PHYSICS 122 LABORATORY
(Spring, 2018)

COURSE GOALS

1. Learn how to perform scientific experiments.
2. Learn how to perform data (including error) analysis and presentation.
3. Learn how to write a scientific report.

PROFESSORS:

Xiangdong Zhu 237 Physics zhu@physics.ucdavis.edu

TEACHING ASSISTANTS:

Clark Travaglini 104 Physics hctrav@ucdavis.edu

MEETING SCHEDULE:

MW 3:10 PM - 6:00 PM, 154 & 156 Roessler Hall
Labs are accessible Monday through Friday, 9 AM – 5:00 PM (via 156 Roessler Hall)

COURSE WEB-PAGES: http://122.physics.ucdavis.edu

1. Manuals and Prelabs in "**Experiments**" Section
2. Reports and Curve-fitting in "**Reports**" Section

REQUIRED AND RECOMMENDED **TEXTS (see below for *required* AMPAD lab book)**:

1. **Philip R. Bevington and D. Keith Robinson,** ***Data Reduction and Error Analysis For the Physical Sciences***, 3rd edition, McGraw-Hill, 2003. [HIGHLY RECOMMENDED]
2. ***Adrian C. Melissinos, Experiments in Modern Physics, Academic Press, 2003.*** [REQUIRED] (Old 1966 edition: UCD Library call number: QC33 M52)
3. W. R. Leo, *Techniques for Nuclear and Particle Physics Experiments*, Springer-Verlag, 2nd Edition. (UCD Library call number: QC793.46 L46)
4. D. W. Preston and E. R. Dietz, *The Art of Experimental Physics*, Wiley, 1991.
5. J.H. More, E.C. Davis, M.A. Caplan, Building Scientific Apparatus, 4th Ed., Cambridge, 2009.

ELECTIVE EXPERIMENTS:

Ferro-electricity
Hall Effect in Doped Semiconductors
Zeeman Effect in Atomic Spectra
Optical Pumping in Rubidium Vapors

COURSE DESCRIPTION (prerequisites: Physics 9 labs, 104A, 105A, 110AB, 115A, 112)

One week of Counting Lab is followed by one week of Electronics Labs. TWO Elective experiments (3.5 weeks per experiment) are to be completed over the rest of the Quarter. One may perform experiments with one partner. Each student writes his or her own lab report. Based on students' preferences and the requirement that no more than two students should be on the same experiment, each student will be assigned two elective experiments..

Before each lab meeting, students must perform pre-labs as the homework (on http://122.physics.ucdavis.edu/?q=node/24). Pre-lab write-ups are due at the beginning of each class. Pre-Labs generally require a day of work or more.

Lab reports are due on dates as shown the Lab Calendar on the 122 webpage and below. They should be written in the style of a journal article (see the detailed description below).

GRADING POLICY

The counting lab report is worth 10 points; and each of the two main elective experiments is worth 40 points. **NO LATE REPORTS WILL BE COLLECTED.** Finally, 10 points of your grade will be based on Prelab exercises, your lab notebook, and the electronics labs. Letter grade will be partially based on in class performance including teamwork.

LAB CALENDAR

Starting dates of the three experiments are indicated below. Lab report due dates in **bold** and **red**.

Week	Dates	Activity
#1	4/2	Pre-lab for Data Analysis due. *Data Analysis* (presentation and errors) and Curve-Fitting. Geiger Counter calibration with ^{137}Cs source
#1	4/4	Pre-lab for Nuclear Decay due. *Nuclear Counting Lab (Radioactivity of background and ^{137}Cs) Introduction to Kaleidagraph: plotting and weighted curve-fitting*
#2	4/9	Pre-lab for Electronics due. *Electronics Lab with RLC AC circuits.*
#2	4/11	*Electronics Lab with Pulses*. **Nuclear counting report due 2 PM**.
#3	4/16	*1st Elective experiment starts*
#6	5/7	**Draft of 1st Elective Lab report due 2 PM**
#6	5/9	*2nd Elective experiment starts*
#7	5/14	**1st Elective Lab report due 2 PM.**
#10	6/6	**2nd Elective Lab report due 2 PM.**

LAB NOTEBOOK (these will be checked and graded):

You are required to have a special lab notebook. In the lab notebook, you will record (1) detailed description of YOUR experimental set-up (everything!); (2) procedures that YOU use to obtain the data; (3) YOUR data; (4) symbolic and numerical analysis of the data including the relevant theory and equations. For data acquired by a computer, you may paste or staple tables or plots into the notebook. The objective is to have all of the important information written down so that (1) the experiment can be reproduced if desired; (2) you can identify mistakes made during design, execution and analysis, and potential sources of errors; (3) you can learn why you are successful and why you fail; (4) you may later realize that you have made an important discovery. MAKE ENTRIES IN PEN ONLY. You can cross out mistakes.

Special notebooks are available at UCD Bookstore: AMPAD Computation Book, 4x4 quad ruled, 9-1/4 11-3/4 in., spiral bound, numbered pages. Note: this particular notebook is *required.* Aim for at least 20 pages per experiment.

PREPARING THE REPORT ON YOUR EXPERIMENT:

Your laboratory report should be as professional as possible. Use the supplied Physical Review article format. Examples of good reports (on other experiments) will be available. A colleague of yours, new to this course, reading your report should be able to understand your experiment and carry it out based on your report. Do not write a cook book ("do this, then do that"), rather outline the physics question, the experiment design, your procedure, error analysis, data analysis, results, and conclusions. In particular, your report should contain in essence the following sections in addition to a brief descriptive title:

(1) (**5 points**) *Abstract:* a brief summary of the experiment and the results (including statistical and systematic error estimates) obtained.

(2) (**20 points**) *Introduction:* stating the motivation for doing the work and spelling out the goal of the work to be performed, and then describing in some detail the theoretical background behind the experiment.

(3) (**20 points**) *Experimental setup and procedure*: clearly stating why they are adequate for the proposed goal of the experiment, sufficient for another student to understand what you have done. Explain hardware method of signal detection and error reduction (experiment design.) List data collection runs or procedures.

(4) (**35 points, 15 points designated to error analysis**) *Results and Analysis:* displaying the processed data that are essential to the goal of the experiment, stating briefly how the original data are processed or analyzed before being displayed, and importantly, making comparison of the processed data with the theoretical expectation as partly outlined in the *introduction* section. Be sure to include error analysis of the data, and show error bars on graphs. (don't display the unprocessed raw data--those should be in your lab notebook! All graphs need axes, tick marks, units, and descriptive captions.)

(5) (**15 points**) *Discussion*: From the results obtained, have you achieved the goal set in *introduction* section? Explain. Do the results support the understanding of the subject within experimental uncertainties? Again, explain. Suggest possible improved experiments which could result in greater precision.

(6) (**5 points**) *Conclusion*.

(7) *References.* Published journal articles, books, etc. relevant to this experiment, including experimental techniques, electronics, data analysis, and statistics. Full author, title, etc.

The figures, with *fully descriptive captions*, should be inserted in the text. Make your own figures. Use of the work of others, without attribution, is scientific misconduct. The Physical Review style is recommended, and may result in a higher grade. You may use either Tex or Word, single spacing. See the 122 web page for examples and a style file.

Experiment Preference	1st	2nd	3rd
Ferro-electricity of TGS			N/A
Hall Effect in Semiconductors			N/A
Fundamental Noise (not offered)			N/A
Nuclear magnetic resonance (not offered)			N/A
Pulsed NMR of Protons (not offered)			N/A
Zeeman Effect of Atomic Spectrum			N/A
Balmer Series of Hydrogen (not offered)			N/A
Optical Pumping in Rb vapor			N/A
γ-Ray Spectroscopy (not offered)			N/A
Rutherford Scattering (not offered)			N/A
Muon Lifetime (not offered)			N/A

Physics 122 Lab sign-up Sheet

Chose experiments from 122A only for Spring of 2018