Advanced Physics Laboratory (PHYS 175)

Lecture and Lab: Sequoia 140
M, W 2:00 PM – 5:00 PM

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Office Hours: Tues/Thurs 10:00 – 11:00
and by appointment

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Office Hours: Tues/Thurs 11:20 – 12:00
and by appointment

Course Summary

Physics 175 is a "quasi-capstone" course for physics majors. In this course, students are expected to hone and demonstrate their physics knowledge in a laboratory setting. Emphasis will be placed on developing your laboratory skills, data analysis techniques, scientific writing, and oral presentation. Data collection and analysis will be done in groups, as is the majority of experiments performed today. It is important to learn how to work efficiently and effectively in such an environment.

The prerequisites for 175 are: Physics 106, Physics 115 or 145, and six additional units of upper division physics. If you feel that you need to take this class without these prerequisites, please be prepared to explain why.

Required Texts

John R. Taylor, An Introduction to Error Analysis, 2nd Ed. University Science Books, 1997. (ISBN: 0-935702-75-X)

Laboratory Notebook. The bookstore has several options, but please don't bother with the NRC paper type (i.e. self copying) – they are really messy. A low-cost option is a grid paper composition book.

Access to spreadsheet software is imperative in this class. If you do not have EXCEL, consider getting it (bookstore has student priced version) or another package. (Open Office has a fairly high powered spreadsheet available for free download at www.openoffice.org). The Physics Electronics/Instrumentation Lab has EXCEL on its computers.

Familiarity with Mathematica or another mathematical package is very useful.

Modus Operandi

While this class is largely laboratory based, the first couple of weeks of the semester will concentrate on lectures on data analysis and presentation. Homework will be assigned during the first four weeks of the semester. This homework will give you the opportunity to practice your data analysis techniques prior to needing it in your lab reports. Homework should be done individually.

Once we begin the experiments, you will be broken into small groups. Each group will rotate through a series of experiments. The schedule will be provided at the end of the first week of classes, you will not do every single experiment. Each experiment has multiple parts to it and is given two weeks (four lab sessions) to complete. The data collection for each experiment should take no more than three sessions (some will take only two). You should use the remaining time to reduce your data on the computers. It is your opportunity to get guidance from Drs. DeGraffenreid and Sergan. The final experiment is given an extra half week because it will be your formal report (see below).

Some of the experiments will be guided by Sergan, others by DeGraffenreid. The names of the experiments and their guide are listed below:

Geiger Counter	Sergan
Gamma Ray Spectroscopy	
Lifetimes	
X-Ray	
Oil Drop Experiment	DeGraffenreid
Atomic Spectroscopy	
Molecular Spectroscopy	

There is to be no eating or drinking in the nuclear physics room or in the optics suite. Failure to follow this rule will result in a grade of 0 for that experiment. You may have beverages in rooms 138 and 140, so long as you clean up after yourselves. If we have any problems with a mess, all food and beverages will be banned.

Grading

Homework 20 Points

Each homework assignment is worth 5 points, based on the following scale:

5 – Good Effort on all problems
3 – Marginal Effort on problems
1 – Minimal Effort on problems
0 – No homework turned in

Informal Lab Reports 10 Points Each

The first five experiments will have informal reports. They are described in the appendix that follows. Each informal report is worth 10 points, broken down as follows:

3 Points – Performing experiment (Penalties for unsafe, shoddy & inefficient work)
3 Points – Analysis (Did you do what you were asked? Did you do it right?)
2 Points – Writing (Are work and results clearly explained in good English?)
2 Points – Presentation of results (Quality of figures/graphs/tables)

The informal reports are due 1 week after the scheduled completion of the experiment. Each person will turn in their own report. Late reports will be penalized ½ point per day (up to 3 points).

Formal Lab Report & Presentation 50 Points

The final experiment for the semester is designated for the formal report. The experiment is to be performed by and analyzed by the group as a whole. Only one written report will be turned in by each group. A 25 minute presentation on the experiment will be given by the group during finals week (Wed 5/19).

The report should be much more detailed than the informal reports – akin to a journal article, with a detailed introduction, background, procedure, and results. The report is due at the time of the presentations (during finals week). The report is worth 30 points will be broken down as follows:

7 Points – Analysis
6 Points – Performing Experiment
6 Points – Writing
6 Points – Presentation of results
5 Points – Background research

Late formal reports will not be accepted.

The presentation is worth 20 points. It should be designed in the model of a talk to an audience of people with a strong background in the general field of your experiment, but not with people who have actually performed the experiment. Think of it as a presentation at a conference of professionals, they know enough to ask good questions, but not enough to answer the questions. The presentation can be made by an individual or a group, but the message should be clear. You may use, but are not required to, PowerPoint for your presentation.

You must also turn in a self analysis of your group's work. It is a brief report signed by all the members of the group describing their individual contributions to the work. It will not affect the grade on this experiment; however, the details contained in it may contribute to the instructor evaluation portion of your grade. Failure to turn in the self analysis will result in a 50% reduction of your formal report and presentation scores.

Laboratory Notebook 15 Points

You are required to keep a notebook in which you record your activities. The notebook should be a record of how you set up the experiment and of your observations. This includes all of your notes and preliminary

thoughts. Write everything directly in your journal, not on individual pieces of paper you might or might not remember to tape in the journal. Describe what you are doing and why, as you go. Refer to computer-based analysis by including file names. You should tape in graphs and results from spreadsheets. Keep in mind also that diagrams and sketches are often much easier to sort though than text. Why write five sentences when one well-drawn sketch will tell you much more?

Lab notebook is due by the time of your group's presentation.

Instructor Evaluation	15 Points

A portion of your grade will be based on our observations of your work as well as the information contained in your group's self analysis. Elements considered will be efficiency in lab (don't waste time), contribution to experiment (don't let partner do all work), queries, and general laboratory skills. Continuous improvement as a scientist is what we look for here.

Estimated Total Possible Points	150 Points

We intend to use standard percentages in assigning grades: A = 90-100%; B = 80-90%, etc. However, we will take into consideration the distribution of scores prior to making a final decision.

Academic Dishonesty Statement

The Department of Physics and Astronomy has unanimously approved the following statement:

"The faculty of the Department of Physics and Astronomy will not tolerate academic dishonesty. Falsification of data, copying, unauthorized collaboration, plagiarism, alteration of graded materials, or other actions (as described in, but not necessarily limited to the Sacramento State Policy Manual) *will be promptly reported to the Office of Student Affairs.* The offending student will be penalized on the assignment in question. Serious infractions will result in course failure and a recommendation for administrative sanctions."

If you have any questions regarding this statement, please come and speak with either DeGraffenreid or Sergan. This class is probably the most likely to tempt you, students in this class have been sent up to academic affairs before; please don't let it happen this semester.

Additional Information

If you have a disability and require accommodations, you need to provide disability documentation to SSWD, Lassen Hall 1008, 916-278-6955. Please discuss your accommodation needs with me after class or during my office hours early in the semester.

Appendix: Reports

Informal Report

The written lab report should present a description of the experiment, an analysis of the errors involved, and a discussion of the data and the conclusions that can be drawn from the experiment. Be sure to appropriately cite references!

An appropriate format for a report follows. For a particular experiment not all of the suggestions under each title may apply, but most of the time they will.

I. Introduction
   What is the purpose of the experiment? Include a summary of the theory behind the work.

II. Description of Experiment
   Describe the apparatus used (possibly a sketch of the apparatus with important dimensions), definitions of symbols used, circuit diagrams, etc., as needed for the description.

III. Data
   Include sample data, summaries of data collection, graphs, measurements and other pertinent data. Large quantities of raw data should be included as an appendix. Possibly use photocopies of data from your journal.

IV. Calculations
   Include data analysis and interpretation, and calculations of experimental uncertainties. If there is an unusual or complex calculation include a detailed sample of the calculation.

V. Discussion of Results and Conclusions
   What quantities have been measured? What implications do your results make in terms of testing physics principles or laws? How do your measurements compare with known, published or accepted values? You might also want to include comments on how the experiment could be improved. That is, what could you have done to get better values or more reliable results. (Also are there improvements that could be made in the instructions?)

Formal Report

Before starting to write a formal report you should refer to the AIP Style Manual (available online in pdf format: http://www.aip.org/pubservs/style.html). You should also look up articles in the Physical Review, the Journal of the Optical Society of America, Applied Physics, etc. that report on experimental work. From any computer with a csus.edu domain you can access most of the major physics journals thru Eureka on the CSUS Library webpage. Look them over to get a handle of the format for such papers. You will most likely find the following sections with some possible variations: Abstract, Introduction, Experimental Description, Data Analysis, Results and Conclusions. There may be more sections, but rarely fewer. As always, you must give proper credit when referring to other people's work.

A typical format follows with some comments:

I. Abstract
   This briefly summarizes what was done and found, usually in a manor that allows those somewhat familiar with the field to tell what the paper is about.

II. Introduction
   This section will give the purpose of the experiment. It will contain theory appropriate to the experiment and background material about the experiment. Assume the reader has a basic understanding of physics, but isn't necessarily an expert in the area of your research.

III. Experimental Description
   Describe, in some detail, the apparatus and how it was used in the experiment. In order to describe the experiment you will need to include sketches of the apparatus and block diagrams of the electronics used. Assume the reader has no prior knowledge of the experiment.

IV. Data Analysis
   All the important data needs to be included here. There must be a discussion of the accuracy of the data. Both statistical and systematic uncertainties must be discussed. The method of analyzing the data needs to be discussed (if appropriate).

V. Results
   The results of the experiment and the analysis of the data are given here and discussed.

VI. Conclusions
   If there is a "prior" measurement to which your work can be compared, do so here. Discuss any deviations and give reasonable explanations for discrepancies. If the results will drive the future research (theory or experiment) discuss why here.

VII. References
   Any works cited in the above section need to appropriately cited. For journal articles, this is usually done via inline numbering.