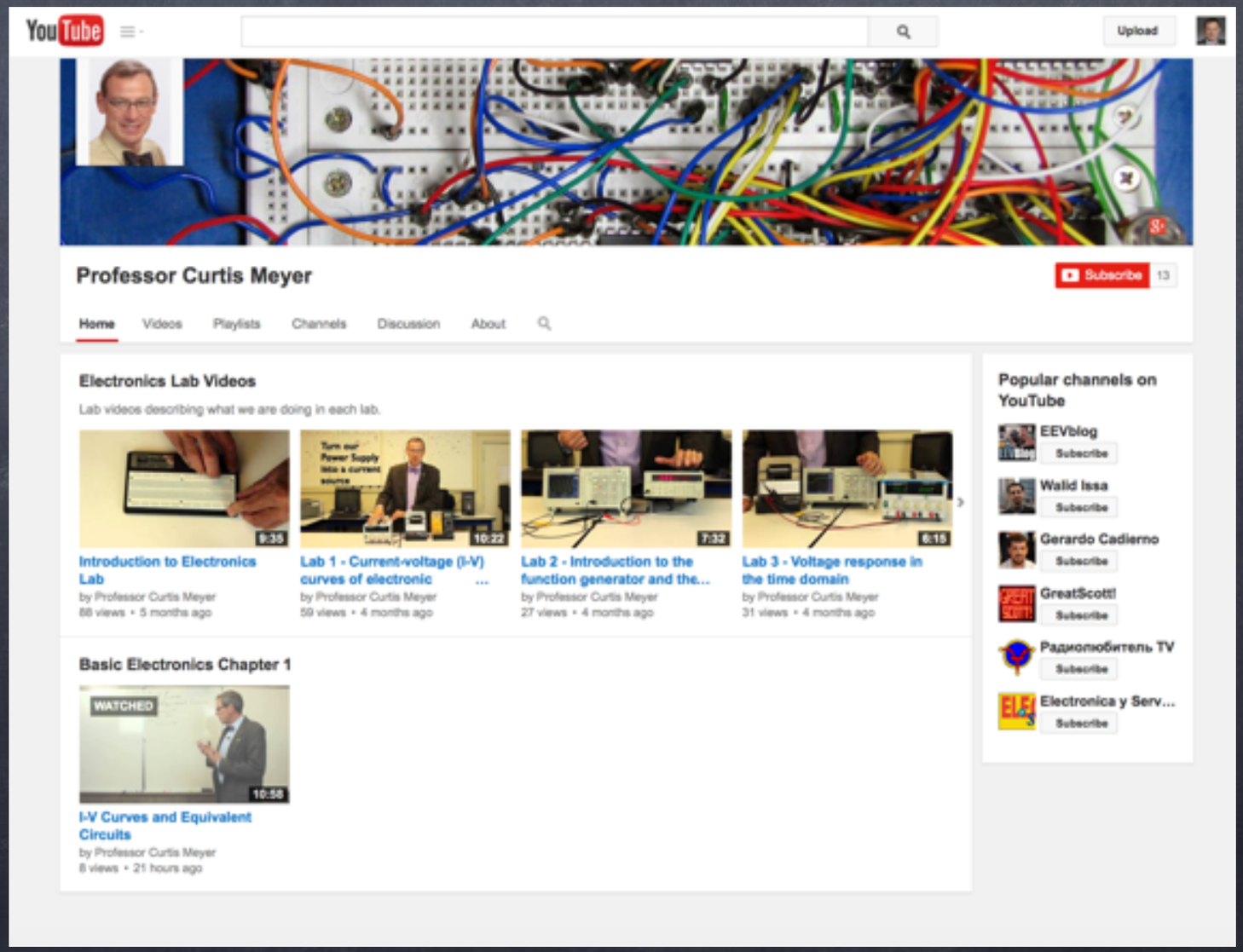


Lab Work

The primary component of this course is the lab. You will have six hours per week in the lab, and if you take advantage of this, you should be able to avoid working on your lab outside of the lab itself.

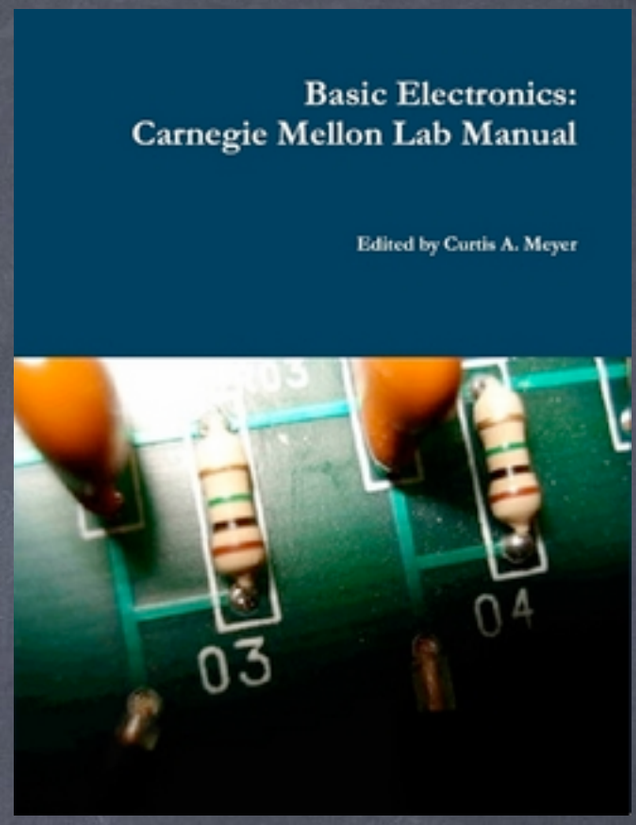
Lab Videos on YouTube

https://www.youtube.com/channel/UCbRal13mz8zToBrNG0X3ExQ



Lab Manual

You will need to get the lab manual from the on-demand publisher, lulu.com. You can purchase a spiral bound version or download a pdf for free.
http://www.lulu.com/spotlight/curtisameyer



Make sure that you come to lab prepared:

Look through the lab in advance.
Watch the lab video in advance.
Do the pre-lab work before starting.
Show up on time.

Do your analysis in the lab:

Computers are available in the lab, but feel free to bring your own laptop if you want. Analysis and plotting is done in excel. During lab, you can get quick feedback from instructors on your work.

Lab Books and Normal Lab Reports

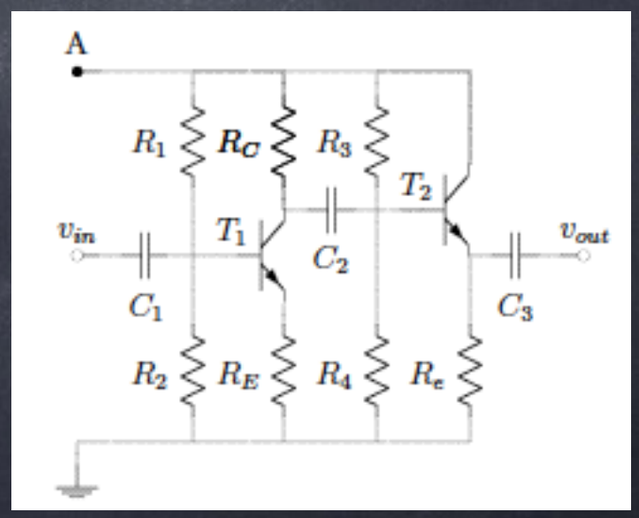
A normal lab report should be a self-contained report that has enough information for someone to repeat your work without outside references. DO NOT simply copy the lab handout, briefly summarize what you are doing and always show circuits. BE SURE to list the values of components used.

Watch the video on keeping a lab book.

You should not need to recopy your lab. Simply take a little extra time as you collect your data, and leave blank spots where you feel you may want to add something later.

Make computer generated plots of your data and neatly trim them to size and glue or tape them in your lab book. It is essential that your plots be accurately labeled.

Do NOT staple things in your lab book.



Grading Lab Books

Chapter 1

DC Elements and Measurements

Reference Reading: Chapter 1, Sections 1.3, 1.4, 1.5 and 1.6.
Time: Two lab periods will be devoted to this lab.
Goals:

1. Become familiar with basic DC ("direct current": zero frequency or constant bias) elements, measurements, and responses.

2. Become familiar with I-V curves for several (linear and non-linear) elements we will use throughout the semester.

3. Become familiar with power dissipation computation and the power limitations of real devices.

4. Be able to replace a circuit element with a "Thévenin equivalent" circuit which has the same I-V curve.

5. Test the basic circuit theory of linear devices developed in class and the textbook, most importantly, the voltage-divider equation and Thévenin's theorem.

Expectations:

1. In each section, you are expected to provide a neat table of the data that you measured where you clearly label what each data set is and include units for all measured quantities. You are expected to clearly record the measured values of any components that you use.

2. You are expected to make your final plots in a program such as Excel. Make sure that your data points appear clearly on the plots, that all axes are clearly labeled and have units. These plots should be neatly attached using tape (not staples) into your lab book.

3. If it is possible to compare your measurements with an expectation or a prediction, you are expected to do so. *E.g.* does the slope of the I–V curve of a resistor agree with the measured resistance?

4. You are expected to answer the questions encountered in this manual in your lab write up. You do not need to include answers to the "additional problems" at the end of the lab, however, those questions have been taken from a quiz over this lab from a past semester.

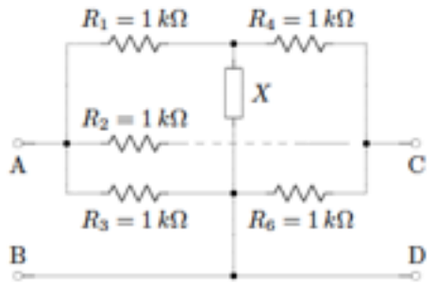
Grading Lab Books

Appendix E

Sample Lab Report

Purpose

In this lab, we will be measuring the input and output resistance of the circuit shown to the right. The input resistance, R_{in}, of the circuit is the equivalent resistance that a DC voltage source would see when connected to the A and B terminals. The output resistance, R_{out}, is the Thévenin resistance, R_{th}, as measured between the C and D outputs of the circuit. The component labeled X in the circuit will be both a 1 kΩ resistor and a blue light-emitting diode (LED).



The Input Resistance Measurement for $X = R_5$

Procedure

(1) We start by building the circuit shown above, where X is a resistor, R_5. For this, we have chosen precision (1% tolerance) 1 kΩ resistors, whose values we have measured using an ohmmeter.

$R_1 = 0.998\,k\Omega$ $R_2 = 1.004\,k\Omega$ $R_3 = 0.994\,k\Omega$
$R_4 = 0.994\,k\Omega$ $R_5 = 0.997\,k\Omega$ $R_6 = 0.997\,k\Omega$

(2) To measure the input resistance, R_{in}, we will connect a variable DC voltage source (0 to 12 V) to the input terminals, A and B. Using an ammeter, we will measure the current, I_{in}, flowing into the resistor network, and using a voltmeter, we will measure the input voltage, V_{in} between the input terminals A and B. For these measurements, we have the circuit, as shown below.

(3) We will now vary the input voltage from ≈ 0 to 12 V in 2 V steps and record the voltage and current as measured by our two meters.

Appendix D

Lab Reports

D.1 Sections in a Lab Report

Your lab work will be recorded in a lab book that is provided in lab. Do your preliminary lab questions in this book and then have an instructor sign off when you have completed them. Your actual work should be recorded in your lab book in ink, although you may tape in printouts of data spread sheets and computer-generated plots of your data. A lab book should roughly follow the following organization.

1. Your *preliminary lab questions* with an instructor's signature to verify that this has been accurately completed. This accounts for **10%** of your lab's score.
2. An *introduction/purpose* for the lab which identifies the goals of the lab. This should be at most a three-to-four sentence description of what you will be doing, and what you expect to learn from the lab. This accounts for **5%** of your lab score.
3. A *procedure* of how you did this lab. This should be a short description of how you set up the lab. It **MUST** include relevant circuit diagrams. It is also a good place to include the measured values of all the components that you are using. Finally, you should summarize the measurements that you will be making. *eg* "We will measure the frequency response of the circuit by using a measured input signal and scanning over a frequency range from 1 to 1,000,000 Hz. We will measure the input voltage, the output voltage and the phase difference between the input and the output using our oscilloscope." Do not write a novel, but write enough information that you can set up and repeat your measurement using only your lab book. If there are multiple sections to the lab, you need a procedure for each section. This accounts for **10 to 20%** of your lab score.
4. Your *data and preliminary plots* show the data that you collected. This should contain the data that you collected during the lab. It is either in hand-written, properly labeled tables, or from a printed out spreadsheet. Be sure this is labeled including units. This section can also contain neat, hand-drawn sketches of the data to help identify where you need to collect additional data points. These are not your analysis plots, they only help you identify when the data are changing rapidly and allow you to collect additional points if needed. Finally, if there were problems encountered during data collection, mention them here, and describe how they were resolved. This accounts for **10 to 30%** of your lab's score.
5. Your *analysis and discussion* of your data is a very important part of your lab. This section should include computer-generated plots of your data. If possible, you should also overlay the expected theoretical curves on top of your data and comment on where things agree and disagree. For major disagreements, there should be some additional discussion as to why this occurred. This

D.2 Grading Rubric for a Lab Report

Section	Excellent	Good	Poor
Purpose or Introduction	Concise statement of what you will doing in the lab. Brief description of what theory or property is being tested. Length is at most one paragraph. A table of contents is provided to the other sections in the lab report.	A rough statement of what you will doing in the lab. Mentioning some of theory or properties being tested in the lab. Overly lengthly, but covers most of the important points.	A vague statement of what you will doing in the lab. Mentioning little of theory or properties being tested in the lab. Missing several important points.
Procedure	A neatly drawn circuit diagram. A clearly labeled list of measured components and their values next to the circuit diagram. A brief statement of how the components have been measured. A statement of what you will measure, and the equipment that you will use to make the measurement. A list of special or unusual equipment settings that you used.	A circuit diagram. Measured values of components are given. A statement of what you will measure, and the equipment that you will use to make the measurement.	A circuit diagram. Vague or little information on what you did, or how you made the measurements.

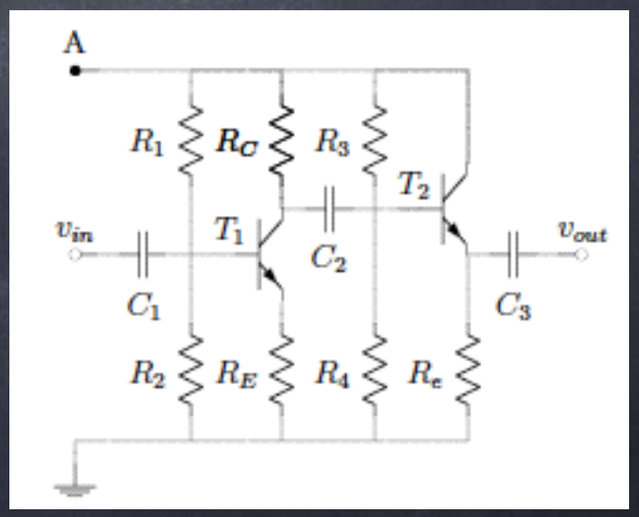
Lab Quizzes

During the lecture on the Thursday when a lab report is due, we will have a 25 minute quiz over the material in the lab.

You are allowed to use your lab report during the quiz. The only allowed inserts in your lab book are the neatly trimmed and attached plots. You will be asked to remove all material that is not properly attached in the report before the quiz.

At the end of the quiz, you will turn in your quiz and your report.

Questions from old quizzes are at the end of each lab.



Final Comments

If you participate in the labs, don't miss classes and turn in reasonable and legible work on time, you will do very well in this course. It should be straightforward to earn a B grade.

This course has a lot of instructor contact, so we will know all of you, and also know who is doing work in the lab. Make sure that this is not all one-sided.