PHYS 310
Experimental Physics
Spring 2026

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 (optional): 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 will be drafted collectively early in the semester.

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 the "Lecture" column in the Google spreadsheet Calendar linked in the **Course Calendar** section).

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

Careful documentation is a critical aspect of a scientific investigation. A researcher should maintain a 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.

The 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 understand 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 about 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.

Citation and AI Policy

If you incorporate research, data, ideas or information from others in your any of your assignments e.g. writing, programming, problem sets, presentations, you must cite them. This citation requirement applies to print and web-based sources, including AI tools such as ChatGPT. This is a writing course designed to strengthen your scientific voice. We strongly suggest that you do not use ChatGPT in writing for this course. However, if you choose to use it in any capacity, 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. Talks will be announced in class, via email, and on the course website.

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 that you 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

To succeed as a physicist, you don't have to be a "genius" - instead, you need consistent effort and willingness to reflect and improve based on feedback. This semester, we are trying out elements of standards-based grading. To earn an A, you should meet *all* 5 numbered standards:

Standards-graded assignments: The first 3 types of assignments will be graded 0-100% based on a list of grading criteria that we will provide to you early in the assignment. Their purpose is to assess whether you are meeting the class learning goals.

1. Physics experiments: This course has 1 intro experiment (weighted 1/3 as much as other projects) and 4 large experiments. Your weighted average on these projects should be at least:

A: 90% B: 80% C: 70%

2. Formal communication: You will write formal papers on 2 experiments (Lab 2 and Lab 3), and give a formal presentation during the final exam session. Each will involve a draft and feedback. Your average on these 3 assignments should be at least:

A: 90% B: 70% C: 50%

3. Data analysis homework: You will have 6 homework assignments to practice data analysis skills, each graded 2, 1, or 0. Out of 12 max points, you should earn at least:

A: 9 B: 7 C: 5

Consistent effort to learn: The remaining 2 grading standards are completion-based. Their purpose is to incentivize consistent effort, and contributing to your group and the class.

4. Informal communication: The following assignments are graded based on completion, on time and as specified in the assignment description. They will all be graded 1, 0.5, or 0.

- 12 weekly oral reports (3 per project)
- 3 short project summaries (Projects 0, 1, 4)
- 8 reading journals
- 4 seminar reports

Out of a max 27 points, you should earn at least:

A: 25.0 B: 22.0 C: 15.0

5. On-time attendance: This is a small, group-work-based class. Email your instructors before the start of class if you'll be late, and instructors AND lab partner for absences. Each unexcused late arrival (<1 hr) counts as 0.5 unexcused absences. The maximum number of unexcused absences you can have is:

A: 0.5 B: 2.0 C: 3.5

Grading Clarifications

Course grade: To earn an A, you should meet all 5 standards for an A. Same for B or C.

A-, B+, etc: An A- consists of meeting all but 1 requirement at an A level, and 1 requirement at a B level. A B+ consists of meeting 2-3 requirements at an A level, and the other 2-3 requirements at a B level. Same for B-, C+, etc relative to B and C levels.

D and F grades: A D grade consists of earning below C level on one requirement. An F grade consists of earning below C level on 2 or more requirements.

Excused absences: We encourage you to ask for excused absences for important life/academic/career events, holidays, illness, etc. To have an excused absence, you should receive instructor approval *in advance*, notify your lab partner, and make plans with both your instructor and lab partner to make up missed course/lab work. Exception: in extenuating circumstances (severe illness or emergencies), please contact your instructor and lab partners as soon as possible once your situation stabilizes.

Unexcused absences and late arrivals: You can convert an unexcused absence to only count as 0.5 if you email your instructors AND lab partner *by 1 hour into class*. You can convert an unexcused late to only count as 0.25 if you email your instructors *before the start of class*.

Late work: The final deadline for late work without instructor approval is 2 days after the deadline (HW, readings, project summaries). The exception is seminar reports, where the final deadline is the final exam date. Major assessments (papers, experiments) require instructor approval for late submission.

Grading for HW: The possible grades are 2 (excellent), 1 (acceptable), and 0 (skipped). An A in the course is 9/12 because we will be picky.

Grading for project summaries, reading, seminar reports: The possible grades are 1.0 (on time and complete), 0.5 (on time and does not meet expectations, or meets expectations and late), or 0 (missed late deadline).

Grading for oral reports: The possible grades are 1.0 (meets expectations), 0.5 (does not meet expectations), or 0 (missed without excused absence). Excused absences can be replaced with a 1-page update.

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

- Develop proficiency in methods of Experimental Physics, including
  - problem solving
  - record keeping with a notebook
  - appropriate data analysis and dissemination
- Develop proficiency in communicating experimental outcomes
  - in writing
  - through oral presentations
- Reflect on the ethics of contemporary physics
  - regarding outcomes, and
  - practices

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 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. We want you to observe your holidays for religious or cultural reasons. Please notify us directly by email or, based on the Office of Religious & Spiritual Life website, by emailing (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 Office (Matthea Mitchell, 7-1542, mm119@bucknell.edu), the Counseling Center, and Pennsylvania crisis services for sexual or domestic violence at Transitions (1-800-850-7948).

Mental health resources. If you find yourself struggling, please contact us immediately 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 through Student Affairs: 570-577-1601 (can help you navigate when mental health impacts class performance)