Course syllabus

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

PHYS 375
Fall 2020

Overview

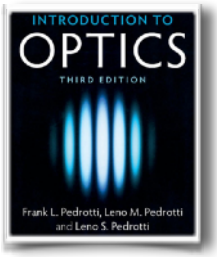
This is the fourth laboratory course in the sequence for physics majors. As in the other courses, the primary objectives consist of learning physics through experimental investigation and becoming familiar with the fundamentals of lab work, namely careful experimental set up and measurements, proper 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, polarization, interference, interferometers, diffraction, spectrometers, and atomic spectra.

Course organization

Each section will be divided into halves and will generally carry out each of the 6 experiments during 3h of alternating weeks. A series of videos released in ELMS will provide the theoretical underpinnings for the experimental work. Data analysis will be done in MATLAB and python. The Mondays 2pm-2:50pm slots will be used as office hours to discuss the lectures, experiments, and homework (due right before these sessions).

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
Released as videos in ELMS, discussed during office hours

Office hours
Mondays 2:00pm – 2:50pm
https://umd.zoom.us/j/92233784698
You can also contact us via email and we'll find a time that is convenient for everyone involved.

Labs (Franco Sevilla)
0101 - Mon 3:00pm - 5:50pm
0103 - Tue 3:00pm - 5:50pm
PHY #3115 (Toll bld.)

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

Prerequisites
PHYS 273, PHYS 276

Grades

The final grade will be based on the following:

- **Homework (30%)**: due biweekly, lowest score is dropped
- **Lab notebooks (40%)**: due biweekly
- **Lab report #1 (10%):** due the week of September 28 (pod A) or October 5 (pod B)
- **Lab report #2 (20%):** due the week of November 9 (pod A) or November 16 (pod B)

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. The lab reports are 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.

Lab notebooks and reports are to be submitted in .pdf files via ELMS. Notebooks 2,3, 5, and 6 are due at the beginning of your lab section the week after the experiment is finished (see "Schedule"). Lab notebooks + reports 1 and 4 are due two 2 weeks after the experiment is done. A document submitted after the deadline will receive a **penalty for each week it is late of 20%**, unless you have prior approval from your instructor. **You must submit a notebook for all experiments to pass the course.**

Homework is also 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". Homework are **due Fridays at 1pm**, and a **penalty of 20% per day late** will be applied. **Solutions will be posted by Mondays at noon**, and **no homework will be accepted after that time**. Only a subset of the problems, announced after submission, will be graded.

COVID-19 situation and policies

COVID-19 is a **very serious disease** that not only affects populations at risk. It also kills or permanently/long-term damages the organs of young and healthy individuals with a frequency yet to be measured, but possibly fairly high. The virus transmits primarily via droplets and aerosols emitted via mouth and nose while breathing, talking, coughing, or sneezing, and possibly through surfaces as well. **Droplets fall to ground** quickly and close to the emitter, so their risks are mitigated by **social distancing, masks,** and **face shields**. **Aerosols float** in the air and can accumulate in indoor places, so their risks are mitigated by **decreased person density** and **ventilation**. The virus is **transmitted most effectively by infected people** displaying symptoms, but, insidiously, it also spreads **via asymptomatic carriers**. Thus, the following measures will be in place to avoid spread during the lab sessions

- **Stay at home** and notify the instructors **if any of the COVID-19 symptoms are experienced** (fever, cough, new loss of taste or smell, and others).
- **Masks** covering nose, mouth, and chin **are compulsory**. Face shields are recommended.
- Maintain a **distance of at least 6 feet** apart from others without face shield.
- To ensure social distancing and low density, **only 7 students will be allowed in the lab at a time**, so the sections will be divided into halves alphabetically by last name (**Pod A** and **Pod B**). Depending on the experiment, each half will come either in alternating weeks for 3h, or 1.5h each week. In the latter case, 10 minutes would be devoted to cleaning the set up before the next half comes into the lab. The University will thoroughly clean the labs between sessions.
- Ventilation will be maximized by leaving the **doors open** and having a fan move the air.

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

Course schedule

Note: This is a tentative schedule, and subject to change as necessary – monitor the course ELMS page for current deadlines. Note that Sep 7 is Labor day, so there will not be office hours. **Lab notebooks 2,3, 5, and 6** are **due one week after the lab is taken**, right before the session, and **Lab notebooks+reports 1 and 4 are due two weeks after**.

WEEK OF	LAB	TOPICS	WORK DUE	
Aug 31	0	ONLINE asynchronous: Introduction to MATLAB and the experimental set up	HW #1	Fri 1pm
Sep 7			Lab #0	Fri 1pm
Sep 14	1A	Refraction and reflection of light [REPORT #1]	HW #2	Fri 1pm
Sep 21	1B			
Sep 28	2A	Refraction of light through curved surfaces: Lenses		
Oct 5	2B		HW #3	Fri 1pm
Oct 12	3A	The polarization of light		
Oct 19	3B		HW #4	Fri 1pm
Oct 26	4A	The Michelson interferometer [REPORT #2]		
Nov 2	4B		HW #5	Fri 1pm
Nov 9	5A	Diffraction		
Nov 16	5B		HW #6	Fri 1pm
Nov 23	Thanksgiving week			
Nov 30	6A	Atomic spectra		
Dec 7	6B		HW #7	Fri 1pm
Dec 14				

All due at 3pm	Pod A				Pod B			
	0101	0103	0102	0104	0101	0103	0102	0104
LN #1 + LR #1	Sep 28	Sep 29	Sep 30	Oct 1	Oct 5	Oct 6	Oct 7	Oct 8
LN #2	Oct 5	Oct 6	Oct 7	Oct 8	Oct 12	Oct 13	Oct 14	Oct 15
LN #3	Oct 19	Oct 20	Oct 21	Oct 22	Oct 26	Oct 27	Oct 28	Oct 29
LN #4 + LR #4	Nov 9	Nov 10	Nov 11	Nov 12	Nov 16	Nov 17	Nov 18	Nov 19
LN #5	Nov 16	Nov 17	Nov 18	Nov 19	Nov 23	Nov 24	Nov 25	Nov 30
LN #6	Dec 7	Dec 8	Dec 9	Dec 10	Dec 14	Dec 15	Dec 16	Dec 17

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. If it is not possible to arrange sufficient lab makeups, alternative assessments based on oral or written remote exams will be employed.

Course specifics

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.**
- **Check the COVID-19 policies (stay home if sick, bring a mask, maintain social distancing).**

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

Experiments #1 and #4 will also require a lab report. The goal of these reports is to learn how to produce formal and clear scientific documents with proper formatting. Make sure you include proper captions for all tables and figures, and reference external results.

Reports 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

Slides for the lectures will be posted together with each video.

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.

Other 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.