Course syllabus

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

PHYS 375
Spring 2022

Overview

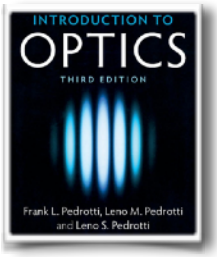
The primary objective of this course consists of learning experimental physics through studying optics and becoming familiar with the fundamentals of lab work, namely careful experimental set up and measurements, proper documentation, and analysis of the measurement uncertainties. This class is one of a few offered in our undergraduate curriculum where you will have the opportunity to develop experimental procedures, and not simply carry out prewritten instructions. You will learn how to carefully take data, analyze it, understand the origins and propagation of errors, and devise experimental protocols.

You will also learn how to use modern programming languages (MATLAB or Python). Learning programmatic data acquisition and analysis is one of the key aspects of this course, so we will not accept Excel "code." Data acquisition will be in MATLAB and analysis in either MATLAB or Python.

Course organization

With the exception of a one-week introduction to the lab equipment, all of the labs will each take place over a two-week period, and you will have two lab sessions to complete the experiments. Lectures will be Mondays 2 pm - 2:50 pm. This time will be used to learn the geometrical and wave optics covered in the experiments.

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.

Prof. Alicia Kollár
2112, PSC Building
akollar@umd.edu

Teaching assistants
Eun Ji Ko
eko@umd.edu
Ibukunoluwa (IBK) Adisa
iadisa@umd.edu

Lectures
Mondays 2:00pm – 2:50pm
PHYS 1402

Office hours
Thursdays 3:00pm-6:00pm
PHYS 3115

Labs (Ko)
0101 - Mon 3:00pm - 5:50pm
0301 - Wed 3:00pm - 5:50pm
PHY #3115 (Toll bldg.)

Labs (Adisa)
0201 - Tue 3:00pm - 5:50pm
0401 - Thur 3:00pm - 5:50pm
PHY #3115 (Toll bldg.)

Prerequisites
PHYS 273, PHYS 276

Grades

The final grade will be based on the following:

- **Pre-lab code (10%):** due ~biweekly (at 12 noon, the day of the lab session)
- **Lab Notebooks (40%)**: due ~biweekly (see schedule below)
- **Formal Lab Reports (30%):** associated with the labs on Refraction and Diffraction
- **Homework (20%)**: due every 2-3 weeks, see schedule below, lowest score is dropped

Pre-lab code: prior to coming to the lab, you should read through the lab manual and prepare an initial draft of all scripts that you think you will need for the lab. Place all your scripts in a single zipped folder. Pre-lab codes are **due by 12 noon**, the day of your laboratory session. *Prelabs will have a 50% late penalty if submitted after noon but before the start of your lab session, and will not be accepted after 3pm.*

Lab Notebooks and Lab Report: For all labs, you will be required to submit a **notebook** containing notes taken while performing the lab, along with accompanying files detailed in the lab. The **lab notebooks** are 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. For two of the labs, you will need to submit a **formal lab report**. This is a formal document, modeled on a thesis, consisting of an introduction, 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 report are to be submitted in .pdf files via ELMS. Please see ELMS for the exact due date of these reports. Lab Notebooks are typically due at 10 pm, 6 days after the experiment is finished (e.g. notebooks for a Monday lab section are due the following Sunday at 10 pm; see "Schedule"). The formal Lab Reports are due at 10 pm, 13 days after the experiment is finished. A document submitted after the deadline will receive a **late penalty** unless you have prior approval from your instructor. *The late penalty is 5% for a delayed submission on the same day, 2.5% for each additional day's delay, with a maximum penalty of 40%.* **You must submit a notebook for all experiments to pass the course.**

Guidelines for the notebook and files, and the formal lab report, will be found in the "Files" section of ELMS. Please read the guidelines carefully so you will know what is required. You may not receive a good grade if you do not check the requirements first.

Homework: Homework will be assigned on ELMS and submitted as .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 Mondays at 1 pm**, *and a* **penalty of 20% for all late HWs, with an additional 20% per day late** *will be applied. Solutions will be posted by Friday at 1 pm, and* **no homework will be accepted after that time**. Only a subset of the problems, announced after submission, will be graded. The homework grade will be a weighted average of the completion grade (40% weight) and the grade from a subset of the problems that will be graded (60% weight).

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, and masks**. **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 COVID-19 symptoms are experienced** (fever, cough, new loss of taste or smell, and others).
- **Masks** covering nose, mouth, and chin **are compulsory**. Masks with a vent are not allowed.
- Wear KN95 masks in the lab and lecture, whenever possible.
- Maintain a **distance of at least 6 feet** apart from others as much as possible.

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. **Lab notebooks** are **due six days after the lab is taken**, the **night before** the next session. The **formal lab reports are due the night before your lab session one week later (13 days after the lab)**.

WEEK OF	LAB	TOPICS	HW DUE	
Jan 24	0	Lab 0 - Advanced Data Analysis		
Jan 31	0			
Feb7	1	Lab 0.5 - Introduction to DAQ Setup		
Feb 14	2	Lab 1 - Refraction [REPORT #1]	HW #1	Mon 1pm
Feb 21	2			
Feb 28	3	Lab 2 - Lenses	HW #2	Mon 1pm
Mar 7	3			
Mar 14	-	——	HW #3	Mon 1pm
Mar 21		Spring Break		
Mar 28	3	Lab 3 - Polarization		
Apr 4	3			
Apr 11	4	Lab 4 - Diffraction [REPORT #2]		
Apr 18	4		HW #4	Mon 1pm
Apr 25	5	Lab 5 - Interferometry		
May 2	5		HW #5	Mon 1pm
May 9		——		

Due dates for Lab Notebooks and Lab Reports:

All due at 10pm	0101	0201	0301	0401
Notebook #0	Feb 6	Feb 7	Feb 8	Feb 9
Notebook #0.5	Feb 13	Feb 14	Feb 15	Feb 16
Notebook #1	Feb 27	Feb 28	Mar 1	Mar 2
Report #1	Mar 6	Mar 7	Mar 8	Mar 9
Notebook #2	Mar 13	Mar 14	Mar 15	Mar 16
Notebook #3	Apr 10	Apr 11	Apr 12	Apr 13
Notebook #4	Apr 24	Apr 25	Apr 26	Apr 27
Report #4	May 1	May 2	May 3	May 4
Notebook #5	May 8	May 9	May 10	May 11

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, wear 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 into the calculations you performed, computer programs you 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 formal lab report. 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.

A copy of your data analysis codes should be included with each lab notebook.

Programming Languages

The official programming language for this course is MATLAB. All data acquisition must be done in this language, and the course instructors are available to answer questions about how to write data acquisition and analysis code in this language.

If you have prior experience using Python and whish to do so, data analysis may be carried out in Python, rather than MATLAB. However, we cannot guarantee software support for this language. Students who are new to coding or to Python should plan to work in MATLAB.

We will not accept code written in any other languages. MATLAB and Python syntax are close enough for assignments in these two languages to be graded simultaneously. It is unfair to expect the TA to be versed in all possible languages, so we will not be able to accept code written in any other languages (e.g. Java, C, C++ …)

Lastly, Excel is not a programming language, and we will not accept "code" in Excel. Learning to cary out programatic data acquisition and analysis is one of the central objectives of this course. Once mastered, this skill will allow you to go **far** beyond what is possible in Excel. While it is technically possible to do some of the data analysis required for this course in Excel, this will not help you build the advanced data analysis skills required for the latter parts of 375, 405, and independent research.

Tips for Doing Well

- Read the lab instructions carefully before you go to the lab and attempt an experiment. Make sure to complete the code pre-lab.
- 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 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 basic data analysis while taking data to confirm that the apparatus is working properly. You want to catch any software or hardware bugs early.
- **Analyze the data that you take on the first week of the lab before the second week so that you can revise your data-taking procedure if necessary.**
- 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). 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.