

General Information

PHYS 375 : Experimental Physics III Electromagnetic Waves, Optics and Modern Physics

Spring 2016

Instructor: Dr. Wendell Hill

IPST Rm. 2120

301-405-4813

wth@umd.edu

Section 0101: Mondays 15:00 to 17:50

Section 0301: Wednesdays 15:00 to 17:50

Instructor: Dr. Andris Skuja

PSC 3103

301-405-6059

skuja@umd.edu

Section 0201: Tuesdays 15:00 to 17:50

TA: Nightvid Cole

Phys 0104

301-405-8577

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All sections

Office Hours: You may stop by Prof Hill's and Skuja's offices any time, but it is usually best to make an appointment via email. Your TA's office hours are yet to be determined and by appointment.

Meeting locations (All Section):

Lectures: Rm. PHYS 1402, Monday 14:00 to 14:50

Labs: Rm. PHYS 3203

Required Text:

Introduction to Modern Optics, 2nd Ed., Grant R. Fowles, Dover Books

Also available at BookHolders:

<http://www.bookholders.com/store.asp?mode=booklist&classid=PHYS375§ionid=0101&schoolid=1¤tsem=S16>

Plus one of the following:

An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurement, John R. Taylor, University Science Books.

or

Data Reduction and Error Analysis for the Physical Sciences, Phillip R. Bevington and D. Keith Robinson, McGraw Hill.

Recommended Texts:

Introduction to Optics, 3rd Ed, F.L. Pedrotti, L.S. Pedrotti, and L.M. Pedrotti, Pearson.
Optics, 4th Ed., Eugene Hecht, Addison-Wesley.

Prerequisites:

PHYS273 and PHYS276

Course Overview:

PHYS375 is a three (3) credit course that meets four hours a week. The primary laboratory objective consists of learning physics through experimental investigation. This class is one of a few offered in our undergraduate curriculum where you can learn some aspects of geometrical (ray) and physical (wave) optics. Topics to be covered include the following: electromagnetic waves; ray, wave and laser beam propagation; polarization; interference; interferometers; diffraction; spectrometers; and atomic spectra. There will be six experiments, each generally completed over two class periods. Each lab will include a substantial lecture component. You will also learn how to take and analyze data carefully while gaining a better understanding of the origins of errors (uncertainties) and how to propagate them appropriately. Furthermore, you will acquire an appreciation for the subtleties of experimental physics and learn how to prepare a useful written presentation of scientific results.

Lectures:

Lectures are a required component of this class. Important topics directly related to the experiments will be covered in the lectures. This is your opportunity to learn the basics of classical optics and the interaction of light with matter. In addition, this will enable you to

make connections to your other courses (quantum mechanics, electromagnetism, math physics, etc.), deepen your understanding of physics and prepare you for more contemporary studies in quantum optics and photonics.

You will not get full credit for the course if you do not attend the lectures. Attendance will be taken. Note, without a compelling reason, students not participating in the week's lecture run the risk of not being allowed to perform the week's lab activity. This determination is at the discretion of your instructor.

Experiments:

As mentioned above, you will do six (6) experiments during the semester, spending approximately two weeks on each experiment. In addition, there will be an introductory lab the first week of classes (Week 0 on the schedule) where you will explore some basic features of *MATLAB*, the *LAB JACK*, diode lasers and photodiodes. You must complete and analyze all experiments to pass this course.

Computers:

Developing a working knowledge of computers in the context of solving physics problems is an important skill in physics research. You will accumulate and analyze data with a computer-based system using *MATLAB* in this course. We will provide some elementary *MATLAB* code for use in data collection and analysis; using these you will develop additional code.

Lab Notebook:

Keeping a meticulous, detailed record of your experiments is important in Physics 375, 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. In order to do the analysis for your experiments, you will often need a record of how you set up the experiment – distances, angles, laser conditions, etc. – and how you executed the measurements. Make sure you have this information recorded before you leave the lab each time; again, do not rely on your memory! It is often helpful to take photos of your setup with your phone camera. Preparing tables ahead of time and thinking through how you would like to make your measurements will not only lead to better results, it will make the experience more enjoyable.

Historically, notes have been recorded with pen and paper in a notebook with bound, numbered pages that are intended to last for decades. Today, more and more researchers are moving toward electronic notebooks, which not only saves paper, it enables access to your notes from virtually anywhere in the world. In this class we will create an electronic

notebook with *MSWord*. (You might find *MSWord*'s notebook layout" helpful for this purpose.) You will need to upload your notebook to ELMS so it can be viewed with your report (described in the next section). This notebook should have sufficient evidence to "convict" you of having done the experiment and to repeat your experiment with it alone. At times, you may find it helpful to write things by hand. Thus, you will also need a dedicated notebook that lies flat (such as a spiral notebook) for this purpose. Your handwritten notes (e.g., calculations) must also be uploaded to your electronic notebook. Please resist the urge to use scraps of paper or individual binder pages for your notes and recopying information into your bound notebook; a loose-leaf notebook is not really appropriate for detailing your experiments! If you use a program to perform calculations (e.g., *Excel*, *MATLAB*, etc.) upload copies of the code and the results to your electronic notebook. Extremely large programs and data sets may need special handling; ask your instructor for advice. You might find it useful to use a Google drive or other cloud-based storage options to keep your data and notebooks. However, you must prepare a single notebook document with your notes and analysis for each experiment and upload it to ELMS as a pdf file for your instructor and TA to grade along with your report; the notebook pdf document must be a separate document from your report document! Remember, there has to be sufficient evidence that you performed the experiment and the analysis to get full credit for you reports (see report grade budget below).

Lab Reports:

Lab reports must be written using either *MSWord* or *Latex* and must be submitted electronically as a pdf file to ELMS by the due date and time, along with the pdf notebook file. Reports (and notebooks) are due at the beginning of the lab period (3:00 PM) on the due date indicated by the course schedule. Reports (and/or notebooks) turned in electronically after 3:00 PM will be consider at least one (1) day late! Reports will be considered on time if (1) both the report and notebook files are submitted before the deadline and (2) both files are readable electronically as pdf files. If either file is not readable as a pdf file electronically by your instructor and TA, they will have to be resubmitted and will likely be considered late!

You will write a report for each of the six. The report for the introductory lab (Lab 0) will consist of answering questions and will count as an additional homework assignment; it will be due at the beginning of the second lecture. The reports for Experiments 1 - 6 should consist of prose and be between 10 and 15 pages long. Reports should be complete with embedded tables and figures and appear as professional documents. Details for what to include are given below. The six reports are due at the start of each lecture on the dates indicated by the schedule along with the notebook files! Reports must be submitted electronically to ELMS. Lab reports submitted after the deadline will receive a 20% penalty for each day they are late, and therefore a penalty of 100% unless you have approval from

your instructor ahead of time – *No Exceptions!!!!*

Every Report must have the following:

- **Title Page** – name of the experiment, abstract, your name, section number and date.
 - Abstract – a brief summary of what was done and the results.
- **Introductory Material** – a brief description of what will be described in the paper. This is where you should provide the reason you are doing this experiment and why your reader should care; mention relevant theory (and equations), what you are testing, explaining only the theory required to understand your experiment, data and the analysis used to arrive at your conclusions.
- **Experimental Approach/Method and Measurements** – a brief description of your actual experimental setup and approach (not what the manual told you to use or do). All descriptions should be give in complete sentences; DO NOT CUT AND PASTE THE EQUIPMENT LIST GIVEN IN THE MANUAL!
 - Provide schematics and diagrams of equipment and experimental setup.
 - Give a description of the experimental procedures.
 - Present raw data (plots and tables with units!); no analysis at this point!
- **Experimental Results and Analysis**
 - Provide plots and tables of analyzed data; focus on the final result in these reports; your attempts and failures, etc. should appear in you notebook; all tables and figures must be numbered in order and have captions explaining their content.
 - Give 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**
 - Compare your results to expected/known/previous results.
 - Provide 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.

The grading of lab reports will follow the following rubric:

Organization and logic of report	15 pt
Laboratory skill and documentation – this is your your notebook score and is based on how well you performed the experiment, documented what you did and documented how the analysis. Your notebook should show all the steps you took to carryout and to perform the experiment and analyze the data, both successful and failed steps. The analysis that appears in your report should be backed up in your lab notebook.	40 pt
Data analysis – how believable is your data as presented in the paper (report). Was the correct analysis performed? Were the errors handled appropriately?	30 pt
Discussion of results – comparison to theory, comparison to other results, description of ways to improve the measurements	15 pt
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TOTAL	100 pt

Homework:

Homework material is designed to complement the lecture and laboratory segments of the course. Homework is assigned every two weeks, with due dates falling between the lab report's due dates. Typically, each homework problem will be worth about 5 pt with the total number of points varying per assignment. **Assignments are due at the beginning of the lecture period before the lecture begins. Late homework assignments (submissions attempted after lecture begins on the due date) will be considered 1 hr late. Assignments received after the beginning of Monday's lab will be considered 2 hr late. Assignments received after 6PM on the date due will receive a score of 0! To pass the course, you must submit all assignments even if they late enough to receive 0 pt!** You have at least a week to complete each assignment; the assignment due dates are given in the course schedule. If you will be late or miss a lecture on a due date plan ahead and get your assignment in early. Solutions will be posted at midnight on the due date.

Homework assignments should be turned in before lecture on paper and submitted to ELMS before the due time. Generally, attendance will be taken by the hardcopy of the homework assignments submitted in class. You need preapproval to submit your online only! Online submissions not accompanied by a hardcopy are subject to receiving less than 100%!

Final Exam:

The final exam will consist of two parts. The written part will be taken during the lecture period the last time the lecture meets (see the schedule). The lab part will be given the same week as the written part but during the lab times. You will be prepared to do well on the exam if you do all the labs and homework assignments diligently.

Experiment Instructions (Lab Manual):

The course emphasizes your own experimental design. Consequently, we will not use a traditional Lab Manual. Information necessary for each lab will be made available via ELMS. This is another reason why you must keep detailed notes about what you did.

Course Grading:

Lab Reports – all will count and have to be completed to pass the course. Late lab report submissions are subject to a loss of 20% per day starting at 2:00 PM on the due date!	50%
Homework – all will count and have to be completed to pass the course. Late homework submissions are subject to a loss of 20% per hr starting at 2:00 PM; solutions will be posted at midnight the day the assignments are due.	20%
Final Exam (written and lab performance).	20%
Lecture Attendance & Participation and Lab Attitude & Aptitude	10%

Missed Labs

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. Before missing one of the six labs, you **must be PRE-APPROVED by your instructor**. Your instructor will try to arrange for you take the lab in another section during the same week that it is originally scheduled. If this proves not to be possible, you will be able to make up the lab during one of the designated make-up times. You will get credit for missed labs only if you have made appropriate arrangements with your instructor. **Unapproved absences are subject to a loss of points!**

In case of Bad weather:

Winter in the Washington Metro area can bring large snowstorms that make travel dangerous. Should this happen and the University is closed as a result during a scheduled

lab, class will be canceled, and we will most likely reschedule the lab for the following week. Closing is announced over local radio and TV as well as on the [University's homepage](#).

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 isn't making sense or isn't working 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.

Academic Integrity:

"The University of Maryland has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism." For more information on the Code of Academic Integrity or the Student Honor Council, please visit the following url: <http://shc.umd.edu/SHC/Default.aspx>