General Information

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

Fall 2018

Instructor: Dr. Wendell Hill
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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
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Section 0201: Tuesdays 15:00 to 17:50

TA: All sections
TBD
TBD
TBD
TBD@umd.edu

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 1410, Monday 14:00 to 14:50
Labs: Rm. PHYS 3203
Schedule:
http://www.physics.umd.edu/courses/Phys375/HillFall18/PHYS375 Fall 2018 Schedule.htm

Required Text: Available at the UMD Bookstore and BookHolders;
Introduction to Modern Optics, 2nd Ed., Grant R. Fowles, Dover Books

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.

DO NOT purchase the E-LAB MANUAL ACCESS CODE for Expert TA!

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 are five experiments, each generally completed over two class periods, plus an introductory lab. 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 summary of your 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 five (5) 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 you will create an electronic notebook in *MSWord* or some other friendly word processor. (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 with *MSWord* or *Latex* and must be submitted electronically as a **pdf** file to ELMS along with your lab notes, also a **pdf** file. Reports (and notebooks) are due at the beginning of the lab period (15:00) on the dates indicated by the course schedule. 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 pdf file is not readable by your instructor and/or TA, it will have to be resubmitted and might be considered late! Reports (and/or notebooks) turned in after 15:00 will be considered at least one (1) day late! 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 (5) unless you have prior approval from your instructor. **You must turn in a report and lab notes for each experiment. You must submit a report for all experiments to pass the course! No Exceptions!!!!**

You will write a report for each of the five experiments. No report or lab notes are due for the introductory lab (Lab 0). However, you are responsible for answering five (5) questions posed in the description; your solutions are to be submitted as part of HW 0. The reports for Experiments 1 - 6 should consist of prose contained within 7 and 10 pages, but no more than 15 pages. Details for what to include are given below. Reports should be complete with embedded tables and figures and easy to read. Use equation mode for symbols and formula!

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:

Lab Notebooks – experiment & analysis documentation: Your notebook score is 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.		**40 pt**
Lab Reports – summary of the experiments and results:		**60 pt**
• Organization and Logic of the report	15 pt	
• Summary (not the details) of data analysis – make clear what you did in the analysis, the details will be in your notebook; justify your approach to the analysis; describe the major sources of uncertainties.	30 pt	
• Discussion of results – compare your results with theory and similar results found in the literature if appropriate; discuss issues you faced in doing the experiments and how you might improve the measurements with the instrumentation you have.	15 pt	
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, the homework helps prepare you for the experiments. You can download the assignments from ELMS. Assignments are due on the day of lecture before the lecture begins. Solutions will be posted on Wednesday morning. Any homework received after the solutions are released will receive 0 pt. You have at least a week to complete each assignment; the assignment due dates are given in the course schedule.

Homework assignments should be turned in before lecture on paper. Attendance will be taken; a hardcopy of the homework assignments submitted in class and random photos of the class are the proof you were in class. If, for some reason, you cannot make it to class let your instructor know and request permission to submit your homework online as a pdf file. Prior approval is required to receive credit for you homework! Your assignment must be readable and turned before the solutions are released, which generally occurs at 11:59 pm on the due date + 1 day!

Final Exam:

A final exam will be given and may consist one or two parts. There will definitely be a written part; see the schedule for when it will occur. There may also be a lab part, that will would be given the last week all three sections can meet. You will be prepared to do well on the exam if you do all the experiments 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 3:00 PM on the due date!	50%
Homework – all will count and have to be completed to pass the course. Late homework is subject to a 25% loss if turned in after 2 PM on the due date; 50% loss if turned in the following day before midnight; 100% loss if turned after solutions are posted, 12AM due date +2 (Wed).	20%
Final Exam (see course webpage for schedule link).	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 five 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 meeting, 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

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