

# Physics 310 - Intermediate Laboratory

## Syllabus - Spring 2022

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Please check my webpage for the latest info.

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[**COVID-19 NOTICE:** The Spring 2022 semester is (still) taking place in the middle of a global pandemic. We have experienced our society turned upside down and inside out. In the Spring 2020 semester Truman (and everywhere else) shifted to online instruction due to the pandemic. During the Fall 2020, Spring 2021, and Fall 2021 semesters Truman managed to hold classes on campus and online in a variety of delivery formats including completely in person. We will try to do that again this semester. This class is scheduled to meet in person for the entire semester. There is a possibility that some of us will need to quarantine or isolate during the semester. I will contact you if that is the case for me. If I have to quarantine I will teach via Zoom during the quarantine. If I have to isolate it means I have the virus. What happens then depends on the severity of my reaction to it. I'll try to let you know what is going on in that case. I am fully vaccinated and boosted so there is a significantly reduced probability that I will have a severe reaction if I get covid. Please let me know if you have to quarantine or isolate so we can work out how best to keep you on track.

In terms of the number of cases and deaths, the US is worse off now than we were Spring 2020 when the pandemic began. But we have learned a lot more about the virus. We have a better understanding of how it spreads and how to minimize that spread. We just can't let our guard down. Especially now that there is a vaccine. You should already be aware of the special rules for holding classes that are in place. You will be required to wear a face covering that completely covers your nose and mouth. You will be expected to keep the covering on at all times while we are meeting. In the event you arrive to class without a face covering, I will ask you to leave until you are able to obtain one and return. Thank you for your help in containing this virus and helping to protect your peers.

If we need to pivot to online instruction again we will substitute the in person labs planned for the semester with the online labs developed by the textbook's editor and co-authors. You are, of course, free to explore those labs. Bear in mind that the course for which the textbook was developed is different from Truman's course. Not all of the textbook's labs translate to a Truman lab and vice versa.]

Now to the actual syllabus...

## Syllabus Begins Here

“... in theory there is no difference between theory and practice, while in practice there is.”

-Benjamin Brewster (1892) [<https://quoteinvestigator.com/2018/04/14/theory/>]

**Required Books (We will also use the same textbook in PHYS 446-Advanced Lab.):**

- *Experimental Physics: Principles and Practice for the Laboratory* Edited by Walter Fox Smith and material on the accompanying website (email the editor for access, Prof. Walter Smith at [wsmith@haverford.edu](mailto:wsmith@haverford.edu))
- A bound lab notebook.

**From the Catalog:** The Intermediate Physics Laboratory course introduces students to the fundamentals of experimental design, measurement, data analysis, error analysis, and laboratory record keeping. In this course students also learn the basics of hardware and/or software involved in computer interfacing. Students perform experiments from different parts of physics, including Optics, Mechanics, Nuclear, Electricity and Magnetism, and/or Solid-state physics.

Prerequisites: grade of “C” or higher in PHYS 196 - Physics II.

**General Information:** This course serves as an experimental physics ‘bridge’ between the labs of PHYS 195/196 and the much more sophisticated experience in Advanced Lab (PHYS 446). The introductory labs of 195 and 196 are designed primarily to demonstrate phenomena encountered in the lectures. Along the way you are introduced to the concept of uncertainty and the rigors reporting of scientific information. At the other end of the spectrum, in Advanced Lab, the labs are often more complex and the expectation is for work approaching professionalism. Deep critical thought, attention to detail, thorough and well-documented analysis of data, and expert report writing are the goals. The focus of Intermediate Lab is on the careful acquisition of meaningful data and on their (‘data’ is the plural of ‘datum’) quantitative analysis. We seek to acquire a deeper understanding of the concept of uncertainty and to begin to develop the statistical tools used for interpreting quantitative results. We will also learn some useful software tools for doing the analysis.

**Course Structure:** The course meets once a week for three hours. Because we are meeting in the introductory lab classrooms, you must have your equipment put away before the beginning of the following day. Note, I did not say the end of class. You will probably need to work on your experiments outside of class. Spending a little time after class would be a more efficient way to do this than coming in at another time. If you do need to come in at an alternate time, you can ask any of the Physics faculty to open it for you. Obviously, you will not be able to use the room when there is another class in there. One way to minimize spending extra time in the lab is to prepare for the experiment *before* you come to class. Read the pre-lab early so you know what you need to research about your experiment before you work in the lab.

**Course Objectives:** At the end of the this course the student shall be able to

- design experiments to make measurements of a variety of physical phenomena.
- keep careful and detailed notes of experiments.
- analyze data using basic statistical models.
- use a spreadsheet to analyze data.
- use Octave and/or Python to analyze data.

**Experiments:** Each experiment has a pre-lab associated with it that describes the general idea behind the experiment and some rough experimental design considerations. You will be required to fill in the theory behind the experiment and flesh out the details of the experimental design. This process will require you to consult outside references including your textbooks from previous classes, library books, journal articles, and the internet. You must cite these references appropriately in your report. I realize the internet is a

convenient source but it is not always the most reliable. Additionally, there is information that is more easily obtained from other sources. Try to use some non-internet sources. *Once you understand the theory* and have an experimental design you will then collect and analyze the data. Finally, you will interpret the data in the context of the theory. All of this will be written in two places: your lab report and your lab notebook.

For the Intermediate Lab course, your lab report is a short, coherent summary of the goal(s) of the experiment and the results obtained. While it is not expected to be formal, it should be clear. Your lab notebook is a record of all your work in the lab. It should also be clear but is less formal and not as concise. In your notebook you should write everything of importance that you do in lab: ideas for the experimental design, rough sketches of the setup, a neat drawing of the final design, and, yes, even your data. If you take your data using a computer, you should indicate in your lab notebook where the data is located including the computer identification, e.g. “Ima Student’s laptop”, and the file name. The results of analysis of the data should be taped, pasted, or stapled in your notebook, preferably taped. Likewise any graphs you make using your data should also go into your notebook, even if they are also in your report. In fact, almost everything in your report should have originated in your notebook. It is a good idea to get in the habit of keeping a good notebook now. To encourage this, you will turn in copies of your notebook pages when you turn in your lab report. The notebook pages will be graded on completeness and how well they corroborate what is in the report. Note: This does not mean that you should include every little thing from your notebook in your final report. Your lab notebook may have notes on ideas that did not work. There is no need to include such detours in the final report unless something useful can be learned from them. I will discuss these ideas in more detail in class.

**Attendance:** Students with sanctioned absences will not be penalized for being absent, but will be expected to make up any missed work within a reasonable length of time. The professor reserves the right to deem additional absences as unsanctioned once a student has missed 6.67% of class time for sanctioned absences. A list of sanctioned absences can be found in the General Catalog. Sanctioned absences include serving as a representative of the University at intercollegiate athletic events, professional conferences, academic competitions, and field trips for courses, interviews for graduate school or careers, health-related absences (with documentation), and absences covered by Truman’s non-discrimination policy. For an absence to be sanctioned, students must notify the professor of scheduled absences during the free add/drop period and as soon as possible for any other absences. Students should also provide the faculty member with written notification of the absence. Arrangements for making up prior work should be made prior to the absence. If the absence is unexpected, the student should arrange to make up the missed work as soon as possible. An appeal of a faculty member’s attendance policy can be made through the University Grade Appeals process (see the General Catalog for details).

**Substantive Interaction:** Truman policy and federal regulations require that students demonstrate that they are academically engaged in the courses they take. You must meet this requirement within the first calendar week of the semester, beginning at 12:00 am on Monday, 10 January 2022, and ending 11:59 pm Saturday, 15 January 2022. Failure to do so, or to provide an explanation of an extenuating circumstance by that date and time will result in your removal from the course. Under certain circumstances, removal could impact your scholarship eligibility or financial aid. For the purposes of this class, establishing academic engagement requires, at a minimum, attending class and engaging in your labs.

**Grades:** You will be graded as follows:

- Lab Reports(40% each)
- The quality of your lab notebook (40%)
- Homework (20%).

**Credit Hour Justification:** The *minimum* investment of time by the average Truman student necessary to achieve the learning goals in this course are approximately one “hour” of more or less formal instruction and approximately two “hours” (120 minutes) of work in the laboratory under the instructor’s tutelage and a minimum of three hours of out-of-class student work each week for the two credit hours awarded. The

outside work consists of readings and problem sets that present the underlying theory for the laboratory work and troubleshooting difficulties encountered doing the labs. In many ways the teaching model is similar to what is now called a “flipped” classroom. This average time per week for an average student may have weekly variations.

**Students with Disabilities:** I am committed to working with students with disabilities in conjunction with Truman’s Office of Disability Services to fulfill any needs of those students, in alignment with the American’s with Disabilities Act (ADA) of 1990. Please let me know early if you have special needs.

**Academic Honesty:** Obviously, you are to do your own work in this class. In addition, you must learn to properly cite the work of others in your lab reports. It is part of scientific writing to cite the work of authors who have preceded your work in a field and whose work directly influences your work. If you have questions about proper citation please ask me before you turn in the report. Plagiarism is using the work of others and claiming it as your own. Plagiarism will be grounds for disciplinary action that may include expulsion from school. Changing your data is scientific misconduct and will not be tolerated. I will discuss these issues in more depth during class.

**Office Hours:** Office hours are not the only times I am available for help. My listed office hours just indicate the times I guarantee I will be in or near my office (MG 3002) or my lab (MG 3147). I encourage you to come and ask questions when you need help. If you cannot make it during the regular office hours, then please schedule a time to meet with me. My standard weekly schedule is posted on my door and on the web. Please check the web for the latest version.

## Standard University Policies

Please see the accompanying document with that title.