Physics 231 Laboratory Syllabus

Magic is any sufficiently advanced technology.
- Arthur C. Clarke

Lab Spacetime: Mondays 10:10 – 12:05 in Nielsen Physics 510 (section 71096)
TA: Bradley Wogsland (bwogslan@utk.edu)
Tutoring Center: Mon 11:15- 3:30 Nielsen Physics 203 (I'll be in there 12:10 – 1:20)
Tues-Thurs 11:15 – 4:35 Nielsen Physics 203
Fri 11:15- 3:30 Nielsen Physics 201
Text: *Selected Introductory Physics Experiments* by James E. Parks
Physics Labs Webpage: http://www.phys.utk.edu/physlabs.html
Lab Class page: http://web.utk.edu/~bwogslan/emag/phys231.html

Schedule of Labs:

Jan 24	Electric Fields
Jan 31	Ohm's Law
Feb 7	Instrument Amplifier
Feb 14	Wheatstone Bridge
Feb 21	Resistance vs. Temperature
Feb 28	Electrical Energy
Mar 7	e/m Ratio
Mar 14	Ampere's Law
Mar 28	RC & RL Circuits
Apr 4	Oscilloscope
Apr 11	AC Circuits I
Apr 18	AC Circuits II

Lab Grade: 11 Lab Reports (equally weighted except the last which counts twice)

Scale: 90-100 A
80-89 B
70-79 C
60-69 D
0-59 F

Laboratory Objectives
The laboratory component of your physics course has many objectives. Some important ones are:

- **Experience with scientific apparatus:**
This ranges from being able to read instrument scales, to knowing safety hazards, to effectively using specific pieces of equipment, to using computerized data acquisition systems.
- **Data analysis:**
How do you assess whether theory and experiment are in agreement? You will become familiar with the formal procedures associated with data analysis such as propagation of errors and linear regression analysis. You will also use a spreadsheet on the lab's personal computers for data analysis.
- **Communication skills:**

You should learn how to present your results in a written report. Guidelines below…

• **Physical concepts:**

The lab should reinforce the physics from your lecture courses.

Ground Rules

Attendance

You must attend each laboratory period and do all experiments in your assigned section. In general, you will **not** be permitted to do your experiments in another section. An exception may be made only in cases of dire necessity with the prior approval of the instructors of the assigned section and of the section in which you would like to transfer.

Make-ups

The last week is usually reserved for make-ups. Missed labs can only be made up if there is a documented medical or family exigency. Usually only one (but no more than two) make-up experiment is permitted. Because of end-of-term pressures it is better to avoid needing any make-ups. If you know in advance that you cannot attend a particular lab session, speak to your instructor. It may be possible to do the experiment at some other time.

Penalties for Missing Reports

Failure to do and/or turn in a report on an experiment will result in a grade of zero for that experiment. Two labs or less may be made up (if excused) by making an arrangement for doing so with the lab instructor (see above). In well-documented emergencies a grade of incomplete ("I") may be possible. In the case that several severe emergencies resulted in missing two or more experiments the student should apply to the Office of the Dean of the College for permission to withdraw from the course with a hardship grade of "W."

Preparation

Before each laboratory you are expected to read the experimental write-up and any related sections of the text so that you are familiar with the theory and the experimental procedure. As it is often impossible to have the laboratory come after the relevant material has been discussed in lecture, you will often have to read ahead in your textbook. *If the write-up has prelab questions, these will be collected at the beginning of the lab period,* graded, and returned with your laboratory write-up.

Promptness

It is important to arrive at the start of the laboratory period. The instructor uses this time to give any information not in the write-up and to warn of any possible safety hazards or pitfalls in performing the experiment.

Conduct

Eating, drinking, and smoking are not permitted in the laboratory. Of course, loud talking and disruptive behavior are also prohibited.

Partners

Generally, you will work with one partner. When necessary, groups of three may be permitted. Rotate the experimental tasks so that each partner becomes familiar with all aspects of the experiments, e.g., do not have one partner take all the data while the other does all the recording or analysis.

Data Sheets

Each partner must have his or her own data sheets. They should list the name of all partners and the date performed. The data sheets may come from the writeup, a spreadsheet printout, or you may have to write up your own data sheets. All

necessary data should be on these data sheets. All data (single item and tabulated) should be clearly labeled with a *description* of the number and its *units*, and when appropriate, its *uncertainty*. If you use the spreadsheet printout, put the partners and date at the top and put data labels and units at the top of each column -- you can even do this by hand, if necessary. The instructor can check to see that the data appears reasonable. Graphs made in the lab during the experiment make it much easier to detect errors or omissions. **Guard the data sheet -- it is the only proof that you performed the experiment.**

Repeating All or Part of the Experiment

If the instructor finds a report unacceptable, it may become necessary to repeat all or part of the experiment. In this case, a new data sheet should be filled out with the required data and initialed by the instructor. The report should be resubmitted with any revisions in the analysis, conclusions, etc. that are warranted.

Checking Out

If you finish early, begin preparing the laboratory report. In some cases, you may be able to finish it in class. Clean up your area, leaving it as you found it, unless specified otherwise. Groups coming after you should expect to find all the equipment in working order. If something broke during your experiment, report it to the instructor so a replacement can be found.

Writing the Lab Report

Your lab write-ups are to be turned in at the beginning of the following lab session. Begin each of the following topics on a separate page using additional pages as necessary. It should contain the following information:

a. Title page: A title page should include the following: (1) the name of the experiment, (2) your name, (3) the name of your partner, (4) the course name and number, (5) the section number, (6) the name of your lab instructor, (7) the date the experiment is performed, and (8) the date the report is submitted. Make sure the partners listed on this page are those with whom you performed the experiment.

b. Purpose and method: This should be short: a paragraph or two describing what measurements were made and for what purpose. You are trying to show that you understand the relationship between the experimental procedures and the theory. This can sometimes be fairly obvious or simple and may only take a sentence or two. Procedural details should not be given, unless they are in some way original or non-standard.

c. Data tables: The original or photocopies of the original data sheets, collected in class and initialed by the instructor, should come first. Neatened or expanded versions of the data with additional derived quantities may come next. Once again, remember labels, units, and uncertainties.

d. Calculations, including **Error analysis**: Whenever possible calculations should be done in the lab. Include in your calculations the units associated with any variable and, where appropriate, cancel units or change them to derived units (e.g., change kg·m/s2 to N). Describe and show all work. If you do the calculations with the spreadsheet, remember to put labels and units on any additional columns, and state in the report how these columns were calculated.

e. Graphs, when appropriate, should include a title, and axis labels with units. These should also be done in the lab, if possible. If straight line fitting is performed on the data, either by hand or with a linear regression program, remember to record the slope and intercept and their uncertainties. Draw in the regression line determined from the slope and intercept. Whenever possible put error bars on each graph point.

This is too tricky to do with the spreadsheet program -- so you may have to add them after the printout from the spreadsheet has been made. If the error bars are too small or data points are difficult to see on the graph, put a small circle around each one.

f. Conclusions: This should include a brief discussion of the main findings. For example: "We found that there is a linear relationship between the measured variable … and … This can be seen from the graph and is predicted by the theory." Also state whether your results agree with expectations to within the uncertainties of the measurements: For example: "The slope of the graph of … versus … as determined by (linear regression, hand fitting) was …±… (units). This value, together with Eqn. …, and the measured quantities …=…±… (units), and …=…±… (units), allowed for a determination of …=…±… (units). This is within … standard deviations of the accepted value of … (units)." Discuss the *main* sources of error. "The main sources of uncertainty in the determination of … are …."

g. Questions: Answer all questions posed in the handout.

General Laboratory Guidelines

We will do all we can to give you a quality experience in the physics laboratory. Please feel free to submit suggestions or complaints about the lab to your instructor or to Dr. Parks – his mailbox is in the main office, Room 401. However, obtaining a quality lab experience is ultimately up to you. You should take care that the data you obtain is the best possible. Make graphs of the data while you are in the lab and compare them with other groups'. Show them to the instructor. Do all the calculations in the lab, including the error analysis. The spreadsheet program is handy for this. Before you leave the lab, you should know whether the theory and experiment are in agreement.