Spring 2019

COURSE SYLLABUS
PHYSICS 415L: OPTICS LABORATORY

Description:
Laboratory to accompany PHYS 415. Corequisite: PHYS 415 enrollment.

Text:
None. Hand-outs will be given for each experiment.

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Office Hours:
I will announce office hours in class. Feel free to check to see if I am in at other times as well.

Goals:
This course is designed to supplement, in a hands-on manner, Physics 415. Thus, it shares the goals of that course. In addition, this course is designed to be an *exploration* of optical phenomena, some of the equipment and techniques that are used to observe them, and some of the applications of these phenomena. Thus, I intend that you not only study in more detail certain optical processes, but also gain facility in setting up optical experiments and become familiar with some commonly used optical instruments and devices. Finally, I intend that you gain some facility in keeping a well-documented lab notebook and in communicating your results, two essential skills for a research scientist.

Outline:
We will do some experiments from the following list. The specific experiments we perform will depend on time and interest.

Section 1: Geometric Optics	1.1	Spencer Spectrometer
Section 2: Detectors	2.1	Semiconductor Detectors
	2.2	Photomultiplier Tube
Section 3: Interferometry	3.1	Michelson Interferometer (Measurement of Wavelength)
	3.2	Michelson Interferometer (Measurement of Sodium Doublet)
	3.3	Michelson Interferometer (Measurement of Air's Refractive Index)
	3.4	Fabry-Perot Interferometer (Measurement of Wavelength)
	3.5	Michelson Interferometer (Measurement of Glass Dispersion)
Section 4: Polarization	4.1	Production & Analysis of Polarized Light
	4.2	Dichroic Sheet Polarizers
	4.3	Fresnel Equations
Section 5: Diffraction	5.1	Fraunhofer Diffraction
	5.2	Fresnel Diffraction
Section 7: Nonlinear Optics	7.1	Faraday Rotation

Sometimes more than one experiment will be performed in one session. I will give you an experiment hand-out several days before you are to perform the experiment so that you can read it and be familiar with the experiment before you come to lab.

Notebook:
You are required to keep a lab notebook. The exact size and form is your choice. I would prefer a bound notebook. All observations, measurements, calculations, and results should be entered in the notebook. Most experiment hand-outs contain a "Report" section with a list of calculations to perform, plots to make and analyze, and/or questions to answer. All of these results must also be entered in your lab notebook. I will collect your lab notebooks periodically to grade your performance for each lab. You will be told in advance when I will be collecting notebooks. Note that a formal written report is not required for each lab.

Some guidelines for keeping a good lab notebook:
1. Always enter the date in the margin of your lab notebook any time you make an entry.
2. Number the pages.
3. Use ink. Lead can fade and be erased.
4. Never completely cross out an error or use white-out. Simply put one line through the error and write the correction next to the error.
5. Secure print-outs of plots, data, etc. in your notebook with tape or glue. Be sure to fully explain each plot.
6. Be as neat and as organized as possible.
7. Keep the notebook as documented as possible. Make references to other pages when appropriate. Some one who reads the experiment hand-out should be able to read your lab notebook and easily understand your data and results.

Paper:
You must present your results from one experiment in the form of a scientific paper. The paper is due at the end of the semester but can be turned in earlier. The paper must be written using a word processor and plotting software. Stylistically, it should follow the format of the sample paper from the *American Journal of Physics* that is posted on our course page. Include the same sections and use the same headings as the example paper. Specifically, the paper should have the following elements.

Title (in bold)

Name of Author
Author's Affiliation (in italics)

Abstract (few sentences which summarize what you will present in the paper)

I. Introduction (Give a little background to the topic that you investigated. Describe what you examined and how you examined it. You should describe the theory behind what you examined. Don't go overboard, though, on the theory. Your readers should have some familiarity with the topic. Number equations in parentheses on the right side of the page as in the sample paper.)

II. Experiment (Describe the set-up and exactly what quantities you measured. Diagrams are very useful in describing set-ups. I would expect that at least one diagram is necessary.)

III. Results and Discussion (Include your raw results and the subsequent analyses performed on the results. Include any plots with appropriate descriptions.)

IV. Conclusions (A brief summary of what you can conclude from your results. You should also make suggestions for improvements in the experiment for future use.)

References (Follow the format for references in the sample paper. You do not have to refer explicitly to the sources in the body of the paper. You can use the experimental description that I handed out to you as a reference.)

All diagrams and plots should be labeled as "Fig. #" starting with "Fig. 1". Each should include a caption. They should be referred to in the body of the paper as "Fig. #". All tables should be labeled as "Table #" starting with "Table I". Each should include a title. They should be referred to in the body of the paper as "Table #". Again, see the sample paper for specific examples. The papers should not be too lengthy. I suggest that you show me a draft of your paper for my comments before you make your final submission.

Grading:

For each experiment set, you will receive a grade out of 100 points. A set may consist of one long experiment or more than one shorter experiments. You should complete the "Report" section of an experiment in your notebook as soon as possible. If a section is not complete at the time of grading, your grade for that experiment set will be substantially reduced. No resubmission is allowed. Feel free to come in and discuss your results to a particular experiment at anytime.

The average of all of your set scores will contribute 80% to your final grade. The remaining 20% will come from your paper. Your final letter grade is determined using the following scale.

A	B	C	D	F
(90-100)	(80-90)	(70-80)	(60-70)	(<60)

Attendance/Participation:

It is extremely important to attend the scheduled lab meetings since equipment will be shared between different experimental setups. If you must miss a lab meeting, let me know beforehand so that we can make arrangements. Missing lab meetings without warning or without making up work will be considered in determining your final grade.

A Final Word:

I fully intend that this lab be a fun and exciting journey into the fascinating world of light. The lab notebook is designed to make efficient use of your time in this course while helping you gain insight.