Course syllabus

Experimental Physics III: Electromagnetic Waves, Optics, and Modern Physics

PHYS 375
Fall 2021

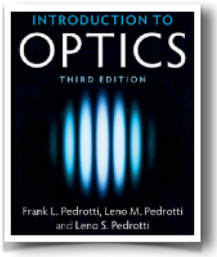
Overview

This is the third laboratory course in the sequence for physics majors. As in the other courses, the primary objectives consist of learning physics through experimental investigation and becoming familiar with the fundamentals of lab work, namely careful experimental set up and measurements, proper documentation, and analysis of the measurement uncertainties.

This class is one of a few offered in our undergraduate curriculum where you can learn key aspects of geometrical (ray) and physical (wave) optics. The required Monday lectures will provide the theoretical underpinnings for the six experiments that will be carried out, each generally completed over two class periods. Data analysis will be done in MATLAB and python.

Topics to be covered include the following: electromagnetic waves; ray, wave and laser beam propagation; polarization; interference; interferometers; diffraction; spectrometers; and atomic spectra.

Textbooks



Recommended textbook
Introduction to Optics
F. Pedrotti, L. M. Pedrotti, and L. S. Pedrotti
Cambridge University Press, 3rd edition (2017)
ISBN: 978-1108428262

Additionally, "An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurement" by John Taylor will be helpful for error analysis. Also, a nice reference for MATLAB is "MATLAB For Beginners: A Gentle Approach" by Peter Kattan, and a good quick primer on statistics is "A Practical Guide to Data Analysis" by Louis Lyons.

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Lectures
All sections meet
Mondays 2:00pm – 2:50pm
PHY #1410 (Toll bld.)

Labs
0101 - Mon 3:00pm - 5:50pm
0102 - Wed 3:00pm - 5:50pm
0103 - Tue 3:00pm - 5:50pm
0104 - Thu 3:00pm - 5:50pm
PHY #3115 (Toll bld.)

Office hours
We are happy to meet with you! Contact us with an email and we'll find a time that is convenient for everyone involved.

Prerequisites
PHYS 273, PHYS 276

Grades

The final grade will be based on the following:

- **Pre-lab material (5%)**: due biweekly
- **Lab notebooks (35%)**: due biweekly
- **Lab report (25%)**: best grade out of 1st submission and 90% of 2nd submission
- **Homework (20%)**: due biweekly, lowest score is dropped
- **Final exams (15%)**: during the last two lecture times

Prior to coming to the lab, you should read through the lab manual and prepare an initial draft of all scripts that you will need for the lab. Place all your scripts in a single zipped folder. Pre-lab materials are due in ELMS by just before your first lab session for each of the seven experiments, and no late submissions are accepted.

The lab notebooks are the the written record of everything you do in the lab: set up, measurements, results. They should allow you to repeat the experiment a long time from now. They are due at the beginning of your lab section the week after the experiment is finished (see "Schedule"). **You must submit a notebook of sufficient quality for all six experiments to pass the course.**

For Experiment #2 (lenses), you will submit a lab report. This will be the formal document containing a brief description of the experiment, the results, and conclusions. More details on these items can be found in the "Course specifics" section below. A lab notebook or report submitted after the deadline will receive a **penalty for each week it is late of 20%**, unless you have prior approval from your instructor.

Homework are due at the beginning of the lecture after it was assigned. **Late homework will not be accepted** as solutions will be posted shortly after the deadline and explained in the lecture. Only a subset of the problems, announced after submission, will be graded.

Lab notebooks and reports, as well as homework, are to be submitted in .pdf files via ELMS. After uploading the file, **you should make sure that it is the correct file and is readable by previewing it in the system.** You can do this by clicking on "Submission Details" and then on "View Feedback".

The final exams will cover the material seen in the lectures and labs. They will be taken in class in the time slot of the last two lectures.

COVID-19 situation and policies

COVID-19 is a **very serious disease** that not only affects populations at risk. In some cases, it also kills or permanently/long-term damages the organs of young and healthy individuals. The virus is **transmitted most effectively by infected people** displaying symptoms, but, insidiously, it also spreads **via asymptomatic carriers**. Thus, until further notice, the following measures will be in place

- **Vaccines** are **mandatory**.
- **Stay at home** and notify the instructors **if any of the COVID-19 symptoms are experienced**.
- **Masks** covering nose, mouth, and chin **are compulsory**. The instructor may choose to remove their mask if a distance of more than 6 feet can be ensured with respect to all students.
- Ventilation will be maximized.

Students that do not follow these measures will not be allowed to enter the lab and lecture hall.

Course schedule

Note: This is a tentative schedule, and subject to change as necessary – monitor the course ELMS page for current deadlines. In the unlikely event of a prolonged university closing, or an extended absence from the university, adjustments to the course schedule, deadlines, and assignments will be made based on the duration of the closing and the specific dates missed.

DATE	LECTURE	LAB	TOPICS	WORK DUE
Aug 30	1	**0**	**MATLAB and LabJack programming**	Lab #0
Sep 6	**Labor day week**			
Sep 13	2	**1**	**Refraction and reflection of light**	HW #1
Sep 20	3			HW #2
Sep 27	4	**2**	**Refraction of light through curved surfaces: Lenses**	Lab #1
Oct 4	5			HW #3
Oct 11	6	**3**	**The polarization of light**	Lab #2
Oct 18	7			HW #4 & Report 1st
Oct 25	8	**4**	**The Michelson interferometer**	Lab #3
Nov 1	9			HW #5
Nov 8	10	**5**	**Diffraction**	Lab #4
Nov 15	11			HW #6
Nov 22	12 (TBD)	**Thanksgiving week**		
Nov 29	13	**6**	**Atomic spectra**	Lab #5 & Report 2nd
Dec 6	Exam #1			
Dec 13	Exam #2			Lab #6

"Report 1st" refers to the **first submission** of the **lab report** you will prepare for **Lab #2**. **"Report 2nd"** refers to the **optional second submission** for that same report you can do to try to improve your grade.

If you should miss a lab for any reason, contact your instructor as soon as possible to make arrangements for a makeup. Labs may be missed only for valid reasons as specified by the University rules book. Your instructor will try to arrange for you take the lab in another section during the same week that it is originally scheduled.

Lab policies

- **No food or liquids (including water) are allowed in the laboratory.**
- **Closed-toe shoes are required in the laboratory, no open toe shoes (sandals, flip-flops, etc) will be allowed.**

Course specifics

Lab notebooks

Keeping a meticulous, detailed record of your experiments is important in this course, and in experimental science in general. You must have a written record of everything you do in the lab; do not rely on your memory.

Your notebook grade will be based on how well you document the experiment you performed and the details of your analysis. Your notebook should show all the steps you took to perform the experiment: distances with uncertainties, step sizes, scan speeds, etc. You should describe how measurements were made, what went the calculations you performed, computer programs wrote and/or used, etc. You should be able to use only your notes to repeat the experiment five years from now. From your notes you will write your reports. Thus, it should be possible to find the raw data used for the results you present in your reports. If your analysis relies on outside results, include references to those.

Lab reports

As discussed in the previous sections, you will submit a lab report for Lab #2. This lab report should have around 8 pages (no more than 15) and include the following:

- **Title Page:** name of the experiment, abstract (a brief summary of what was done and the results), your name, section number, and date.
- **Introduction:** a brief description of the experiment and its motivation, relevant theory and equations, as well as the analysis used to arrive at your conclusions.
- **Methods and measurements**: a brief description of your actual experimental setup and approach, without copying what the manual told you to use or do.
    - Schematics and diagrams of equipment and experimental setup.
    - Description of the experimental procedures.
    - Synthesized raw data (most important plots and tables with units, putting several plots on same canvas when possible).
- **Experimental results and analysis**: plots and tables of analyzed data, including your attempts and failures. All tables and figures must be numbered in order and have captions explaining their content.
    - Include a clear description of the uncertainties and sources of errors; the actual analysis/error propagation and approaches used (programs, etc.) belong in your notebooks.
    - Present the final results with uncertainties.
- **Discussion of results**: comparison of your results to expected/known/previous results.
    - Include a critical discussion of how well your measurements fit the theory or model.
    - Discuss ways to improve measurement and other possible measurements that could be made.
- **Conclusions**: short summary of what you discovered and presented in the report.

Lectures

The material covered in the lectures is instrumental to the understanding of the experiments and will be tested in the homework and final exams. Slides for the lectures will be posted after each lecture.

Tips for Doing Well

- Read the lab instructions carefully before you go to the lab and attempt an experiment. Prepare tables in your notebook to enter data.
- During class, keep a neat, well-organized and complete record in your lab notebook of the experiment including diagrams of measurement configurations actually used to obtain data, your results, and the analysis used to obtain the results
- When something in the lab is not making sense or working properly talk to your TA or instructor as soon as possible – do not hesitate to ask even what you think might be a trivial questions if you are not sure!
- Do not leave class unless you have finished your data collection and are reasonably sure about how to handle the analysis. It is often a good idea to discuss your results with your instructor or TA before leaving as well.
- Do the assigned homework diligently.
- Physics is a community effort. You are welcome to work together on and talk to your fellow students about most aspects of this class (i.e., experiments and homework); the only exception are all components of the exam, which must be done individually. You are also encouraged to your TA and instructor in and out of class.

Campus policies

It is our **shared responsibility** to **know and abide by the University of Maryland's policies** that relate to all courses, which include topics like:

- **Accessibility and accommodations**: we in UMD are committed to providing appropriate accommodations for students with disabilities. Students with a documented disability should inform me within the add/drop period if academic accommodations are needed.
- **Academic integrity**: the UMD Honor Code prohibits students from cheating, fabricating information, facilitating academic dishonesty, and plagiarism in any course. Consequences of academic dishonesty are severe if caught, and, in most cases, even if not caught right away or ever.
- **Student and instructor conduct**: students are responsible for upholding UMD's standards of conduct, and we the instructors are responsible for meeting the expectations for faculty providing undergraduate courses, such as providing a complete syllabus promptly, evaluating and sharing the student's performance throughout the course, or being reasonably available.

Please visit www.ugst.umd.edu/courserelatedpolicies.html for the Office of Undergraduate Studies' full list of campus-wide policies and follow up with me if you have questions.