Phys. 1361, Wave Motion and Optics, Fall 2020

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Lectures	WF	1:15-2:05 pm	900 LRDC	**G. Dutt**
Laboratory	W	2:15-5:20 pm	306 OEH	**TA: Pubudu Wijesinghe**
Laboratory	F	2:15-5:20 pm	306 OEH	**TA: Qi Yao**

TA contact :
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Qi Yao, 500 Allen, e-mail : qiy28@pitt.edu, Office hours : TBD
The course manual will be distributed on Canvas. Print only what you need on a given day! **A** week-by-week lab schedule will be posted in Canvas, in the calendar. Please check the calendar regularly.

E-mail: We frequently use e-mail for announcements and distributing course material. Please, read your e-mail regularly, and make sure that your account is not over quota!

Covid-19 Pandemic and Flex@Pitt

This semester presents another challenge as the first full semester since the Covid-19 pandemic started and the introduction of the Flex@Pitt instructional model. In addition to all the other challenges of teaching during this period, this course faces a unique set of challenges since we have a strong laboratory component. I have tried to address these challenges, but realize that this may need adjustment and work as we go along, and I ask for your patience as we try to figure out how to give you the best educational experience. I also realize many of you face challenges, whether its learning from home or coming for in-person classes and labs, and want to do my best to accommodate you while remaining fair to everyone. The approach I am adopting offers two options for students to choose from, which are enumerated in the labs section of this syllabus. I am planning to be as open and transparent as possible during this semester, and why changes may have to be made as we go along, and I hope you will also be open and transparent and let me know when something is or is not working.

Lectures

The two weekly lectures cover the theory of geometrical and physical optics, and waves in general. The plan is to have the lecture material posted, with lecture videos to be available prior to the actual class time, and then to use the in-class time for group discussion, questions on the material, and some problem solving. Each lecture will have associated quizzes and there will be assignments for the videos to ensure you are watching them and to help with active learning. This is the first time I am teaching the course in this manner, so changes may be made to this plan as we go along. Whenever possible, the lectures will include a discussion of lab project of the week, but it is not always possible to synchronize labs and lectures exactly. Therefore, you should always read the chapter of the textbook that deals with the subject of the current lab experiment.

Extra Credit: The quizzes, outlines, reading and other assignments that are posted in the videos and on Canvas will be used for extra credit accounting for 7.5%. This implies you can get a total of 107.5% or equivalently you could drop ~ 3 HWs and make up for it with the extra credit. I don't encourage you to do that of course, since the HW will be important for your exams.

Textbook
Author: E. Hecht
Title: Introduction to Optics (5th edition)
Pearson, ISBN-13: 978-0133977226
ISBN-10: 0133977226

I am aware that the cost of this textbook is high. A lot of the material is the same as in the earlier editions, but if problems are assigned from the text, you will need to look up the right problem from this edition.
There is also an e-book available via Redshelf which is significantly cheaper. I can supply details if anyone is interested.

Exams
There are two exams, one midterm, one final, both of which will be remote. Separate grades will be given for homework which will be assigned in class.

Some additional exercises are included in the lab hand-outs for the first nine standard labs. These exercises should be turned in along with the lab reports.

Laboratory

There are nine standard labs that have to be completed by everyone. I am offering the following options to complete the labs to accommodate the Flex@Pitt approach:

- **Option A:** Students work in teams of two, with one partner in lab and the other zooming in remotely and observing and participating remotely as much as possible. Team members will rotate so that every student gets a chance to work in the lab. The labs are setup for social distancing, with thick blackout curtains between each optical setup. In this manner, we also restrict the number of students to at most 6 in each section. This option is probably the best for most students as you will be able to use all the equipment that is referred to in the lab manuals.
- **Option B:** Students work in teams of two, with one partner in lab and the other zooming in remotely. However, remote partner does not come in, but instead uses an optics kit. The student working remotely will have to zoom with their lab partner during the labs, and try to setup the same experiment with the optics kit at home. We are requesting that you come in one time at the beginning of the semester (once the kits are ready) to pick up your kit, or arrange to have someone you trust pick up the kit and ship it to you. Please note that the equipment in the kits does not correspond to what is in the lab manuals, so some amount of work and ingenuity will be required by the remote partner to figure this out and setup the experiment.

If you do not have a partner, you may work on your own, but we encourage such students to either come in to lab or zoom during the lab section time, since the TA and instructors will be available during that time. For maintaining safety precautions during the pandemic, we will have safety protocols which will be covered in the first lab week, and posted on Canvas and in the labs. To help with social distancing, the labs will be opened to you for the entire week, so you can choose to come

in at a different time during the week as well, but be aware that you may not have any instructor or TA available to help. It is best to check with Dr. Danko before you come in to make sure that the setup is still available. More details will be posted on canvas.

After you have completed the standard labs, you (with your lab partner) will do one or two special projects during the last three weeks of the term. Since we have only a limited number of set-ups for the special projects, you have to discuss your choice with the instructor ahead of time. We usually make up the exact schedule for the special projects during the week after the midterm exam. If you wait too long, you may not be able to do the experiment of your choice.

Remote students: Since you will not be able to carry out the special labs at home, you will submit two papers that are related to these advanced experiments. More details can be worked out in consultation with the instructor at the appropriate time.

Lab assignments

Standard Labs		**available set-ups**	**manual?**	**time**	
0	Data and Error Analysis		Yes, detailed	1	week
1	Refraction	10	yes, detailed	1	week
2	Lenses – I	10	yes, detailed	1	week
3	Lenses - II	10	yes, detailed	1	week
4	Linear Polarization	10	yes, detailed	1	week
5	Circular polarization and Optical Activity	10	yes, detailed	1	week
6	Interference (Michelson, Newton's rings, Fizeau)	10	yes, detailed	1	week
7	Diffraction by slits	10	yes, detailed	1	week
8	Fresnel Diffraction	10	yes, detailed	1	week

Special projects (Labs 9 – 12): (Discuss your choice with instructor!)

	Title	setups	Manual ?	difficulty	Time (weeks)
1	Michelson Interferometer and Lloyds mirror, index of refraction of gases	1	brief	moderate	2
2a	Microwaves, part 1, standing waves, polarization	2	brief	moderate	1
OR 2b	Bragg diffraction with microwaves and electrons	1	brief	moderate	1
3	Spatial Fourier Transform	1	brief	moderate	2
4	Coherence length of light sources (temporal)	1	brief	moderate	1
5	Ultrasound	1	brief	hard	1
6	Acousto-Optics	1	brief	moderate	1
7	Faraday effect	1	brief	moderate	1
8	Grating spectrometer with photomultiplier	1	brief	moderate	2
9	Holography (experimental)	1	brief	moderate	2
10	Frustrated total internal reflection (FTIR)		detailed	hard	2
11	Fiber Optics	1	commercial manual	moderate	2
12	Single-photon interference	1	commercial manual	moderate	2
13	Fresnel Reflection coefficients	1	brief	moderate	2
14	Optical pumping	1	brief	Moderate	2

Lab manual and lab schedule

The lab manual will be made available on Canvas in the form of pdf files. See instructor and/or lab coordinator for copies. **A** week-by-week lab schedule will be posted in Canvas. Please check Canvas and the schedulre regularly. There may be additional material for the special projects.

Lab Reports

Written reports are required for all lab assignments. Your lab notebook that you maintain during the lab sections can serve this purpose, *provided it is clear and well-written*. I require everyone to start a OneNote lab notebook that will be shared with the TA of your section, and give it a title like "YourName – Optics Lab Notebook – Fall 2020".

To make sure that all students come to the lab prepared, the "Prelabs" must be completed before the lab session. "Prelabs" should have the title, main objectives of the experiment, and essential theory (no need for long derivations) and outline the experiments that you are going to perform and what results are to be expected. *Please, don't just "copy and paste" material from the manual.* This will definitely lead to point deductions. Prelabs should contain the "working equations" that you will use to analyze the data, give examples of data analysis using "dummy data" (e.g. plots of 1/x vs 1/y or Voltage vs. angle^2 will be made), and outline the error analysis. A Canvas assignment will be created for each week, where you can turn in your prelabs before the lab session is allowed to begin.

You must take written "Notes" while doing the experiment. These "Notes" should contain all measured numbers and descriptions of procedures used, sketches of optical setups and whatever information is required to document what you did in the lab. You may also take pictures of the setup, *but labels and captions are needed to explain what is in the photo*. The notes should be sufficiently clear and detailed that other people can follow them. Ask yourself if you would be able to make sense of your notes a year later! You must keep your own notes even if you work with a partner. If the TA cannot easily understand your notes, then points will be deducted even if the work is correct.

The "Analysis" part of your report will contain the analysis of the data, error analysis, comparison of experimental data to theory, and state the conclusions that can be drawn from your experimental work. The reports should include clearly identified graphs, sketches, and computer print-outs (if any). The style of writing can be informal, but the material should be presented in a logical, intelligible order. You are welcome to add a critical analysis of the experimental procedures and to suggest improvements.

You MUST get a TA or Lab manager to sign off on the lab notebook before the end of the class.

The entire report has to be submitted for grading no later than one week following the lab session (exceptions may be made during exam weeks and around Thanksgiving). The deadlines for submission of reports are firm. We will subtract **10%** for each day after the due date.

Remote students: For those of you taking the labs remotely, you must describe the challenges with trying to setup the experiments at home, how you overcame them, and corresponding uncertainties in your data. You should definitely attach pictures of the setups, with labels on the various parts, and high-resolution clear pictures of any optical images you took during the experiment.

Use of computers:

You are strongly encouraged to use computers for data analysis, graphing of data, and writing your reports. You may use any computer program that you like, provided that you explain how you

did the analysis. I personally suggest using Python for this purpose, and have handouts that I can give you. There are several computers in the optics lab and other labs in the department. Contact your instructor or Dr. Danko regarding room access etc. You are allowed to copy course material from the lab computers to your USB memory sticks etc, but not proprietary software!

Grading

Grading of reports: 0 to 50 points
10 points max for prelabs,
25 points max for notes
15 points max for analysis

Satisfactory reports will typically get 40 points. Better-than-average reports may get up to 50 points.

Course grades are based on: lab reports 45 %, final exam 20 %, midterm exam 20 %,
homework 15%
(The percentage for homework may be small, but it is very unlikely that you will do well on the exams if you don't do your homework!)

Laboratory safety etc.:

Optics is not particularly hazardous. The lasers that we use have low power, **but you should never stare into the laser beam or shine it in the direction of other students. Be careful when redirecting the laser beam with mirrors!**

Treat the equipment with some respect! Some of it is delicate and expensive. Handle optical components by mounts or edges to avoid fingerprints on optical surfaces. Ask for help with cleaning of optical surfaces (simple lenses can be wiped with lens cleaning tissue). First-surface mirrors are easily damaged by improper cleaning; get instructions before cleaning them. If you don't know how things work or fit together, ask for help.

The person in charge of all lab equipment is Dr. Danko(OEH 324). See him if you need special equipment or supplies (batteries, film etc.) or if you suspect that something is wrong with the equipment. Do not attempt to fix the equipment yourself!

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No equipment is to be removed from the lab without permission!