

This course is the junior/senior capstone laboratory course for physics majors.

INSTRUCTOR: Jim Napolitano email: tuf43817@temple.edu
ASSISTANT: Maya Desai email: maya.desai@temple.edu
WEB PAGE: <https://faculty.cst.temple.edu/~tuf43817/PHYS4796/>
MEETINGS: SERC 225 Tue & Thu 2:00-4:50 PM

COURSE OBJECTIVES

This course has three different learning goals, all equally important.

- **Learn new physics.** Many of the experiments in this laboratory cover physics that you have not explicitly studied in other courses.
- **Learn how to do experiments.** There is an art to making accurate and precise measurements and you will find the ways that work for you.
- **Learn how to write.** Complete and succinct communication of scientific results is one of the most important things all scientists need to learn.

TEXTBOOKS AND OTHER RESOURCES

We will not follow any particular textbook, and you're not required to buy anything, but I want to point your attention to three things in particular.

- “An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements”, 3rd Ed. (2022), by John R. Taylor
- “Experiments in Modern Physics”, 2nd Ed. (2003), by Adrian C. Melissinos and Jim Napolitano
- “Resource Letter ALC-1: Advanced Laboratory Courses”, by Walter F. Smith, American Journal of Physics 92, 648–654 (2024)

Links to each of these are provided on the course web page. Taylor's book is excellent, and I strongly recommend you get a copy, particularly given the updates in the third edition. I list the second book only because I'm sure I'll refer to it from time to time. The AJP article has many useful references to books, articles, and report writing. Recall also Chapter 9 of the “Concepts” textbook we developed in PHYS2502 Mathematical Physics.

WORKING IN THE LAB

You'll work on the experiments with a lab partner. You can keep the same partner throughout the term, or if you want to switch at some point, tell me and we'll work something out. It's important for you to work together to take the data and record your results. If one of you is working on an experiment alone, please provide an explanation.

The experiments will always be available for you to work on during regular class hours, Tue & Thu 2:00-4:50 PM. If you need access after hours, we can make the necessary arrangements, but in those cases it is absolutely required that there be at least two people in the laboratory.

LAB NOTEBOOK

You need to keep a lab notebook, which I will inspect and grade from time to time. This will serve as your diary for all of the work you do in the lab, and you will find it to be an invaluable reference when you write up your lab reports. Lab partners are allowed to share a notebook if you like. I will be looking for neatness of records and organization when I grade the notebooks, but remember this will be your main reference for your report. In addition to identifying your name(s) and the experiment, you want to keep a record of everything you did including the dates and times at which you did them.

One option is a hardbound notebook with grid lines on the pages, for example the National Brand 1-Subject Computation Notebook (Staples Item #567644). The grid lines are useful for making plots by hand as you take data so that you can identify trends quickly. You may keep your lab notebook online if you prefer, but you need to provide me with a URL where I can find it, or periodically upload it to Canvas where I can see it.

Do not take your lab notes on loose pieces of paper with the aim of transcribing them to something else later. You will be surprised to see how often you will be glad that you kept everything you neatly and clearly wrote down in the order in which you wrote things.

LAB REPORTS

Every student needs to turn in their own report on each of the experiments. You will turn in **five lab reports** over the course of the semester. The due dates for first drafts and final versions of these are indicated on the schedule (below). The due dates are strict; you will lose credit for late reports. **Please take these due dates seriously.**

Try to keep your reports under ten pages long, double-spaced in 12-point font with one-inch margins (or the `fullpage` option in \LaTeX), including figures, tables, and references. **Twelve pages is an absolute maximum.** You can say a lot with a good figure, so as written¹ by William Strunk, “Omit unnecessary words” in the text and figure captions.

A report template is posted on the course website. You are welcome to be creative with this, but some aspects (title, date, lab partner, abstract, reference, . . .) of it are required. (You can guess which, but see me if you have questions.) I have also posted the \LaTeX files I used to generate the template. You don’t need to use \LaTeX to write your report, but I recommend it. There are plenty of free \LaTeX engines, or you can use the `OVERLEAF` website.

You should also look at some journal articles written by professional physicists. The articles in the American Journal of Physics are generally very well written. See also the research articles in the Physical Review, although articles in Am.J.Phys. are generally better written.

It is important to include references. See how this is done in various journal articles. In the template, I use the `BIBTEX` package, which is useful if you want to build your own reference database, but there are more straightforward ways to add references. **Please note that websites are not valid references.**

On the specified due dates, you will first hand in a draft which I will critique and also grade, and a week later you will hand in the final report which is graded separately. The reports must be in PDF file format submitted to Canvas.

¹Strunk & White, “Elements of Style”. E.B. White went on to write *Charlotte’s Web*.

CLASS SCHEDULE

This class focusses on the laboratory experiments, with at least two weeks allotted for each of the five experiments. There will be no regular lectures, but I will often start class with a discussion about some relevant topic. These are indicated in the schedule below, although the details will likely change over the course of the term.

Week	Tuesday	Topic	Experiment	Report Due (by 5pm on Thursday)
1	14 Jan	Analyzing a data list	Lab #1 (Group)	—
2	21 Jan	Fitting to models	Lab #1 (Group)	—
3	28 Jan	Elementary circuits	Lab #2 (Group)	Lab #1 Draft
4	4 Feb	Op-Amp circuits	Lab #2 (Group)	Lab #1 Final
5	11 Feb	—	Lab #3 (Independent)	—
6	18 Feb	—	Lab #3 (Independent)	Lab #2 Draft
7	25 Feb	—	Lab #3 (Independent)	Lab #2 Final
Spring Break: No Meetings				
8	11 Mar	—	Lab #4 (Independent)	Lab #3 Draft
9	18 Mar	—	Lab #4 (Independent)	Lab #3 Final
10	25 Mar	—	Lab #4 (Independent)	—
11	1 Apr	—	Lab #5 (Independent)	Lab #4 Draft
12	8 Apr	—	Lab #5 (Independent)	Lab #4 Final
13	15 Apr	—	Lab #5 (Independent)	—
14	22 Apr	—	Final measurements	Lab #5 Draft
Thursday 1 May				Lab #5 Final

Remember: The due dates are strict. If you want to get your draft or final report in earlier, that is perfectly fine, and I will review and grade it sooner.

Details of the experiments are posted on the course web page.

Everyone will do the same first and second experiments. The first is simple physics, but is a good exercise in precision measurement. The second has to do with basic electronics and how to use an oscilloscope to take data.

For the third, fourth, and fifth experiments, you will have your choice of a number of options. (Maya and I will be working on these the first few weeks of the class, so we can decide which are in good enough shape for you to make measurements.) If more than one pair of partners wants to do the same experiment, negotiate with each other to figure out who goes when.

GRADING

There is no homework and no final exam. Your grade will be based on your lab notebooks (30%) and your draft and final lab reports (70%). There is an obvious subjectivity in grading, so I will only use letter grades with grade modifiers, and average these together for your course grade.

Every day a report is late will cost you a letter grade for that report. If you really have a problem meeting the deadline, see me as early as possible before the due date, but I am going to insist that you have a good reason for needing the extra time.