Course syllabus

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

PHYS 375
Fall 2019

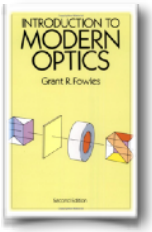
Overview

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. 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.

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

Textbooks



Required textbook
Introduction to Modern Optics
Grant R. Fowles
Dover Publications; 2nd edition (1989)
ISBN: 978-0486659572

This book is quite succinct. You can also use "Introduction to Optics" by F. Pedrotti, L. M. Pedrotti, and L. S. Pedrotti for more thorough explanations. Additionally, "An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurement" by John Taylor or "Data Reduction and Error Analysis for the Physical Sciences" by Phillip Bevington and D. Keith Robinson 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 (Franco Sevilla)
All sections meet
Mondays 2:00pm – 2:50pm
PHY #1410 (Toll bld.)

Labs (Franco Sevilla)
0101 - Mon 3:00pm - 5:50pm
0102 - Tue 3:00pm - 5:50pm
PHY #3115 (Toll bld.)

Labs (Skuja)
0103 - Wed 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:

- **Lab notebooks (20%)**: due biweekly
- **Lab reports (35%)**: due biweekly
- **Homework (20%)**: due biweekly, lowest score is dropped.
- **Final exam (25%)**: divided into two parts worth 12.5% each

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 and are due at the beginning of your lab section the week after the experiment is finished (see "Schedule"). A lab report submitted after the deadline will receive a 20% penalty for each day it is late, and therefore a penalty of 100% after five days unless you have prior approval from your instructor. **You must submit a report 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 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.

The final exam will be taken in class in the time slots of the last two lectures.

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.

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 26	1	**0**	**MATLAB and LabJack programming exercise**	Lab #0
Sep 2	**Labor day week**			
Sep 9	2	**1**	**Refraction and reflection of light**	HW #0
Sep 16	3			HW #1
Sep 23	4	**2**	**Refraction of light through curved surfaces: Lenses**	Lab #1
Sep 30	5			HW #2
Oct 7	6	**3**	**The polarization of light**	Lab #2
Oct 14	7			HW #3
Oct 21	8	**4**	**The Michelson interferometer**	Lab #3
Oct 28	9			HW #4
Nov 4	10	**5**	**Diffraction**	Lab #4
Nov 11	11			HW #5
Nov 18	12	**6**	**Atomic spectra**	Lab #5
Nov 25	**Thanksgiving week**			
Dec 2	Final #1	**6**	**Atomic spectra**	HW #6
Dec 9	Final #2			Lab #6

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 its should be possible to find the raw data used for the results you present in your reports.

Lab reports

Every report for labs 1 through 6 must have 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.
- **Method 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.
    - Raw data (plots and tables with units)
- **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 uncertainty and source 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**: final remarks short summary of what you discovered and presented in the paper.

No report is due for lab 0 (MATLAB and LabJack Programming Exercise), only the notebook with the answers to the questions in part A as well as the results from the measurements in the other parts of that lab.

Lectures

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.