University of Utah
Electrical & Computer Engineering Department
ECE 1250 Lab 1

Introduction

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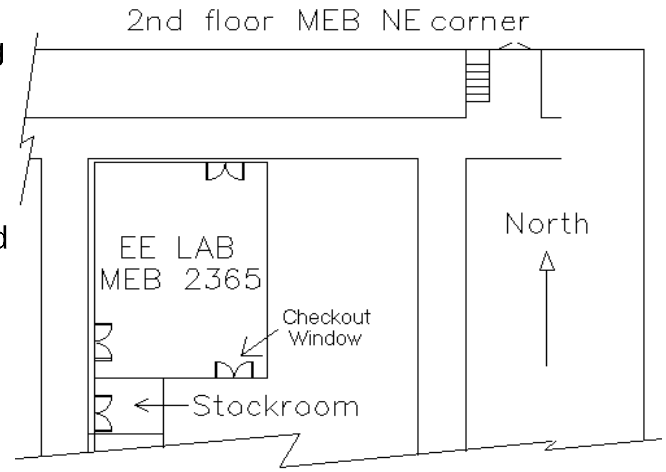
Rev.

Objectives

1. Teach the student to keep an engineering notebook.
2. Talk about lab practices, check-off, and grading.
3. Introduce some lab bench equipment.
4. Show how power supplies, voltmeters and ammeters, are used.
5. Teach good data reporting and graphing.
6. Introduce Matlab by plotting data.



Parts to be supplied by the student:

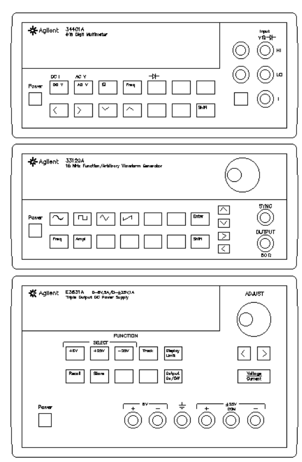
- Lab notebook for this and all future labs.
- Two 50Ω 5W resistors (These may be available in a small box or other container near the checkout window for unofficial borrowing. If the container is empty and you need to buy one, you may wish to leave it in the container for other students as you won't need it again in this class.)

The electrical parts may be purchased from the stockroom. You can buy parts using your U-Card or a lab punch-card, but not with cash.

Check out from window:

- 1157 Light bulb with leads

Choose a workbench space with an Agilent or HP 34401A multimeter and an Agilent or HP E3631A DC power supply, perhaps grouped in a cluster like the one shown at right. (You may use different equipment but then you'll have to modify the specific instructions found in this lab and may need another multi-meter.)



General

TA Lecture

Your lab instructor will present a short lecture at the beginning of lab. Take notes in your notebook either as part of lab 1 or preceding lab 1. Lecture topics:

- Introduce him or herself to the class.
- Inform you of his or her lab notebook policies, due dates and late policies, and drop off locker number.
- Show you how to apply for lab access from your "U" card.
- Show you how to buy parts and supplies using money on your "U" card.
- Show you how to check out equipment and get leads.
- Talk about your lab notebook and checkoff.

Lab Notebook
As engineers many of you will be paid to do research, development, and invention. The companies that employ you may be interested in obtaining patents on these developments. In patents, timing is important—you've got to be first, and you've got be able to prove it. A well-kept engineering notebook can be used in court as part of your proof. The number-one purpose of a true engineering notebook is to keep an accurate, chronological record of your work, and ***you*** may need to keep one someday for your high-paying job. Many non-R&D jobs also require a similar notebook for record keeping or billing purposes. In this class you'll need to keep one to get a grade. We're going to pretend that it's job training.

Keeping a true engineering lab notebook, acceptable in court, is fairly involved. You need to write everything in ink, all pages must be numbered, dated, and signed by others, etc. etc.. By these standards we'll be quite lax in this class. But we will pay particular attention to the following things:

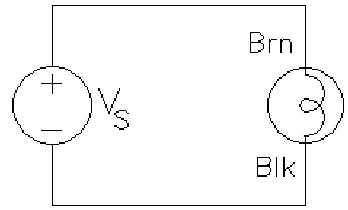
- Work in your lab notebook at lab time—no scribble sheets for data so that you can "write it down neatly later." Before you leave the lab you will need to get your instructor to (check-off) initial your book. Your TA will look for work in the notebook. Some or all of your notebook may be graded at this time.
- Write clearly.
- Describe what you do in lab in such a way that you could repeat the lab again later without referring to a handout.
- Follow the guidelines on the "Lab Notebook" handout for procedures, data, and conclusions.
- Use lots of drawings, tables, and graphs, and label them well. Often these are both easier to create and better than written text. Especially, Draw circuit diagrams of everything that you build.
- Answer the lab handout questions and make requested comments in the form of complete sentences.

My main objectives are that you to work in your notebook, and that you make that work useful for later reference.

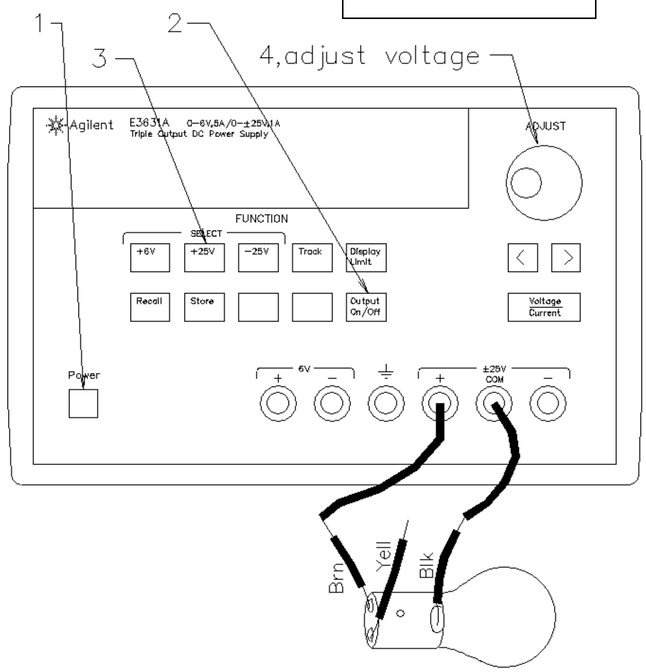
Check-off:
When you are finished with your lab, you should call your lab TA over to check you off. At this time, you should be able to demonstrate a working circuit, answer questions about what you did, and show your finished notebook. You may get part or all of your lab grade right on the spot. Check-off becomes a problem if you ever miss your normal lab time, so try not to. If you have to miss a lab, make arrangements with your TA to make it up. Most TAs will accept a check-off from another TA or from me.

Experiment
Your lab instructor may work together with the whole class and write example notebook entries on the whiteboard for some part of this section. You may wish to follow along or you may go ahead on your own.

Note the circuit shown in the schematic at right. To help you construct the first few circuits, I'll include drawings like the one below the schematic. Soon you'll have to make circuits given only the schematic, so make an effort to learn how to interpret them.

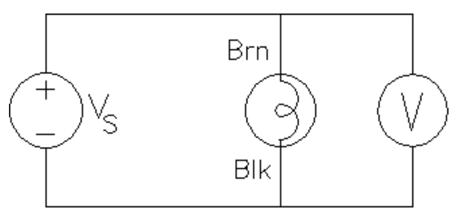


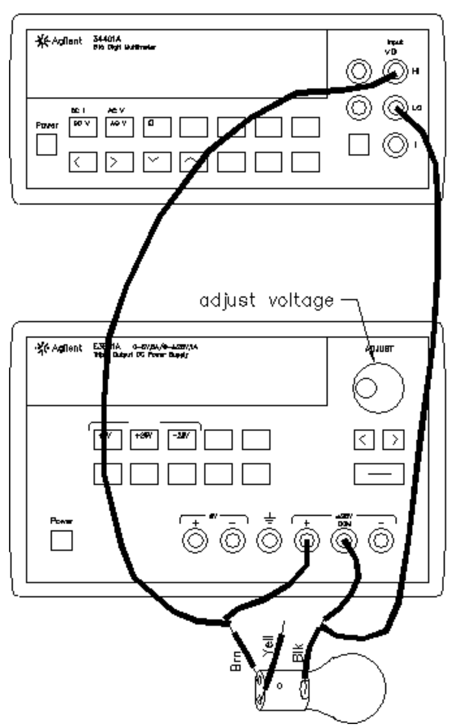
Construct the circuit shown. Use the black and brown leads of the light bulb. For V_S, use the +25V and COM outputs of an Agilent E3631A DC power supply. 1, Turn it on, wait for it to show "OUTPUT OFF". 2, Hit the "Output On/Off" button and 3, the "+25V" button. 4, Use the knob to turn up the voltage until the light bulb is lit, but is not very bright. (Note: the voltages that we will use in this lab are quite safe. You are unlikely to even feel them unless you touch your tongue or and an open wound to the connections. So, handle them all you want, but don't lick them... yeechh.)



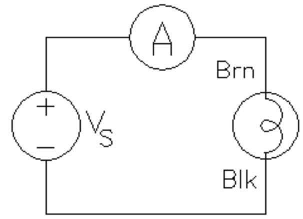
Note how the power supply displays the voltage and current. Try disconnecting the bulb for a moment to see the current drop to zero while the voltage remains almost the same. Feel the bulb with your fingers and note that it is getting warm. Take this as a warning that with higher voltages, it will get quite hot. Heck, try it. Feel the bulb as you turn up the voltage to 14V. Don't hold on long enough to get burned. Turn the voltage back down to a less irritating level. As always, you should draw the circuit and make some comments in your lab notebook about what you did and what you observed.

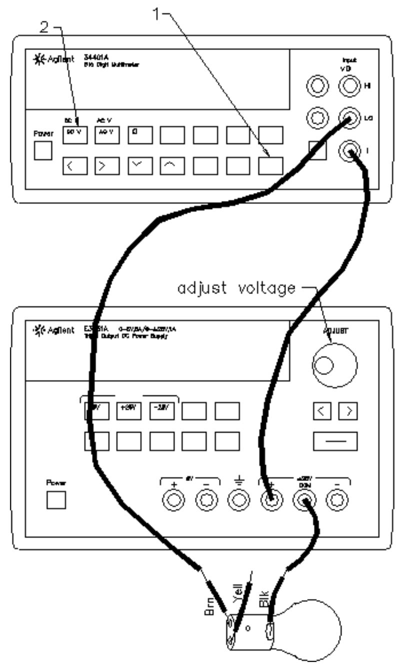
Next, you'll check Kirchhoff's voltage law. Add a voltmeter to the circuit (shown as a circle with a V) and see if the voltage across the resistor is the same as the voltage at the power supply. Hook up a Agilent multimeter and turn it on. It will "wake up" as a voltmeter. Adjust the power supply to several different voltages from 0 to 14V. Is the voltage across the resistor the same (within a few %) as the power supply voltage? If yes, you may rely on the internal voltmeter within the power supply from now on. Try moving the voltmeter leads to the power supply connections. Can you find a non-ideal item(s)? Probably, but the difference will probably be negligible. Remember... make drawings and comments.





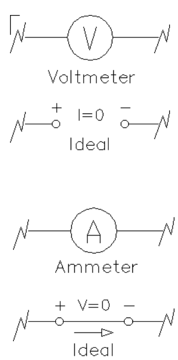
Now you'll use the multimeter as an ammeter and make a new circuit. The ammeter is shown as a circle with an A. Notice that it is wired in the circuit so that the current must flow *through* it. Before rewiring your circuit, turn off the output of the power supply (hit the "Output On/Off" button). An ideal ammeter is a very low resistance and it is very easy to "short" the power supply while rewiring. Once you have the new circuit, 1, hit "Shift" and 2, "DC I" on the multimeter and turn the power supply output back on. Try some different voltages. Can you now read the voltage on the power supply and the current on the multimeter? (Note: If the circuit no longer works, ask your TA to check your circuit and/or replace the fuse in the Agilent multimeter.) Is there some advantage to using the multimeter? Remember... make drawings and comments.





Meters

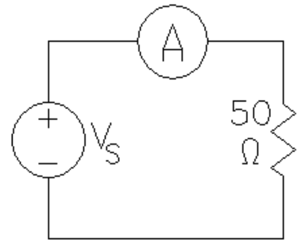
A voltmeter measures the voltage difference **ACROSS** it. An ideal voltmeter acts like an open circuit (no connection) and can be connected between any two points in the circuit to show the voltage (potential) difference between those two points. They are fairly hard to misuse unless you're dealing with high voltages—and we'll try to avoid that in here. The registrar doesn't like it when we kill tuition sources.



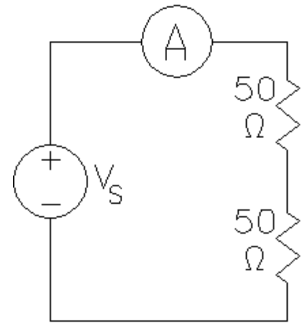
An ammeter, however, is very easy to misuse. An ammeter measures the current that passes **THROUGH** it. An ideal ammeter acts like wire. A wire in the wrong place is known as a short circuit (a direct, low resistance connection, usually unwanted). An ammeter makes a connection, and if you're not careful, you'll make a connection that you don't want. To use an ammeter; make your complete circuit first, then open part of the circuit and replace a wire or connection with the ammeter. The key phrase here is *open up*. If you aren't breaking open some connection in order to insert the ammeter, then you're doing something wrong.

Take a set of measurements of at least 7 different voltages and currents from 0V to 14V and record them in a table (if you make the table big enough to add 3 more columns you'll save some future work). Calculate the resistance at a low voltage and again at the highest voltage. Do these calculations make sense– does a light bulb have resistance like a resistor? Does it obey Ohm's law? It turns out that the resistance of most materials is a function of temperature. Is it a positive coefficient of temperature or a negative one? Calculate the power used by the bulb at 14V. Where do you think most of that power going, to light, or to heat?

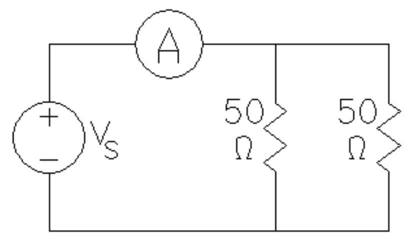
Create a current (I, mA) v.s. voltage (V, volts) graph or plot from this data by hand. Be sure to label everything well and draw your graph accurately and to scale. Make it clear what circuit these measurements refer to.



Turn down the voltage and replace the bulb with the 50Ω, 5W resistor. Take another set of measurements at the same voltages as the bulb and record them in the same or a new table. Add this data to the existing plot and label the new line. Very carefully feel the temperature of the resistor. Calculate the resistance at a low voltage and again at the highest voltage. Does it pretty closely obey Ohm's law? Why isn't the temperature affecting the resistor so much? Calculate the power used by the resistor at 14V. Where is that power going? Remember...(last reminder).



Turn down the voltage and replace the single resistor with two 50Ω, 5W resistors in series. Take another set of measurements at the same voltages as the bulb and record them in the same or a new table. Add this data to the existing plot and label the new line. Calculate the resistance at the highest voltage. Do series resistors add up? Calculate the power used at 14V. If each resistor can dissipate 5W, What is the new rating of this ~100Ω resistance?



Turn down the voltage and replace the single resistor with two 50Ω, 5W resistors in parallel. Take another set of measurements at the same voltages as the bulb and record them in the same or a new table. Add this data to the existing plot and label the new line. Calculate the resistance at the highest voltage. What is the equivalent resistance? Calculate the power used at 14V. If each resistor can dissipate 5W, What is the new rating of this ~25Ω resistance?

Matlab (This section was written by Neil Cotter)
Refer to the attached pages in order to use Matlab to make the same four-line plot that you have already made by hand. Notice that the data he is plotting is not quite like your data-- Plot YOUR data, not HIS, and don't try to fit a straight line to the bulb data. Make notes in your notebook to help guide you with plotting the next time you need to do it. When you've printed your plot, trim it and tape or glue it in your notebook.

Conclude
Call your lab instructor over to check you off. Usually you do this before you tear down your final circuit. Be prepared to discuss your measurements, calculations, and conclusions and to show off your notebook.

Write a conclusion in your notebook. Make sure that you touch on each of the subjects in your objectives. Mention any problems that you encountered in this lab and how you overcame them.

This sort of check-off and conclusion will be required at the end of each lab, even if it's not specifically asked for in the lab handout. Before leaving, make sure everything is turned off and return the stuff you checked out.