

PHYS 310

Experimental Physics

Spring 2024

Instructors

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Materials

Measurements and their Uncertainties: A Practical Guide to Modern Error Analysis, by Ifan Hughes and Thomas Hase (Oxford University Press)

Lab notebook: a blank, bound notebook (to make it an accurate historical record, it should not be possible to add and remove pages such as in a binder)

Course Website

<https://www.eg.bucknell.edu/~phys310/>

Synopsis

PHYS 310 is an upper-level course designed to give you in-depth experience with advanced laboratory and computational techniques. The experimental work that you will do in this class will differ from the laboratory exercises you completed in lower-level physics courses; the experiments will be less stringently prescribed, with more freedom to design and modify your experimental method to improve the quality of your results. A primary goal of this course is to provide you with an experience closer to the kind of experimentation that takes place in academic and industrial research labs. As part of that experience, this course emphasizes *documentation* of your experimental work and *presentation* of the results, in both oral and written form.

Course Environment

Science is a fundamentally social process, and scientific communities achieve excellence only when we value humanity as well as accomplishment, respecting each person's dignity, well-being, and capacity. This is especially important in physics, due to harmful stereotypes about "genius" and what a scientist should be like. We will work with you to make the course an environment where you can be yourself, learn, and contribute with your full potential, whatever your race, gender, nationality, sexuality, disability status, religion, and other facets of your identity. Creating a positive environment is a learning process, and we can all make mistakes in how we treat others. Our goal is to respond effectively and quickly when we

make or witness these mistakes. To help us improve at this, please give us feedback at any time, about any aspect of the course and our teaching, or about any incidents you'd like us to know about or respond to.

Class Guidelines:

- Actively stay in the loop - if you miss, contact people to catch up
- Collaborate & help each other - lots of discussion
- Make it comfortable to ask for help
- Collective success more important than completion
- Idea: post-lab student-professor meetings
- Take questions seriously & be comfortable saying "I don't know"
- Go in depth & explore topics
- Switch roles

Course Structure

We will meet every Tuesday and Thursday from 1:00–3:50 pm. During the semester you will complete five projects, each sponsored by one of the faculty instructors and lasting two to three weeks. While some of the work required for each of these experiments will be completed during the Tuesday/Thursday class periods, you will need to allocate additional time outside of class *between every session* to read background literature, finish the experiments, complete your analysis, and work on assigned homework problems.

While the majority of our scheduled time will be spent in the labs, we will meet in the main classroom for activities during the first hour of each session. On Tuesdays we will discuss various research skills; topics will include analysis of uncertainties in measured data, the writing of scientific papers, delivering scientific talks, ethics involved in scientific research, and other research skills (see "Lecture" column in the calendar at the end of the syllabus).

On Thursdays, each group will give an oral progress report on the previous week's activities (see "Reports" column in the calendar). The reports provide you with an opportunity to explain your projects and what you have been doing, and to receive feedback from your peers on problems that you encountered. These reports will also help you to develop the oral presentation skills that will be vital in your life beyond Bucknell. At the end of the semester each of you will deliver a longer and more formal individual presentation of one of your projects.

Written Work

An essential component of research science is documentation of the experimental and computational work. A researcher maintains a laboratory notebook in which they write everything in detail, including comments about the goals, results and direction of the project. We will emphasize the use of laboratory notebooks in this course and a significant portion of your grade for each project will be based on how well you document your work in your notebook.

Effective communication of research results is an essential component of experimental work; after all, what is the value of your new result if nobody knows about it or can un-

derstand what you've done? You will practice informal communication of your work during the weekly oral progress reports. For two of the projects you will communicate your work more formally by writing papers in the style of a scientific journal publication describing the project, the results, and the main conclusions.

For each paper you will be required to hand in a complete draft of the paper, on which you will receive feedback that can be used to improve the paper. (20% of your grade on the paper will be based on the effort you put into your initial submitted draft.) You will then have a week to revise the paper before submitting your final version. Each paper will be an individual effort; while you and your partners will share experiences, data, and analysis, each of you will construct your own articulation of your project.

If you incorporate research, data, ideas or information from others in your writing, you must cite them. This applies to print and web-based sources. This also applies to AI tools such as Chat GPT. We suggest that you limit your use of Chat-GPT in writing for this course. But, if you choose to use it, then you must cite it. Furthermore, you must submit the transcript of your interaction with the program in the form of a supplementary document which indicates the prompt you used and the output that the program returned.

Seminar Attendance

As part of this course you will be required to attend and report on four research talks or colloquia in STEM departments; watch for announcements of these talks on campus.

Your seminar reports should be a few paragraphs in length and should (a) summarize the talk (what is the subject of talk, what techniques are used to investigate the subject, what are the main results); and (b) give your impressions of the talk (Did you find the talk interesting? Was the delivery effective? Did it connect to things you have learned in any of your classes? Do you have more questions about the subject of the talk? Etc.). We will grade your seminar reports mostly based on effort — if it is clear that you paid attention to the talk and made a strong effort to write a reasonable report of the talk, then you'll do fine.

Class participation

Active participation in all of the class sessions is an essential part of the course. Part of the course grade will be based on your regular and **on-time** attendance, along with your engagement during class. We recommend to maintain the second half of your lab notebooks as a separate section for taking notes during oral presentations, as a way of practicing active listening.

Course Calendar

Links: Course Calendar (Topics and Assignments) and Project Schedule. Please review these as part of reading the syllabus.

Grading

5 Labs (including quality of lab work, participation, oral reports, and notebooks):	50%
2 Papers (and drafts):	20%
Final Presentation:	10%
Homework:	10%
4 Seminar Reports:	5%
Class participation:	5%

IMPORTANT: In order to pass the course, you must satisfactorily complete **all** 5 labs and both papers (with drafts), maintain a lab notebook, and make a final oral presentation.

Bucknell Honor Code

As a student and citizen of the Bucknell University community:

1. I will not lie, cheat, or steal in my academic endeavors.
2. I will forthrightly oppose each and every instance of academic dishonesty.
3. I will let my conscience guide my decision to communicate directly with any person or persons I believe to have been dishonest in academic work.
4. I will let my conscience guide my decision on reporting breaches of academic integrity to the appropriate faculty or deans.

Learning Goals

Students completing the course will

- demonstrate proficiency in the methods of scientific inquiry in laboratory projects, and
- present well-organized, logical and scientifically sound oral and written scientific reports

as called for in our department learning objectives.

University Expectations for Academic Engagement

Courses at Bucknell that receive one unit of academic credit have a minimum expectation of 12 hours per week of student academic engagement. Student academic engagement includes the hours spent both in and out of class.

Resources

Accommodations. Any student who may need an accommodation based on the impact of a disability should contact the Office of Accessibility Resources at 570-577-1188 or OAR@bucknell.edu. The office will help coordinate reasonable accommodations for those students with documented disabilities. If you plan to use an accommodation in this course, please notify us by email in advance and/or meet with one of the instructors to discuss how your accommodations apply in this course.

We are always willing to talk with you about any aspect of your interaction with the course. Please consult us if you have any issues or concerns.

Holiday observances. You are welcome to take off holidays for religious or cultural reasons. Please notify us by email or using the form available through the Office of Religious & Spiritual Life (chaplain@bucknell.edu). Please complete any assignments in advance of the holiday unless you receive our permission for alternate arrangements.

Reporting harassment and discrimination. Our goal is that you have a safe environment, free from discrimination, harassment, or violence. However, if you, or someone you know, have experienced such incidents, we are available to help you identify reporting or support resources, and adapt the classroom environment. Please be aware that faculty members are “responsible employees,” so if you tell us about a situation involving sexual harassment, sexual assault, dating violence, domestic violence, or stalking, we must share that information with Bucknell’s Title IX coordinator. Although we have to make that notification, which leads to the coordinator contacting you, normally you still have a choice about whether to pursue a formal complaint. There are also confidential resources available, including the Interpersonal Violence Prevention and Advocacy Coordinator (Lindsey Higgins, lah050@bucknell.edu), the Counseling Center, and crisis services for sexual or domestic violence at Transitions (1-800-850-7948).

Mental health resources. If you find yourself struggling, please get in touch with us soon and often, so we can work with you. Here are some campus resources available to assist with mental health challenges:

- Counseling & Student Development Center (24-hour phone): 570-577-1604
- Uwill (free online therapy): app.uwill.com, register with a Bucknell email
- Associate Academic Dean or Dean of Students: 570-577-1601 (can help you navigate when mental health impacts class performance)