Instructor:

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Texts:

- *An Introduction to Error Analysis*
  by John R Taylor (University Science, 1997)

- http://www.physics.csbsju.edu/370/
  http://www.physics.csbsju.edu/stats/

Grading:

Your grade will be determined by averaging seven scores: electronics workshop score, 3 lab notebook scores and 3 oral lab report scores. Lab notebook grades are based on what is recorded in your lab notebook. Please be complete and legible! For this COVID year you may omit the usual purpose and theory sections; just include methods, data, analysis, and results. Assigned lab/analysis work is generally due at the beginning of the following experiment. Your corresponding oral reports should be scheduled soon after the start of the next experiment. All work contributing to your grade must be turned in by: Friday 18 December.

Oral Lab Report:

Each of your experiments must be presented as an individual, brief, oral presentation to your lab instructor. Select one of the poster subtopics (there are usually two or three subtopics per lab report, see page 143) associated with a lab. Assemble the required hardcopy plots, figures, and data tables much as you would for a poster, but they need not be 'poster perfect'. (Poster text blocks like Abstract, Methods & Materials, etc. are not part of this performance: your words with associated artifacts must convey what you did.) Prepare a ∼5 minute talk summarizing what you did (what/how did you measure? what were your results? what final conclusions did you draw from your data?...). Prepare for a few minutes of questions from your instructor. Schedule a time to make your presentation (a solo performance with just you and your instructor). Tack your materials on an available blackboard and make your 'elevator pitch' to your instructor. Your performance will be graded on a four point scale: 4=A, 3=C, 2=D, 1=F. A 4 is 'awesome'...you could teach this material!; 3 means no mistakes were made; 2 and 1 denote various levels of failure: from simply incomplete to mis-reporting facts. Achieving awesome results on your first try is rare; you have up to two repeats (generally on different days) to improve your grade. Commonly lab partners will select different lab subtopics of a particular lab and work together to hone what are in the end individual separate performances on related but different subtopics. However, there is no requirement for you to work together.

Questions:

There is no such thing as a dumb question. Questions asked during lecture or lab do not "interrupt", rather they indicate your interests or misunderstandings. The aim of lab is to do things you've never done before; it's no surprise if you've got questions.

Remember: you are almost never alone in your interests, your misunderstandings, or your problems. Please help your classmates and yourself by asking any question vaguely related to physics lab. If you don't want to ask your question during class, that's fine too: I can be found almost any time on the 100-level floor of Engel Science Center.

Times/Locations:

Half of this course will be self-scheduled. I hope many of you will still choose to do that work in the scheduled slot, because you can be then sure to find me (i.e., help) at those times and it will help you avoid the crime of procrastination. However, because of limited lab equipment, in fact you cannot all perform the data collection simultaneously. Of course, data analysis (which usually takes much longer than data collection) can be done simultaneously. Four or more weeks are scheduled for each lab! Much of the actual data collection and analysis will take place in the suite of labs adjacent to my office. The first class meeting will be in the electronics lab: PE116; with luck you'll also be taking data at the observatory.

Half of this course will meet at the scheduled time: lab lectures and workshops. The scheduled room (the astronomy lab room PEngel 319) is used only for lab lectures. If you cannot attend at those times, the responsibility of mastering the material falls on you. (An alternative class time—agreed to by all—would also be fine.) Note that lab lectures typically run a bit more than an hour, which leaves plenty of time to **start the lab immediately following the lab lecture**.

"Do I have to do my lab work during the scheduled lab period?"

The answer is "No, but be forewarned:" three years ago about 10% of the students did not complete this course because they did not turn in the required reports at the required time. If you do not procrastinate and actually put in the scheduled four solid hours[1] of lab work per week, I'll work with you to make sure you complete labs on time. Again: the lab is scheduled for 8:00 A.M. to 12:00 M. once per week, if you arrive in lab at 9:00, fiddle around in lab and leave at 11:00, you are doing half the required work and 50%=F.

Lab Notebook:

Your lab notebook is the primary, graded work-product for this course. It should represent a *detailed* record of what you have done in the laboratory—complete enough so that you could look back after a year or two and reconstruct your work just using your notebook and this manual. Your notebook should include sketches and diagrams to explain the experiment,

[1] i.e., hours when I'm immediately available to answer to your questions and not counting time spent on your cell phone, web browsing, waiting for your lab partner, etc.. . .

data collected, comments on difficulties, self-documented spreadsheets, sample calculations, data analysis, fit reports, final graphs, final results, answers to questions asked in the lab manual, and a critique of the lab. For this COVID year you may cut some of the usual boilerplate: there is no need to repeat methods or theory found in our lab manual. Each lab's 'Checklist" starts with a request for you to "Write an introductory paragraph. . . "; For this COVID year these are just suggestions for preparing for your oral report— you need not actually write out such paragraphs in your lab notebook. Similarly 'Checklist' requests for you to derive an equation can be ignored.

DO NOT collect data on scratch paper and then transfer to your notebook. Your notebook is to be a running (dated!) record of what you have done, not a formal (all errors eliminated) report. There will be no formal lab reports in this course. Do not delete, erase, or tear out sections of your notebook that you want to change. Instead, indicate in the notebook what you want to change and why (such information can be valuable later on). Then lightly draw a line through the unwanted section and proceed with the new work.

Be Prepared!

In this "Advanced Lab" you will typically be combining some fairly advanced physics concepts with equally advanced instruments and at the same time be working 40 hours per week on another class. It will be quite easy to be overwhelmed by the theory and the instrumentation. Your main defense against this tsunami of information is to *read and understand the material before the lecture/lab.* I know that this is difficult: technical readings never seems to make sense the first time through. But frankly, one of the prime skills you should be developing (i.e., the prime skill employers seek) is the ability to read, understand, and act on technical documents. In 191 you were told to: *Read aggressively!* Read with a pencil in hand so you can jot down questions, complete missing steps of algebra, and argue with the author. (In this case you can actually take your complaints, comments, and arguments to the author, rather than imagining how the author would respond.) A significant problem is that readings (in contrast to lectures) generally aim at getting the details right. But details obscure the big picture and misdirect attention. This leads to the suggestion of "skimming" the material. . . which is OK as long as that's just the first step to understanding. I usually instead start by reading for detail, but bit-by-bit my confusion grows and I switch to skimming. But then I repeat the process from the start. After several repeats, I usually reach a point where I'm not making progress, and I find I must do something more active like: talk to somebody about the material, or try to solve a problem—perhaps one of my own design. The aim is to try to find out why the author thinks his points are the important ones.

Catalog Description & Goals: Research and experimentation for juniors. Topics selected by the student in consultation with a faculty member. May be repeated for credit when different experiments are done.

1. Students will conduct experiments and analyze their data using appropriate tools and methods of error analysis.
2. Students will effectively communicate their findings in a variety of formats using appropriate figures and equations.
3. Students will gain knowledge of specialized areas of physics.

Schedule:

Class		Date	Topics
1	W	Sep 2	Electrical Measurements Lab[a] Meet in room PE116.
2	W	Sep 9	[b]
3	W	Sep 16	Lab Lecture: Bubble Chamber & Photometry[c]
4	W	Sep 23	
5	W	Sep 30	
6	W	Oct 7	
7	W	Oct 14	Lab Lecture: Thermionic Emission, Fortran, GPIB
8	W	Oct 21	
9	W	Oct 28	
10	W	Nov 4	
11	W	Nov 11	Lab Lecture: Langmuir Probe?[d]
12	W	Nov 18	
13	W	Dec 2	
14	W	Dec 9	
15	W	Dec 16	

[a] Read "Electrical Measurement Review"! Answer the questions specified on page 21

[b] Read Chapter 0

[c] ASAP schedule a few nights for data collection at observatory

[d] Only if observatory observations were not possible.