Spring 2025 Syllabus
PHYS 408, Optics

Instructor: Dr. Todd Pittman
Office: Physics 318
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Office Hours: Tues. 3:00 – 4:30 pm.

Lectures: MW 3:30 – 4:45 pm
Location: Sondheim 204

Course Text: *Optics* (5th edition), by Eugene Hecht

1. Course introduction

Optics is one of the most exciting and rapidly developing areas of physics. Recent discoveries in optics have led to dramatic advances in areas ranging from astronomical observations to cutting-edge research in quantum computing. In addition, the field of optics continues to enhance our daily lives through more practical applications such as advanced medicine and bringing the internet to our homes and dorms! Last but not least, the growth of integrated-optics, and photonics in general, continues to open new doors in commercial areas with the potential for large-scale financial impact (motivational hint: there are a lot of job opportunities in optics!).

Despite the growing complexity of the field, optics remains rooted in beautiful basic principles and ideas. In this course we will have a chance to study the mathematics and physics of many of these fundamental ideas, as well as an opportunity to dive into a number of "real-world" topics in modern optics. My hope is that this will serve as a solid foundation for future growth, learning, and contributions to the world through your own innovations in optics.

I want to emphasize that this is *your* course in optics, and encourage you to get as much out of it as you can. I have great deal of experience in optics and am passionate about sharing that with you. Please take full advantage of this by asking lots and lots of questions…and always try to come up with new ideas. Investigate any side-topics that appear interesting, think outside-of-the-box, and never hesitate to ask "what if we did this…" This type of theoretical exploration is somewhat equivalent to tinkering with stuff in a lab class, and I highly encourage it…who knows, perhaps you'll make a new discovery in optics and win the Nobel Prize!!

2. Course textbook and materials

The required textbook for this course is *Optics* (5th edition), by Eugene Hecht. This is a great text and is considered *the* standard workhorse optics textbook by most Universities. There are a number of other optics textbooks that are also pretty good. Most of these texts cover the same topics as Hecht, but through a variety of different approaches. If you are struggling to understand something in Hecht, or become interested and want to explore a give topic in more detail, I recommend you spend some time with these other texts. I have put 4 great books on

reserve in the AOK library (you can check them out for 3 hrs at a time). There are also copies of these books in the Meckler Reading Room:

1. *Introduction to Optics*, Pedrotti & Pedrotti
2. *Modern Optics*, Guenther
3. *Fundamentals of Optics*, Jenkins & White
4. *Fundamentals of Photonics*, Saleh & Teich

The Saleh and Teich book does a great job providing an overview of lots of exciting topics in modern optics, and will be a valuable resource for your class presentations. We will also use the *Thorlabs product catalog* in some of our homework problems. Thorlabs is a large optics company that sells a variety of optics equipment for research laboratories, and their catalog provides a wealth of information on optics. It can be found online at www.thorlabs.com

3. Course Logistics and Philosophy

The anchor-point of our course will be our textbook, *Optics*, by Eugene Hecht. A significant portion of the lecture material will be based on the relevant chapters, and most of the homework problems will be taken from the text. However, I don't believe that the standard physics lecture course format is the best way to learn optics. Given the nature of the material, and the fact that most students enrolled in the course are Junior and Senior Physics Majors, we will deviate from the standard lecture course format in two main ways: class participation, and "real world" experiences.

Student Participation

During the classes I would like to encourage as much discussion as possible. In addition to simply making the class more fun, this is the key to optimizing our learning experience. Almost every instructor says "there are no silly questions", but I really mean it. If you have ideas, or something isn't clear, or even if you want to change the direction of the lecture, I want you to speak up and contribute to the class. This is particularly important in a cutting-edge field like optics, where new discoveries are often made by seemingly trivial things that have been overlooked or not questioned. In this sense, you are in a rare position to make contributions because you are seeing this stuff for the first time. Please, please, please share your ideas and questions….I'm interested in what you have to say! In addition to open discussions, we will have several tangible aspects of student participation, including students presenting HW solutions and Class Presentations at the end of the semester.

Real World Experiences

Optics is often taught by lengthy derivations of well-known formulae, with little attention paid to what it actually means, or how if fits in with anything going on the world. I hope to avoid this pitfall! Much of what we are studying has relevance, for example, in my research on quantum computing, as well as lots of other types of exciting optics research and business being conducted all around the world. Throughout the lectures and discussions, I'll try to merge in as many of these "real world" links based on my experience in optics research, current and former Hot-Topics in the world of optics, etc. We'll also use a commercial-optics Product Catalog in some of the

homework, which will help give you a practical perspective to optics. In addition, we'll concentrate on choosing real-world'ish topics for our Class Presentations in modern optics.

4. Course Schedule

A *tentative* schedule for lecture material, exams, and class presentations is shown below. Depending on the level of class interest and discussion, we will probably spend more (or less) time on certain topics, and we will undoubtedly need to adjust the schedule of topics and readings on-the-fly during the semester. However, to help you with your planning, the exam dates are firm.

The basic idea is to get started reading the sections of Hecht listed below before we start each subject; this will go a long way towards facilitating fruitful discussions during our class time. Note that we will generally be following the progression of topics in the textbook. However, in the interest of leaving enough time for "modern optics" topics at the end of the semester, we will skip geometrical optics since this has been covered in other courses. I can provide auxiliary materials and exercises outside of class for those who would like to strengthen their knowledge of geometric optics.

Date	Topic	Reading (Hecht)
Mon. Jan 27	Class introduction and overview	
	History & Wave Motion	1.1 – 1.5, 2.1 – 2.9
	E&M theory, Photons, Light	3.1 – 3.7
	Light Propagation	4.1 – 4.5, 4.9
	Superposition of Waves	7.1 – 7.4
Mon. Mar. 3	**EXAM 1**	
	Polarization	8.1 – 8.11
	Interference	9.1 – 9.8
Spring Break	----------	----------
	Interference (continued)	
	Diffraction	10.1 – 10.2.3, 10.2.8
Mon. Apr. 14	**EXAM 2**	
	Fiber Optics	5.6 and handouts
	Lasers and Quantum Optics	13.1, 4.11 and handouts
	Class Presentations	
Wed. May 21	**FINAL EXAM** (3:30 - 5:30 pm)	

Note: Shortly after Exam 2 we will form our Class Presentation groups/topics

5. Course Grading

- Homework 15%
- Exam 1 20%
- Exam 2 20%
- Class Presentation 15%
- Class Participation 5%
- Final Exam 25%

Homework

We'll have Homework assignments roughly 2 or 3 times per month. Understanding the HW problems is a key part of your learning experience, and significant portions of the Exams will be along the lines of the HW problems. Homework will be turned in at the beginning of the class in which it is due. I cannot accept late HW since it is not fair to your classmates, and we will discuss solutions in class.

I strongly feel that making sure you have a chance to understand the homework is a valuable part of your learning experience. Therefore, we will spend a significant portion of the class (on homework due dates) going over the homework.

On the day the homework is assigned, a subset of the problems (most likely two or three problems) will be assigned to several students (one problem per student; and we'll just go in alphabetical order through the semester). On the day the homework is due, these students will take turns presenting their ideas and solutions at the board, and leading any discussion of the problems. The point of this exercise is not to put students "in the hot seat", or embarrass you if you were unable to solve the problems. If you didn't get it, that's OK; hopefully you can lead a discussion and we'll come to the solution together with input from the rest of the class. There will be no grade assigned to your performance at the front of the class. Rather, this gives the designated student an opportunity to practice technical public speaking, facilitates class discussions, and gives the rest of the class a chance to see a diversity of approaches and methods to problem solving, rather than just seeing the instructor week after week. Please feel free to use my office hours, etc. to help you prepare when it is your turn to lead the discussions!

More details on the HW expectations and grading will be provided in the "*PHYS 408 HW Guidelines and Grading Rubric*" document that will be handed out with the first HW assignment.

Exams

Exam 1 and Exam 2 will be standard closed-book in-class exams. The Final Exam will also be a closed-book in-class exam; it will be a comprehensive exam covering material from the entire course, with a slightly heavier emphasis on the material since Exam 2. Depending on class interest, we will spend class time going over the exam solutions.

Class Presentations

One of the more exciting aspects of this course will be the Class Presentations. As can be seen from the Schedule, in the beginning of the course we will cover what can be considered "standard topics" in optics. After this foundation, we will have a chance to dive into various topics in "modern optics". Many modern optics topics can be considered stand-alone topics; in other words, they don't necessarily build upon previous material as is the case in with the material in most core-physics classes. We therefore have an opportunity in this course to do meaningful independent Class Presentations.

The idea behind the Class Presentations is to divide you into groups of roughly 3 students. Each group will choose a "modern optics topic", such as pulsed lasers, holography, cavities, telecommunications, optical displays, nonlinear optics, etc. Each group will then be responsible for giving a (roughly 45 minute) presentation to the class. We will allow some class time for preparation, but the majority of your presentation will be put together outside of class. Most of these topics will not be well-covered by Hecht, and you will need to find auxiliary information to make your presentation a success. (I will be able to help you find this information). I will assign the group members, and then we'll attempt to dish-out topics of interest of each group accordingly. I will provide a list of topics, but you are certainly free (and encouraged!) to propose any other topics that you find interesting. We will also discuss methods of presenting the material, such as using PowerPoint or similar software.

In addition to getting a chance to work and learn as a team, and practice technical presentations, the nice thing about these kinds of Class Presentation projects is that you will become an expert in a specific topic! Furthermore, by listening to the other presentations, you will be able to get a nice summary of a variety of other topics. Paying attention and participating in all of the discussions is important (part of the Final Exam will cover the topics chosen by the groups). Note that the Class Presentation is worth 15% of your final grade. It is important to work well together, as a single grade will be given to each member of a given group (except in extreme cases). Generally speaking, the presentations will be graded based on clarity, thoroughness, and correctness. Further details about the exact grading criteria will be given when we form the presentation groups and choose topics.

Class Participation

General class participation is worth 5 % of your final grade. This is not based on your turns at presenting homework solutions, or your group Class Presentation. Rather, it is based on your level of participation in general discussions throughout the course.

6. Academic Integrity

As with all courses, Academic Integrity is required in PHYS 408:

By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal. To read the full Student Academic Conduct Policy, consult the UMBC Student Handbook, the Faculty Handbook, or the UMBC Policies section of the UMBC Directory.

The issue of academic integrity, particularly with regards to plagiarism, can be confusing in the areas of how to handle "working together" on homework sets, and adequately referencing materials used in your Class Presentation.

In this course, I encourage you to work together on homework sets as much as you want, except for the actual task of writing up the solutions you will turn in. In other words, it is perfectly acceptable to meet and discuss the problems, compare answers, and go over techniques with other students in the class. However, each of you should work, by yourself, when its time to sit down and write up the actual solutions you will turn in.

The same can be said for using outside materials. In some cases, it may be possible to find solutions to similar (or identical) homework problems from other texts, former students, the internet, (or even the back of Hecht!). If this is the case, you must not simply copy these solutions, and turn them in. Write the solutions in your own way, with your own words. Keep in mind that the homework is only worth 15 % of your grade, and your ability to do well on the Exams will be greatly dependent on your ability to independently solve the homework problems. Whereas it may be tempting to use outside sources (and it is not prohibited), it may be a better strategy to struggle and learn the problems on your own, even if it sometimes means missing a few homework points. (if you've really struggled, you will appreciate the provided solutions much more, and can use that as a chance to make the material really sink-in).

During the Class Presentations, it is expected that you reference the material you have used. Remember, I'm not expecting you to invent your modern optics topic from scratch; rather, to provide a nice overview of the topic to the rest of the class. Therefore, I encourage, and expect you to use a variety of sources, and give them proper credit through footnotes, etc. in your presentation. This is the normal thing to do and actually enhances the quality of these kinds of presentations. We'll talk more about proper referencing as we get closer to the Class Presentations.

7. Additional UMBC Policies, Procedures, and Resources

Accessibility and Disability Accommodations, Guidance and Resources

Accommodations for students with disabilities are provided for all students with a qualified disability under the Americans with Disabilities Act (ADA & ADAAA) and Section 504 of the Rehabilitation Act who request and are eligible for accommodations. The Office of Student Disability Services (SDS) is the UMBC department designated to coordinate accommodations that creates equal access for students when barriers to participation exist in University courses, programs, or activities.

If you have a documented disability and need to request academic accommodations in your courses, please refer to the SDS website at sds.umbc.edu for registration information and office procedures.

SDS email: disAbility@umbc.edu

SDS phone: 410-455-2459

If you will be using SDS approved accommodations in this class, please contact the instructor to discuss implementation of the accommodations. During remote instruction requirements due to COVID, communication and flexibility will be essential for success.

Sexual Assault, Sexual Harassment, and Gender Based Violence and Discrimination

UMBC Policy in addition to federal and state law (to include Title IX) prohibits discrimination and harassment on the basis of sex, sexual orientation, and gender identity in University programs and activities. Any student who is impacted by sexual harassment, sexual assault, domestic violence, dating violence, stalking, sexual exploitation, gender discrimination, pregnancy discrimination, gender-based harassment, or related retaliation should contact the University's Title IX Coordinator to make a report and/or access support and resources. The Title IX Coordinator can be reached at titleixcoordinator@umbc.edu or 410-455-1717.

You can access support and resources even if you do not want to take any further action. You will not be forced to file a formal complaint or police report. Please be aware that the University may take action on its own if essential to protect the safety of the community.

If you are interested in making a report, please use the Online Reporting/Referral Form. Please note that, if you report anonymously, the University's ability to respond will be limited.

Notice that Faculty and Teaching Assistants are Responsible Employees with Mandatory Reporting Obligations

All faculty members and teaching assistants are considered Responsible Employees, per UMBC's Policy on Sexual Misconduct, Sexual Harassment, and Gender Discrimination. Faculty and teaching assistants therefore required to report all known information regarding alleged conduct that may be a violation of the Policy to the Title IX Coordinator, even if a student discloses an experience that occurred before attending UMBC and/or an incident that only involves people not affiliated with UMBC. Reports are required regardless of the amount of detail provided and even in instances where support has already been offered or received.

While faculty members want to encourage you to share information related to your life experiences through discussion and written work, students should understand that faculty are required to report past and present sexual harassment, sexual assault, domestic and dating violence, stalking, and gender discrimination that is shared with them to the Title IX Coordinator so that the University can inform students of their rights, resources, and support. While you are encouraged to do so, you are not obligated to respond to outreach conducted as a result of a report to the Title IX Coordinator.

If you need to speak with someone in confidence, who does not have an obligation to report to the Title IX Coordinator, UMBC has a number of Confidential Resources available to support you:

Retriever Integrated Health (Main Campus): 410-455-2472; Monday – Friday 8:30 a.m. – 5 p.m.; For After-Hours Support, Call 988.

Center for Counseling and Well-Being (Shady Grove Campus): 301-738-6273; Monday-Thursday 10:00a.m. – 7:00 p.m. and Friday 10:00 a.m. – 2:00 p.m. (virtual) Online Appointment Request Form

Pastoral Counseling via The Gathering Space for Spiritual Well-Being: 410-455-6795; i3b@umbc.edu; Monday – Friday 8:00 a.m. – 10:00 p.m.

Other Resources

Women's Center (open to students of all genders): 410-455-2714; womenscenter@umbc.edu; Monday – Thursday 9:30 a.m. – 5:00 p.m. and Friday 10:00 a.m. – 4 p.m.

Shady Grove Student Resources, Maryland Resources, National Resources.

Child Abuse and Neglect

Please note that Maryland law and UMBC policy require that faculty report all disclosures or suspicions of child abuse or neglect to the Department of Social Services and/or the police even if the person who experienced the abuse or neglect is now over 18.