

Physics 446 - Advanced Laboratory

Syllabus - Spring 2020

Instructor: Dr. Michael Goggin

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Please check my webpage for the latest info.

Office Hours: T & Th 12-1 PM

T 4:30-5:30 PM & Th 4:30-5:50 PM

W 1:30-2:30 PM

Also by appointment

Web Page: <http://mgoggin.sites.truman.edu>

“... 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:

- *Measurements and their Uncertainties* by Ifan G. Hughes and Thomas P. A. Hase
- A bound lab notebook. (You may use the one you used in Electronics or Intermediate Lab, if you have one.)

From the Catalog: Experiments in light, heat, electricity and magnetism, and modern physics. Pre- or co-requisite: PHYS 250.

General Information: This is may be your first formal exposure at Truman to experimental physics at an advanced level. The experiments you did in your introductory sequence are not as involved as the experiments in this course. Some of you may have taken Electronics, which is a lab class and teaches you about an area of knowledge that is very useful to the experimenter, but it does not teach you experimental *physics*. I will assume you learned *something* in Intermediate Lab. You may also be (or have been) exposed to experimental methods during research projects but the exposure is informal and will vary greatly from project to project. The purpose of Advanced Lab is to give you a common background in various aspects of experimental physics. Some of these aspects are:

- experimental design
- data collection, e.g. extracting a signal from noise
- data analysis with uncertainty
- expressing your results in writing
- the use of scientific software

“People who write obscurely are either unskilled in writing or up to mischief.”

-Sir Peter Medawar, “Science and Literature” in *Plato’s Republic* (1984)

This is a writing enhanced course. By the end of the course you will be expected to be able to write near-publication-quality manuscripts. Furthermore, you will be able to do it using L^AT_EX. Regardless of

what you do after Truman, learning to write technical documents well will be an important outcome of this course. Judging from comments made by previous students, it is also the part that takes the most time and is the least satisfying *in the beginning*. Many students, however, are pleased, and maybe a bit surprised, by the quality of their writing at the end of the course. Please be aware, however, that good writing is a necessary but not a sufficient condition for success in this course. The quality of your experiments will be a more important factor in achieving a good grade.

This course is also designed to promote a professional attitude in you. Much of the work in this course is self-motivated. You are responsible for working without direct supervision and for meeting course deadlines. I will not explain how to do each lab it is up to you to interpret the pre-lab and perform the experiment. I will, of course, help you to understand and set up the experiment, but only after you have demonstrated due diligence in figuring it out on your own. As preparation for the working world, including graduate school, all work is due when specified. If it is late, it will cost one letter grade per day overdue including Saturday and Sunday. In addition, all labs must be turned in to pass the class. **If you fail to turn in one lab you will fail the class.** (Failing to complete a report can be grounds for termination in the working world.)

Course Structure: The course is divided into a recitation time and a lab time. The recitation time is when formal teaching will occur and probably should be called a lecture period. I will use the recitation time to explain how to use L^AT_EX, Inkscape, and other software, keeping a lab notebook, some basics on writing, etc. We will also work through the book on error analysis. There will be homework associated with the recitation, e.g. problems from the error analysis text, example programs for analyzing or plotting data, etc. Because we are transitioning to a new curriculum, the homework will be based on the backgrounds of the students in the class. If everyone has taken Intermediate Lab, we will be able to do more interesting things. If not, we'll spend more time on some of the topics covered there.

The lab period is a time reserved for you to work on your experiments and receive help from me. I encourage you to use this time to work on your experiments, but you are also encouraged to work on the experiments outside of the formally scheduled times. You are expected to leave your equipment set up during the two weeks you have to complete an experiment. You may also ask for help from me at times outside the regularly scheduled time, but be aware that I will not always be able to provide it. Also take note that I will be less inclined to ignore my other work to help you if a) you have not been working during the lab time without a good reason (e.g. interference from someone else's experiment prevents you from working on yours) and b) it is the day before the lab is due and you are still *setting things up*. **You** are responsible for finishing the lab on time.

You will be expected to do five labs, one every two weeks or so, and work through a tutorial on LabVIEW. I will assign the labs and LabVIEW tutorial as the semester progresses.

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.

Your lab report is designed to be read by someone unfamiliar with the details of your experiment. Great care must be taken to write clearly and concisely. It is a synthesis of the most relevant aspects and most relevant results of your experiment. Your lab notebook, on the other hand, 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 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 photocopies 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 wrong turns in the final report unless something useful can be learned from them. I will discuss these ideas in more detail in class.

Resist the temptation to start setting up your experiment before you read through and understand the theory. There is a good chance that you will only take bad data. You will then have to retake your data. One of the biggest sources of poor performance in this course is not bothering to gain a thorough understanding of the physics of the experiment. The pre-labs alone will not give you that understanding. You must read outside material.

Attendance: I expect you to come to each recitation and the beginning of *each* lab period. After we finish any group business you are free to go about your business. I encourage you to stay and work but I recognize that may not always be possible or desirable. For example, your experiment may be sensitive to vibration and you will get better data at night, when the building is empty. Do not put off working on the lab. It will take longer than you think. Note: While you have a certain amount of freedom in allocating your time you are still obligated to be in class if I deem it necessary. Do not schedule anything else during class time.

Grades: You will be graded as follows:

- first two lab write-ups (6% each)
- second two lab write-ups (14% each)
- your fifth lab write-up (18%)
- your LabVIEW assignment (12%)
- the quality of your lab notebook (15%)
- homework (15%).

Students with Disabilities: I am committed to working with students with disabilities in conjunction with Trumans Office of Disability Services to fulfill any needs of those students, in alignment with the Americans 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 3172) 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 class schedule is posted on my door and on the web. Please check the web for the latest version.

Standard University Policies

Emergency Procedures: In each classroom on campus, there is a poster of emergency procedures explaining best practices in the event of an active shooter/hostile intruder, fire, severe weather, bomb threat, power outage, and medical emergency. This poster is also available as a PDF at this link: <http://police.truman.edu/files/2015/12/Emergency-Procedures.pdf> .



Students should be aware of the classroom environment and note the exits for the room and building. For more detailed information about emergency procedures, please consult the Emergency Guide for Academic Buildings: <http://police.truman.edu/emergency-procedures/academic-buildings/>

This six-minute video provides some basic information on how to react in the event there is an active shooter in your location: <http://police.truman.edu/emergency-procedures/active-shooter/active-shooter-preparedness-video/>

Truman students, faculty, and staff can sign up for the TruAlert emergency text messaging service via TruView. TruAlert sends a text message to all enrolled cell phones in the event of an emergency at the University. To register, sign in to TruView and click on the “Truman” tab. Click on the registration link in the lower right of the page under the “Update and View My Personal Information” channel on the “Emergency Text Messaging” or “Update Emergency Text Messaging Information” link. During a campus emergency, information will also be posted on the TruAlert website <http://trualert.truman.edu/>.

Disability Services: To obtain disability-related academic accommodations students with documented disabilities must contact the course instructor and the Office of Student Access and Disability Services (OSA) as soon as possible. Truman complies with ADA requirements. For additional information, refer to the Office of Student Access and Disability Services website at <http://disabilityservices.truman.edu/> You may also contact OSA by phone at (660) 785-4478 or email <mailto:studentaccess@truman.edu>

Title IX: Truman State University, in compliance with applicable laws and recognizing its deeper commitment to equity, diversity and inclusion which enhances accessibility and promotes excellence in all aspects of the Truman Experience, does not discriminate on the basis of age, color, disability, national origin, race, religion, retaliation, sex (including pregnancy), sexual orientation, or protected veteran status in its programs and activities, including employment, admissions, and educational programs and activities. Faculty and staff are considered mandated reporters and therefore are required to report potential violations of the University's Anti-Discrimination Policies to the Institutional Compliance Officer.

Title IX prohibits sex harassment, sexual assault, intimate partner violence, stalking and retaliation. Truman State University encourages individuals who believe they may have been impacted by sexual or gender-based discrimination to consult with the Title IX Coordinator who is available to speak in depth about the resources and options. Faculty and staff are considered mandated reporters and therefore are required to report potential incidents of sexual misconduct that they become aware of to the Title IX Coordinator.

For more information on discrimination or Title IX, or to file a complaint contact:

Dr. Lauri Millot, Institutional Compliance Officer, Title IX and Section 504 Coordinator
Office of Institutional Compliance
Violette Hall, Room 1308
100 E. Normal Ave
Kirksville, MO 63501
Phone: (660) 785-4354
<mailto:titleix@truman.edu>

The institutions complaint procedure can be viewed at <http://titleix.truman.edu/files/2015/08/University-Complaint-Reporting-Resolution-Procedure.pdf> and the complaint form is accessible at <http://titleix.truman.edu/make-a-report/>.

Credit Hour Justification: The *minimum* investment of time by the average Truman student necessary to achieve the learning goals in this course are not less than one hour (50 minutes) of classroom instruction

and a minimum of two hours of out of class student work each week per credit hour awarded or at least the equivalent of two hours (1:50) of laboratory work in the lab and 1 hour of work outside the lab time each week per credit hour awarded. This average time per week for an average student may have weekly variations.

Academic Dishonesty: The General Catalog states: Students are expected to do their own academic work. Any student involved in cheating on a paper, an examination or in any other form of academic dishonesty is subject to disciplinary action, including suspension or expulsion from the class, the students academic program, or the University.

Serious cases of academic dishonesty are reported by the faculty member to his or her Department Chair and to his or her Dean, who may take additional disciplinary action against the dishonest student, including suspension or expulsion from classes in the School. The Dean reports the dishonesty to the Vice President for Academic Affairs, who may also report it to the Vice President for Student Affairs. The Dean may also report the dishonesty to the School in which the dishonest student is enrolled as a major; the Dean of this School may suspend or expel the student from the academic program in the major. The Dean of Students may also suspend or expel the student from the University as outlined in the Student Conduct Code for incidents of academic dishonesty. More information can be found in the General Catalog (http://catalog.truman.edu/content.php?catoid=13&navoid=625#Academic_Dishonesty) and the Student Conduct Code Section 8.050.01 (<http://policies.truman.edu/policylibrary/student-conduct-code/>)

Attendance Policy: The General Catalog states: A student is expected to be present at all classes. Regular class attendance is necessary in order for a student to achieve the desired standard of academic achievement. Irregular attendance normally results in lower levels of achievement. Students are therefore expected to contact instructors as soon as possible when an absence occurs.

More information can be found in the General Catalog: [://catalog.truman.edu/content.php?catoid=13&navoid=625#Attendance_Policy](http://catalog.truman.edu/content.php?catoid=13&navoid=625#Attendance_Policy)

FERPA: Education records are protected by the Family Education Right to Privacy Act (FERPA). As a result, course grades, assignments, advising records, etc. cannot be released to third parties without your permission. There are, however, several exceptions about which you should be aware. For example, education records can be disclosed to employees or offices at Truman who have an educational need to know. These employees and offices may include your academic advisor, the Institutional Compliance Officer, the Registrars Office, or Student Affairs depending on the type of information. For more information about FERPA, see <http://www.truman.edu/registrar/ferpa/>.

Disruptive behavior: “Behavior that persistently or flagrantly interferes with classroom activities is considered disruptive behavior and may be subject to disciplinary action. Such behavior inhibits other students ability to learn and an instructors ability to teach. A student responsible for disruptive behavior may be asked to leave class pending discussion and resolution of the problem and may be reported to the Office of Student Conduct.” (*From Washington State University, suggested by Lou Ann Gilchrist*).