

# Physics 3302/3312

## Advanced Laboratory I/II

### Fall 2019

(2019.08.18)

**Instructor:** Dr. Lloyd Bumm, Nielsen Hall 123/Lin Hall 231, 325-6053

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Office hours: by appointment

Location: NH123/LH231

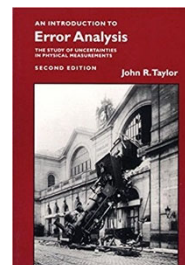
**TAs:** Christopher Leonard, Nielsen Hall 240

E-mail: [Christopher.A.Leonard-1@ou.edu](mailto:Christopher.A.Leonard-1@ou.edu)

Office hours: by appointment

Location: NH240/NHB25

**Textbook:** John R. Taylor, *An Introduction to Error Analysis*, 2nd ed. (University Science Books, 1997).



**Lab Notebook:**



5x5 Quad Ruled  
20# Heavyweight Paper  
[80 graph paper pages]  
(the OU bookstore has  
these for about \$3.50)  
You need two lab notebooks.

**Class Website:** <http://canvas.ou.edu/>



**Course Description:** Physics 3302 and 3312 form a two-semester sequence in experimental science. Advanced Lab is a key inquiry based course for physics and astronomy majors. The learning goals of the course are to become proficient using modern experimental equipment and techniques, engage in the beginnings of experimental design, learn how to analyze data in statistically significant ways, keep a comprehensive lab book, prepare detailed professional laboratory reports, present experimental work in a coherent and concise way, understand scientific ethics, transition students to more independent research and establish connections between experimental and theoretical physics. All of these learning goals are important and many of them are only addressed in the advanced laboratory course.

The skills that are taught in advanced laboratory are particularly important for preparing you for the jobs you will have upon graduation, for graduate school, and for bridging the gap to more focused undergraduate research. You will learn the beginnings of becoming an experimental physicist in the course. The most important things you will learn are, not the physics in each experiment, but how to do experimental physics.

**Prerequisites:** Phys2303 or permission from the instructor.

## **Communication**

**Email:** When contacting your professor or TA via email, be sure to include the course name (Adv Lab) in the subject line and your full name in the body or the signature of your message. Incoherent, confusing, or inappropriate emails will be ignored, so please think before you simply fire off an email. Following these guidelines will help keep your email from getting lost in the daily spam and get you better service. We will try to respond to messages in a timely fashion, but since I receive dozens of messages each day, I ask that you use email judiciously. Here are some guidelines:

- Email to arrange an appointment. Please suggest 2-3 possible times when you can meet so that we can efficiently arrange a time to meet. Please confirm by email after we respond. If you send email, you also need to read email.
- For questions about what you missed when you were absent, consult the calendar on the class website or a trusted classmate instead of emailing.

**Phone & Voicemail:** You can leave me a voicemail on my office phone. However I am often not in my office and I may not check my messages every day (although I do try to do so). Hence phone is simply not a good way to get my attention in a timely manner. Because of this, I generally do not return calls about basic questions than should have been asked by email. **The exceptions are emergencies or**, e.g., you already have a scheduled appointment and you will be late or need to cancel.

## **Course Structure**

There will be around 10 lectures during the semester. These will be given at the beginning of the semester so that you get the information as soon as possible. The lectures cover everything from lab safety to statistical analysis of data. The majority of the class will require you to be in the laboratory with your lab partners to acquire the data you need to write-up your lab reports. These laboratories will be more open ended than you are most likely used to, so you will need to put in the time that is necessary so that you can successfully complete your work. During the time in the lab, you should seek out the TA and me to get advice and help if you need it. I will check your lab books (these should stay at your lab bench with your experiment) and the lab regularly. You should also avail yourself the opportunity to come to office hours.

Expect to work ~8 hours/week outside of the class meeting time. You will complete 3 labs over the semester. This is roughly 1 lab every 4 weeks. **In this course it is IMPERATIVE that you keep up. You will not be able to ‘cram’ for a lab.** Don’t be surprised if you find the course difficult in the beginning. Judge yourself on what you are learning.

**Course Outline:** Here are the lab lectures, most of the course is you doing experiments, keeping a nice lab book, preparing presentations and doing clear and informative lab write-ups.

- Introduction to Advanced Laboratory
- Lab Safety including Laser Safety video
- How to Prepare a Lab Write-up
- Scientific Uncertainty and Measurement
- Propagation of Error
- Binomial, Normal and Poisson Distributions
- Least Squares Fitting (Fitting Data to a Function)
- Back of the Envelope Estimates
- How to Prepare a Talk
- Scientific Ethics

## **Helpful Hints**

**Writing:** Remember, no one writes something well on the first try. There are no excellent writers, only excellent re-writers.

**Presentations:** Practice and preparation pay off. You should be able to explain anything that appears in your presentation. Get your slides done early and focus on what you are going to say about your slides. Visualize giving the talk.

### **Data Taking:**

1. **Get started early.** Leave plenty of time to cope with problems. However long you think something will take, multiply by  $2\pi$ . (If a theorist, multiply by  $1/\alpha$ )
2. **Keep a good lab notebook.** You will hand in your notebook and be graded on it. It's also very helpful to remind you of what you did.
3. **Understand the experiment before you take any data.**
4. **Take bad data before you take good data.** It's almost impossible to know how to best take the data without a little exploration, trial, and error. Be sure to take the data you really need, not what you a priori choose by some arbitrary rule.
5. **Understand the analysis before you take the good data.** Know how you are going to do your analysis before you take the final data. Otherwise, you won't get the data you need.
6. **Know what figures you want before you take the good data.** Presentation counts, and you want the data in the paper to look good.
7. **Plot your data as you go.** Otherwise, you'll: (a) miss some critical piece of data, or (b) have to deal with a crazy data point that you're pretty sure was a mistake.
8. **Keep an eye on sources of error as you go.** You will be required to give error bars on your data. Think about what these are as you go. Sometimes they'll be statistical, sometimes systematic. Note: this is often not an exact science!
9. **Report any problems quickly and fully.** You won't be punished for doing something dumb. But you will be punished for covering up something dumb.

**Learning Experimental Physics:** Playing with your experiments responsibly is how you learn to do experimental physics. You need to work with the experiment long enough so that you understand the nuances of the apparatus.

**Disabilities:** Students with disabilities should have the status of their disability certified with The Office of Disability Services of the Division of Student of Student Affairs.

**Lab Safety:** You are expected to practice excellent lab safety standards in Advanced Laboratory. *All students must attend the safety lecture and discussion before they can do any laboratory.* If you are using a laser in the lab, you need to have watched the laser safety video. You are required to wear laser safety glasses while using any setup with a laser. It is your job to ask others to stop doing what they are doing if you find it unsafe. If someone asks you to stop doing what you are doing, because they think it is unsafe, please stop as they are only trying to help you. Talk to them and agree on a safe way to carry-out a particular procedure. If there is a disagreement seek out the TA or lab instructor. *You are never allowed to work in the laboratory alone.*

## **Grading**

You will be graded on the following metrics:

1. Lab books, based on entries and spot checks
2. Lab reports (3)
3. Pre-lab 5 minute talks, and
4. Final talk and oral exam on a lab of your choice.

There will be short periodic homework assignments depending on how the class is going. These will be minimal if everyone is working hard in the lab so that you can concentrate your time on producing outstanding lab write-ups and experimental results. This also includes attending the lectures.

10%	Pre-labs
70%	90% Lab Write-ups and 10% Laboratory Notebooks
20%	Final Presentation (Oral Exam)

Please come and talk to me if you feel that you are having any problems with the class. It is better to ask for help early. Experimental physics is difficult so don't be surprised if you struggle a little bit. After a while, you will realize that the struggling is the fun part because you will learn new things and achieve successes you didn't think you could. The final talks will start the last week of classes.

Letter grades will be assigned based on your grade as determined above. The grade cut-offs will be decided at the end of the course when all of the scores have been tabulated. Any curve that is applied to the course will work to your advantage. I will never apply a curve that would give you a grade lower than the standard: A >90; B 80-90; C 70-80; D 60-70. This semester's grade distribution will depend on you.

## **Cheating**

There is no cheating in *Advanced Lab*, but if it occurred, it would be punished according to University guidelines. See the student handbook under academic misconduct for a description of infractions and policies. While you will be working together on experiments with your lab group, simple rote copying of the lab reports of another student is cheating. The work of both students will be handed over to [Academic Integrity](#).

## **Canvas Help**

Logon using your OUNetID (AKA your 4+4). For support call the IT Help desk call 325-HELP (325-4357).

## **Students with Disabilities**

Any student in this course who has a disability that may prevent him or her from fully demonstrating his or her abilities should contact me as soon as possible so we can discuss accommodations necessary to ensure full participation in this class.

**This syllabus is subject to change. Any changes will be announced in class and posted on the course website.**