

PHYS 431L

Modern Physics Laboratory

Spring 2022

Laboratory Hours: Tues. and Thurs. 1:00 – 4:30 in Physics 208
Instructor: Matthew Pelton
Office: Physics 313
Office Hours: Tues. 11:00 – 12:45, or by appointment
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Cell Phone: 773-870-5432. Please use for urgent matters only.
Text: There is no textbook required for this course.

Course Hours

The lab course takes place Tuesday and Thursday 1:00 – 4:30 in Physics 208 (with additional experiments in Physics 207 and Physics 305). Both time slots are for working in the lab (there is no lecture component to the course).

Course Objectives

The purpose of this course is to provide a laboratory experience that brings together the physics concepts taught in previous lecture courses, and that approaches the experience of a real-life workplace or graduate school. You will have succeeded in this course if, at the end of the semester, you are able to do the following:

- Design and carry out laboratory experiments using modern techniques
- Analyze experimental data properly
- Prepare professional-level laboratory reports and oral presentations

Working in the Lab

This class will challenge you to carry out experiments independently, working in small groups. All of the required equipment will be at your disposal. The instructor will be there to answer your questions and make sure that you are capable of performing the experiment safely and without damaging the equipment. However, it will be your responsibility to design and assemble the experimental apparatus and decide on the best data-acquisition procedure and data-analysis methods.

It is of the utmost importance that you come to the lab prepared. There will be brief write-ups provided for each experiment, giving a broad overview of the objectives of each experiment. These write-ups are just starting points: they are not complete instructions or lab manuals, and they do not provide all the background information you need to perform and understand the experiments. You will need to perform your own research and reading to obtain this information.

Manuals are available in the laboratory for the equipment that you will be using. These are your primary resources for operating the equipment and should be studied before doing the experiment. They do not, however, provide any information about the particular experiments you will be carrying out. Also available in the lab are textbooks and other scientific background reading for each of these experiments. You are welcome to use these materials as a starting point or to find your own sources for the relevant science. You may borrow manuals and reading material from the lab, but you must (1) coordinate with your lab partner(s) to make sure you all have access and (2) return the materials to the lab by the time you complete your experiment.

You are also welcome to talk to your instructor at any time about the experiment and the scientific background. The instructor will be available during the scheduled lab time, during office hours, and at other times by appointment. The instructor is there to help and to make sure all the required equipment is available and properly functioning; it is up to you to perform the experiment and do the research required to understand it.

For the first part of the semester, you will work on a series of two-week experiments. You will rank your preferences for the experiments that you want to perform, and groups will be assigned to take your preferences into account as much as possible.

In the second part of the semester, you will work on a longer project, exploring one of the earlier experiments in greater depth or using the available equipment to explore a different scientific topic. You will choose your partners and will work as a team to independently determine the scientific goals and plan of action for the project.

You will work with your partner or partners in the lab, performing the experiments and projects together, and helping each other to understand the science. However, laboratory reports, pre-labs, proposals, and the final presentation are your own work.

Course materials, announcements, and grades will be posted on the course Blackboard site. It is your responsibility to check the site and keep up to date with the course requirements.

Lab Safety

Your highest priority when working in the lab must be to do the work safely. It is important to get the labs done, but it is not worth risking your life or your health for it. We would also all be happy if you finish the experiment without damaging the equipment.

If you are not certain that you can do something safely, then don't do it. Ask the instructor or TA for help if you are unsure about the operation of any equipment or tools. It is much better to be too careful than to not be careful enough.

There is a separate handout on specific safety guidelines. You are required to read and understand this, and to follow all the safety rules.

If you are observed working unsafely or contributing to unsafe behavior, you will be required to stop the lab immediately and leave for the rest of the day. If you can convince the instructor that you can continue the work safely, then you will be allowed to complete the experiment during the make-up week. Repeated unsafe or reckless conduct may result in dismissal from the course.

Course Requirements

Pre-Labs

For each of the experiments, you will be required to hand in a pre-lab report. This report must include the following:

- An explanation of the purpose of the experiment
- A brief overview of the theories and principles underlying the experiment
- An outline of the planned experimental approach

The report should be no more than four pages long. You do not need to include a cover page for your pre-lab.

Pre-labs are due by the end of the day before you are scheduled to begin the experiment. Pre-lab reports must be submitted electronically to the course Blackboard site.

At the beginning of each experiment, one student will be randomly selected to briefly summarize to the class the purpose and background for the experiment that they are about to perform.

Before you perform the experiment, the instructor will discuss your pre-lab with you to make sure that there are no issues that will compromise your safety or prevent you from completing the work. You will not be allowed to carry out the lab if the instructor believes that you are not prepared to perform the experiment safely. You may be allowed to perform a make-up experiment later, if you demonstrate at that point that you are prepared.

Proposals

Before beginning the project, you will be required to hand in a project proposal. The proposal must include the following:

- A project title and list of group members
- An explanation of the goals of the project
- An explanation of why these goals are important or interesting
- A brief overview of the scientific theories and principles underlying the project
- A step-by-step outline of the planned experimental approach, including an estimate of the time required to complete each step
- A list of the laboratory equipment that will be used, and a list of any additional materials, supplies, equipment, or other resources that will be required
- A summary of any special hazards that may be encountered in the experiment and any other safety considerations

The proposal should be no more than five pages long. You do not need to include a cover page for your proposal.

During the week before you begin your project, you will meet with the instructor to go over your proposal, make any changes that may be needed, and plan out your work over the next two weeks. Proposals are due the Friday of the week before these discussions. Proposals must be submitted electronically to the course Blackboard site.

During the course of a project, it often becomes clear that changes to the plan are necessary. This is fine, as long as you discuss any major changes with the instructor.

Lab Notebook

You are required to obtain and use a standard laboratory notebook for this course. The UMBC bookstore sells lab notebooks, and they can also be obtained online or at many office supply stores. Practicing scientists often need to come back to their notebooks years later in order to recall the details of the experiments that they did; you should strive to have your notebook entries complete and clear enough to meet this standard. You must make every effort to record and describe *everything* that you're doing. Draw or take pictures. Even if information is stored in a computer, it should be printed out, as a picture, graph, table, etc., and taped into your notebook. All entries should begin with the date that the entry is made.

It is a good idea to plot your data as you acquire it. This way, you will immediately see where more data is required and if there are any apparent systematic errors that could be fixed. This will slow down the data acquisition somewhat, but it will be much more efficient in the long run than having to come back and start all over again when you find out that the data was problematic or incomplete.

In real-world research, lab notebooks are the official record of the experiment performed and are the primary piece of legal evidence used to settle priority disputes, or if there is an accusation of research misconduct. It is therefore forbidden to alter lab notebook entries, including tearing pages out of the book, or even erasing entries – anything that you don't want to keep should be crossed out with a single line.

I may ask to go through your lab notebook at any time during the semester. At the end of the semester, I will review your lab notebooks. You can earn up to 3% extra credit in the course if you have maintained an exceptionally detailed and well-organized lab notebook.

Lab Reports

A complete laboratory report is required for every experiment and project completed. There is no specific template for the report (apart from the cover page). Rather, the report should be prepared in the format and style of a scientific paper.

There is a separate handout explaining the requirements and expectations for the reports.

The handout includes a rubric, which will serve as the basis for grading the reports. Each of the criteria will be evaluated as "Not addressed," "Novice," "Intermediate," or "Proficient," and the evaluations will serve as the basis of your score on the report. Not all of the criteria will be given equal weight, and the conversion of the evaluations to a score will be based on the instructor's judgment. There is an expectation that your report-writing skills will improve over the semester, so, later in the semester, you will have to get better evaluations in order to get a high score than you do earlier in the semester.

Reports must be submitted electronically to the course Blackboard site. All submitted reports will be scanned for plagiarism using the SafeAssign application. Late reports will be accepted only in the case of a documented issue or problem.

Reports are due the Tuesday after the experiment or project is complete. The instructor will provide high-level comments on Blackboard, and the reports will be distributed to another, randomly selected student in the class for anonymous “peer review.” The reviewing student will provide critiques of the written report, based on the rubric provided. Reviews are due the Thursday after the reports are received and will be returned to students by the next day. You will then have until the following Tuesday to revise your report and turn in the final version.

Make-up labs will be given only in the event of a documented issue or problem. You must notify the instructor as soon as possible if you are going to miss a lab or have missed a lab because of an unexpected issue. Going out of town for a recreational trip is not a valid reason for requesting a make-up.

After completing all the experiments, you will have the opportunity to re-submit a revised version one of your lab reports, with the score for the revised report replacing the score for the initially submitted report. Redoing all or part of the experiment is allowed but not required. A week will be available before the projects are started to redo the experiment, if desired, or to make up any experiments that were missed (for a valid reason) earlier in the semester. Make-up lab reports are due the Thursday after this make-up week.

Oral Presentation

At the end of the semester, each student in the course will give a fifteen-minute presentation on one of the projects that they have completed. The presentation will follow the format of a typical research talk given by a scientist in a national conference. There is a separate handout with the guidelines and grading rubric for the presentations. Slides for the presentations must be uploaded to the Blackboard page by the end of the day before the presentations.

Grading

Your final grade will be based on the pre-labs and lab reports for the nine labs during the semester and on the final presentation. There are no exams in the course.

Your percentage score will be calculated as follows:

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| • Pre-labs (4): | 1% each |
| • Initial experiment reports (4): | 1% each |
| • Final lab reports (4): | 14% each |
| • Project proposal: | 2% |
| • Initial project report: | 1% |
| • Final project report: | 18% |
| • Peer reviews (5): | 1% each |
| • Final presentation: | 10% |
| • Lab notebooks: | Up to 3% extra credit |

At the end of the semester, you must have turned in all the experiment and project reports. If you miss even a single report, you will automatically get a C or lower in the course, regardless of the scores that you got for the other reports.

If you complete all reports, your percentage score will be converted to a letter grade as follows:

- 90% and higher: A
- 80% and higher: B
- 70% and higher: C
- 50% and higher: D
- Below 50%: F

Academic Integrity

Lab reports, pre-labs, and the final presentation must be your work alone. It is cheating to copy somebody else's data, analysis, or lab report, in whole or in part; to use unattributed material from other sources, including the internet; or to submit a laboratory report that you wrote in a previous semester. It is a serious violation of academic integrity and scientific standards to alter your laboratory data in any way after the experiment, including the selective omission of data. Reckless and deliberately unsafe behavior in the laboratory is also a serious violation and may result in dismissal from the course.

By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal. To read the full Student Academic Conduct Policy, consult UMBC policies, or the Faculty Handbook (Section 14.3).