Syllabus: Optics I, PHY431, Spring 2019

3 credits *(2 h lecture, 3 h lab)* Prerequisites: PHY 183 or PHY 184 or PHY 184B or PHY 234B or PHY 294H, PHY 192, PHY 215 or PHY 215B, and completion of Tier I writing requirement.

We will cover geometric optics: e.g. lenses, mirrors, ray tracing, aberrations, apertures, and stops, and wave optics: e.g. diffraction, interferometry, polarization, spectroscopy, fiber optics etc. The course integrates lectures/homework/group work/exams with a lab. The lab focuses on practical optics experience and experience with basic scientific practice including 'formal' lab write-ups and rigorous error analysis.

INSTRUCTORS:

Lectures: Carlo Piermarocchi, Rm: 4263 Biomedical & Physical Sciences Bldg., Telephone: 5-5631, Email: carlo@pa.msu.edu. Office Hour: Wednesday 1-2 pm

Laboratory: Pawel Danielewicz, Room 2101, Cyclotron Bldg., Telephone: 5-9672x330 or 517-908-7330, Email: danielew@msu.edu. Office Hour: Tuesday 2-3 pm or by appointment

TAs: Rahul Jain (jainrah1@msu.edu), Rm. 1308 BPS, Office Hour: Tuesday 5-6pm & Joe Kitzman (kitzmanj@msu.edu), Rm. 1308 BPS, Office Hour: Thursday 10-11am

Text: *Introduction to Optics, by (Pedrotti)^3 (Addison-Wesley).*

Course Structure: 2 lectures per week in room 1300 of the Biomedical and Physical Sciences Building. Tuesday and Thursday; 9:10 am - 10:00 am. One lab of about 3 hours every week starting the week of January 28, in room 1250 of BPS.

Homepage: http://d2l.msu.edu

Grading:

Homework: We will have graded homework problems during the semester. Successfully working the homework problems is a key part of learning the material. Normally problems will be posted online on the class D2L site on a Thursday and are due the following Thursday in class (problem sets will be available at least a week before they are due). There will be 9 homework sets altogether, of which the best 8 will count on 10 point scale each towards your final grade. The first homework assignment is due on Thursday, January 17 in class. Late homework will not be accepted.

Group Work: Some special topics will be covered as group work. The groups will be composed of pairs of students who will give a 15 minute presentation on the topic assigned. Each group member will have to contribute to the presentation, and the grade will be individual. Topics will be posted on D2L and students can sign up individually or as a pair on a first-come-first-served basis. Students may also suggest topics. Additional information on the project format and grading expectations will be available in a D2L document.

Midterm Exams: There will be two midterm exams, on Tuesday February 5 and on Thursday March 28. You should bring a calculator and you may bring your course textbook. There are no

midterm makeups -- if you miss either one or both midterms and provide a valid excuse (a written note from a doctor, dean etc.), then your final exam score will be multiplied by either 1.75 or 2.5 depending whether if you miss one or both midterms.

Final Exam: The final exam will take place on Tuesday April 30 from 3:00 pm until 5:00 pm. The final exam will cover everything we get done, but with a slight emphasis on the last half of the course. You should bring a calculator and you may bring your course textbook. You must take the final and, if you miss it due to a valid excuse (see before), you will have to take a make-up -- otherwise you will get a 0.0 for the course.

Optics Lab: The lab will be run by the TAs and Prof. Danielewicz in room 1250 Biomedical & Physical Sciences. The lab contributes 45% to the total class score. The first lab will take place during the week of January 28. There will be a total of 10 labs. See the attached lab syllabus for details.

Final Grades:

The final class score is based on the following formula:

	%
First Midterm	**10**
Second Midterm	**10**
Homework	**7**
Group Work	**8**
Final Exam	**20**
Laboratory Total	**45**
TOTAL	**100**

The required scores for the final grades listed below may be lowered in your favor, but not raised:

Total point percentage	Final grade
>90%	**4.0**
85%-90%	**3.5**
80%-85%	**3.0**
75%-80%	**2.5**
70%-75%	**2.0**
65%-70%	**1.5**
50%-65%	**1.0**
<50%	**0.0**

LABS

Here is a list of the labs. The lab protocols will be placed in a folder on D2L. You need to read through the lab protocols *before* each lab. Lab reports are due the following week in lab. The last lab report and scientific paper are due Thursday, April 25 in class.

WEEK	LAB	DUE DATE (in your section the week of)
Jan 28	L1: Thin Converging Lens (Secs. 1&2)	Feb 4
Feb 4	L2: Thin Divergent Lens (Secs. 1&2) L1: Thin Converging Lens (Sec. 3)	Feb 18 Feb 11
Feb 11	L2: Thin Divergent Lens (Sec. 3)	Feb 18
Feb 18	L3: Periscope, Telescope and Microscope	Feb 25
Feb 25	L4: Lens Aberrations	Mar 11
Mar 11	L5: Polarization	Mar 18
Mar 18	L6: Interference Fringes & Newton's Rings	Mar 25
Mar 25	L7: Michelson Interferometer	Apr 1
Apr 1	L8: Diffraction Slits and Gratings	Apr 8
Apr 8	L9: Holography	Apr 15
Apr 15	L10: Laser Tweezers	Apr 25 (in class)

Requirements: You are required to attend one 2.8 hour lab per week (your section). We require you to maintain a lab notebook to assist you in organizing your experimental notes and for recording raw data. This notebook will not be turned in with your write-ups, but may be inspected by instructors for a variety of reasons. Digital cameras are available in the labs, but you may also use your own. A phone is fine too, if providing sufficient quality. Please also bring a pocket USB flash memory drive to allow you to bring home digital images. There will be no opportunities to make up missed labs. Please consult Prof. Danielewicz for cases where more than one lab is missed for legitimate reasons (such as an extended illness). For each lab session a student may be awarded up to 4 points by the instructors for lab performance including attendance, preparation, independence, but also cooperative spirit, demonstration of problem solving skills and record maintenance.

Partners: The experiments will be performed in groups of two. Groups of three should only occur if an odd number of students attends. Of course, you should divide the labor with your partner. For example, one person might read the measurement values while the other record those values in their notebook, etc. Although each group must perform the experiment independently, you are encouraged to observe and discuss experimental issues with the other groups. Group members will be determined by the TA and will vary from one week to another.

Reports: Each partner is required to write their own formal report for each experiment performed, normally due at the beginning of the following lab (see the lab table before). We will have 10 experiments in all. Each group must perform its own analysis, and the write-ups must be written independently. Hand written reports will not be accepted. The write-ups must be

prepared using a word processor, such as MS Word, with imported graphics and images when applicable. Each report is graded on a 10 point scale, so that a student may earn up to 14 points per lab session. The write-ups should contain (approximate point awards are shown in the brackets):

Title & Abstract [1]: Provide title of the experiment. Underneath provide your name followed by the name of your partner. Thereafter the abstract should briefly state the major goals and results of the experimentation. For example: "A Michelson interferometer has been used to determine the difference in wavelength of the sodium D lines. A value of 5.9 ± 0.2 Å was found, which agrees with the accepted value."

Introduction [3]: Start your report with an introduction that describes ideas behind the experiment, guidance of the theory, methodology and setup. Provide a diagram drawn by yourself and/or your partner showing principal components and relations between them. A hand sketch is all right. The components of the setup should be marked on the diagram.

Analysis & Discussion [3]: Present your results. Quantitatively compare your data with expectations. Always provide error estimates to make your statements meaningful. Do not recopy all the raw data for your report. Rather, give examples and/or the range of the numerical values where appropriate. Present data in terms of graphs as much as sensible. Do the measurements agree with theory within your estimated errors? If not, can you suggest possible sources of the discrepancy? Answer the questions asked in the instructions.

Conclusion [2]: Close your report with a brief statement summarizing your results. Did you find what you expected? What improvements would you make if you were to repeat the measurements?

"Polish" [1]: Overall readability and clarity of the report is important. Are the figures well described and easy to understand? Does your report look 'professional'? Will it be easy to grade by an instructor?

Sample lab report and/or link to such will be provided on D2L. Do not copy and paste lab instructions, unless you are responding to the questions posed there. When you find it necessary to quote in your report any claims, statements, figures or photographs from elsewhere, clearly indicate the sources you used. The first two reports will be graded more leniently than the later reports, to give students extra room for learning from the received feedback.

Scientific Paper (Tier II writing requirement): You should select one of your early lab reports and evolve it into a short experimental science paper in the style of Physical Review Letters or Physics Letters. Rather than following the chronology of activities of the specific lab, you should pick up a scientific issue pursued during the lab, such as phenomenon, experimental method or validity of a formula, and you should place the issue and your measurements in a broader perspective. Paper on designing a better laboratory exercise, in the style of American Journal of Physics, is also an option. If you need extra time for any additional measurements or exploration at the laboratory, in the context of your paper, please negotiate such time with the instructors. Explore the history behind the chosen issue and contemporary literature. Aim at a paper 2200+-400 words long. Add appropriate references.

The paper will be graded on a 30-point basis. In grading, the instructors will look for the following:

Is there a well formulated scientific issue being addressed?

Is there a schematic representation for the experimental setup included?

Is the scientific design of the experiment described?

Is the data analyzed in a scientific manner? Is there a scientific error analysis?

Is there a scientific explanation and/or argument using empirical evidence?

Are there plots with appropriate scales, units, and labels?

Are there relevant citations to the scientific literature?

While most of these questions can be asked of the lab reports too, in the case of the scientific paper you get more time to ponder answers and this will be taken into account by the graders.

The schedule for the scientific paper is as follows:

WEEK	DELIVERY DUE
Mar 11	**Discuss paper topic with TA**
Mar 18	**Literature list**
Mar 25	**Outline**
Apr 8	**Draft**
Apr 23	**Final Paper**

Grades:

Your lab score will consist of the highest 9 of the 10 lab week scores and the paper score that combine to the maximal 9 x 14 + 30 = 156 points. At the end of the semester your point total will be scaled to the base 45% toward your final grade.

Absence / Late Policy: There will be no opportunities to make up a missed lab. If only one lab is missed, there is no need to provide an excuse, as only the highest 9 of 10 labs count toward the final grade. If more than one lab is missed with a legitimate excuse, such as an extended illness, you should inform Prof. Danielewicz within 48 h following the lab. In most cases Prof. Danielewicz will ask for some documentation, such as a doctor's note.

Lab reports that are turned in after their due date will be penalized by one point per day. For example, a lab turned in a week late will be penalized by seven points. If the delay is due to a legitimate reason, once again you should notify Prof. Danielewicz within 48 hours. In most cases Prof. Danielewicz will ask for some documentation, such as a doctor's note. Delays in meeting the paper schedule will result in deductions from the maximum that can be awarded for the paper.