

**Physics 360**  
**Gustavus Adolphus College**  
**Spring 2024**

**Instructor:** Tom Huber (huber@gustavus.edu)

**Office:** Olin 209

**Textbook:** *Optics*, Eugene Hecht, Fifth Edition (Pearson, ISBN: 0133977226)

**Course Description:** An advanced laboratory-centered course covering topics in geometrical, physical, and quantum optics. The classical phenomena of refraction, dispersion, interference, diffraction, and polarization as well as Fourier optics, coherence theory, nonlinear optics, and other modern optical topics will be studied.

### Course Policy and Evaluation

1. **Prerequisites:** *Students must have completed PHY-305 (Experimental Modern Physics) with a grade of C- or better. Students are responsible for informing their instructor at the start of the course if they have not met these prerequisites; failure to do so may lead to dismissal from the course. Students must be co-registered in PHY-360-002 (Optics Lab) and PHY-365 (Project in Physics)*
2. **Lecture & Recitation:** Students are expected to attend all class sessions as listed on the course calendar, including online synchronous sessions. The student is expected to read the assigned chapters in the text **before** coming to class. See the schedule for reading assignments. Lab meets on Monday at 1:30 pm in Olin 112.
3. **Ask for Help:** If you have trouble with any aspect of the course, make sure you let me know as early as possible. By being proactive in reaching out for assistance, I can better help you identify strategies for success. If you have any questions about assignment values, attendance, or other course components that are part of course grades, please contact me before the close of the semester grading period. I will have office hours and welcome the opportunity to talk with you. See <https://homepages.gac.edu/~huber/schedule.htm>

The background of the students in the class is varied, some have had E&M and Quantum while others have not. This will present a challenge to all of us. I will try not to assume things which are an integral part of the text or a standard optics course. This means that some material may be a review for some of you, please be patient!

4. **Classroom and Lab Environment/Ethos:** As is expected in any course in the physics department, each student is asked to work, along with the instructor and their student peers, to develop a culture of cooperation and inclusion within our department. Physics can, at times, be challenging for every one of us, and we all need the respect and support of others. Please do your part in helping to create a positive supportive environment where all members of this classroom community can do their best work.

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5. **Course Communication:** Students are expected to check their Gustavus email at least once every day to ensure that they receive email messages from their instructor. Assignments and additional resources will be posted on the course Moodle site.
6. **Homework:** Homework problems will be assigned according to chapters in the textbook. *Important Note: The problem set numbering is for the US 5<sup>th</sup> Edition; if you are using an International Edition, the problem numbering may be different.* The due dates for these assignments are listed in Moodle. Homework sets should be neat and organized, with the problems appearing in the order assigned. Each student will submit their own assignment, but you are encouraged to discuss and work problems with each other, and your instructor. Copying of homework from classmate or any other source is considered a violation of the academic honor code (for more details, see Academic Honesty policy listed below). Late homework will be accepted at the discretion of the instructor and with some reduction in credit.
7. **Technology policy:** All course documents will be posted on the course Moodle site. You may use a laptop/tablet/phone in class, but only to take notes or access class material. Do not use your laptop/tablet/phone to explore the internet, do email, Tweet, visit Facebook, etc. Exceptions may be made to accommodate student disabilities. I may ask that all devices be put away during some class sessions, so please come to class prepared with a pen and paper.
8. **Exams:** There will be three one-hour exams and a two-hour final exam. Students are expected to arrange in advance to take an examination at other than the announced time. Permission to make up a missed exam "after the fact" will be at the discretion of the instructor and cannot be assumed.
9. **Quizzes/Group Problems:** There will be reading quizzes, in-class quizzes, and group problems throughout the semester based on the assigned reading.
10. **Laboratory:** There will be required laboratory experiments and an Optics Lab Project as described in the laboratory portion of the syllabus. Each group will be expected to keep a good laboratory notebook and turn in one short formal paper on each experiment and for the project.
11. **Preliminary Exam Schedule**
  - Wednesday, Feb 28, Exam 1 on Chapters 2 – 5
  - Wednesday, April 10, Exam 2 on Chapters 6 - 9
  - Monday, May 6, Exam 3 on Chapters 10 - 13
  - Saturday, May 18, 3:30 - 5:30, Comprehensive Final Exam

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### 12. Evaluation:

|                    |     |
|--------------------|-----|
| Hour Exams         | 35% |
| Final Exam         | 15% |
| Homework & Quizzes | 25% |
| Lab & Project      | 25% |

Assignment of final letter grades will be based upon the following guidelines:

|             |             |             |             |
|-------------|-------------|-------------|-------------|
|             | B+ = 86-90% | C+ = 74-78% | D+ = 62-66% |
| A = 94-100% | B = 82-86%  | C = 70-74%  | D = 58-62%  |
| A- = 90-94% | B- = 78-82% | C- = 66-70% |             |

Assignment of final letter grades will also take into account the instructor's subjective evaluation of the student's attendance, initiative, preparation (particularly quantity and quality of homework), and evidence of improvement.

13. **Incompletes:** A grade of incomplete may be awarded at the discretion of the instructor, if requested by the student, under the following conditions: 1) the last day to withdraw has passed, 2) and unforeseen circumstances beyond the student's control (usually restricted to illness or family emergency) preclude completion of the remaining work for the course by the semester deadline. Note that poor planning or having a lot of work to complete at the end of the term are not, in fairness to other students, considered circumstances beyond a student's control. This additional time to complete coursework may not extend beyond the final day of the following semester, and earlier limits may be set at the discretion of the instructor.

14. **Academic Honesty:** Submitting under one's own name work that is merely copied from another individual/source is a violation of the Honor Code. In the context of this course, students are encouraged to collaborate and to discuss their out-of-class assignments. *However, for any graded assignment in this course (e.g. homework, labs, and exams) it is a violation of the Gustavus Honor Code to copy from other individuals or utilize other sources outside of our textbook. Some examples of sources that are prohibited are answer books, computer/web software including artificial intelligence engines, web sites with posted solutions, chat or "homework help" sites, or any other similar sources without attribution. This includes using another individual/source for any parts of problems or for 'checking' answers. You should state the integral number/source when using a printed integral table or website such as Wolfram Alpha/Mathematica.* The overarching principle of the Academic Honesty Policy is that students shall submit their own work, in fairness to others and to self. Ask your professor if you have questions about a particular assignment or kind of work. Please make sure you fully understand the rules related to online work, as it pertains to this course. Unauthorized aid during online exams and assignments is every bit as serious and inappropriate as it would be in an in-person course.

The sanction in this course for a violation of the Honor Code involving plagiarism,

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copying another student on an exam, or other kinds of cheating on a single assignment will usually be a “0” on the plagiarized assignment or exam. For a more significant event, your professor reserves the right to assign you a grade of “F” for the course. In addition, for any Honor Code violation, your professor will notify the Provost’s Office. A letter will be generated by the Provost’s Office and sent to you. The letter will remain on file. There will be no further consequence, beyond the course penalty and the letter, if you do not commit any further Honor Code violations. Repeat offenses could ultimately lead to dismissal from the College. You have the right to appeal any Honor Code violation through an Honor Board hearing process. Full descriptions of the Academic Honesty Policy and the Honor Code can be found in the Academic Catalog, online at [https://gustavus.edu/general\\_catalog/current/acainfo](https://gustavus.edu/general_catalog/current/acainfo).

**15. Academic Accommodations:** Gustavus Adolphus College is committed to ensuring equitable and inclusive learning environments for all students. If you have a disability and anticipate or experience barriers to equal access, please speak with the accessibility resources staff about your needs. A disability may include mental health, attentional, learning, chronic health, sensory, physical, and/or short-term conditions. When appropriate, staff will guide students and professors in making accommodations to ensure equal access. Accommodations cannot be made retroactively; therefore, to maximize your academic success at Gustavus, please contact them as early as possible. Accessibility resources staff are located in the Academic Support Center (<https://gustavus.edu/asc/accessibility/>) (x7227). Accessibility Resources Coordinator, Corrie Odland ([codland@gustavus.edu](mailto:codland@gustavus.edu)), can provide further information. ***When accommodations are given, it is the student’s responsibility to communicate in advance of deadlines, and work with the professor to satisfy the accommodations each time they are utilized in this course.***

**16. Academic Accommodations for Religious Observance:** A student whose religious observance conflicts with a course requirement may request an academic accommodation from the instructor. Students should normally make such requests in writing by the end of the second week of classes, but there may be exceptions. Students may also request accommodations for religious traditions surrounding death and dying when the need arises. The Chaplains' Office annually publishes a multifaith holiday calendar with accommodation notations. You can find it here: <https://gustavus.edu/chaplain/multifaith/>. However, this list is not exhaustive and observances are not necessarily days when individuals will not attend work or school. There are also different levels of observance in different traditions. The Chaplains’ Office is available for consultation on any requests for accommodation that are not included in their calendar.

**17. Multilingual Student Support:** Some Gusties grew up “multilingual,” that is, speaking a language (or languages) other than English at home. Your multilingual background is an incredible resource for you, and for our campus, but it can come with some challenges. Faculty Director for Student Academic Success Elizabeth Kubek ([ekubek@gustavus.edu](mailto:ekubek@gustavus.edu)) can meet with students to consult about specific assignments and concerns, as well as helping connect with the College’s support systems. If you

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want help developing a specific skill (for example, reading word problems on an exam quickly enough, communicating effectively via email, or revising essays), let your professor know, or email Dr. Kubek to make an in-person or virtual appointment. In addition, the Writing Center (<https://gustavus.edu/writingcenter/>) offers tutoring from peers (some of whom are themselves multilingual) who can help you do your best writing.

**18. Mental Wellbeing:** The Gustavus community is committed to and cares about all students. Strained relationships, increased anxiety, alcohol or drug problems, feeling down, difficulty concentrating, and/or lack of motivation may affect a student's academic performance or reduce a student's ability to participate in daily activities. If you or someone you know expresses such mental health concerns or experiences a stressful event that can create barriers to learning, Gustavus services are available to assist you, and include online options. You can learn more about the broad range of confidential health services available on campus at <https://gustavus.edu/counseling/> and <https://gustavus.edu/deanofstudents/services/>.

**19. Title IX: Sexual Misconduct Prevention and Resources:** Gustavus Adolphus College recognizes the dignity of all individuals and promotes respect for all people. As such, we are committed to providing an environment free of all forms of discrimination including sexual and gender-based discrimination, harassment, and violence like sexual assault, domestic violence, dating violence, and stalking. If you (or someone you know) has experienced or is experiencing these types of behaviors, know that you are not alone. Resources and support are available; you can learn more online at <https://gustavus.edu/titleix/>.

Please know that if you choose to confide in me, I am required by the College to report to the Title IX Coordinator, because Gustavus and I want to be sure you are connected with all the support the College can offer. Although it is encouraged, you are not required to respond to outreach from the College if you do not want to. You may speak to someone confidentially by contacting the Sexual Assault Response Team (SART/CADA), Chaplains, Counseling Center, or Health Service staff; conversations with these individuals can be kept strictly confidential. SART/CADA can be reached 24 hours a day at 507-933-6868. You can also make a report yourself, including an anonymous report, through the form at <https://gustavus.edu/titleix/>.

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## Preliminary Schedule of Course Coverage

| <u>Week Beginning</u>                                | <u>Chapter</u> | <u>Title</u>   |
|--|----------------|--|
| Feb 5  | Chapters 2 & 3 | Wave Motion & Electromagnetic Theory,<br>Photons, and Light        |
| Feb 12   | Chapters 3 & 4 | E&M Theory and The Propagation Of<br>Light                         |
| Feb 19   | Chapters 4 & 5 | The Propagation Of Light & Geometrical<br>Optics - Paraxial Theory |
| Feb 26   | Chapter 5 & 6  | Geometrical Optics-Paraxial Theory &<br>More On Geometrical Optics |
| <b>Wednesday, Feb 28, Exam 1 on Chapters 2 – 5</b>   |                |  |
| Mar 4  | Chapter 7      | The Superposition of Waves   |
| Mar 11   | Chapter 8      | Polarization   |
| Mar 18   | Chapter 8 & 9  | Polarization and Interference                                      |
| Mar 27   | Chapter 9      | Interference   |
| Apr 8  | Chapter 10     | Diffraction  |
| <b>Wednesday, April 10, Exam 2 on Chapters 6 - 9</b> |                |  |
| Apr 15   | Chapter 11     | Fourier Optics   |
| Apr 22   | Chapter 11     | Fourier Optics   |
| Apr 29   | Chapter 12     | Applications   |
| <b>Monday, May 8, Exam 3 on Chapters 10 - 13</b>     |                |  |
| May 6  | Chapter 13     | Applications   |
| May 13   | Chapter 13     | Presentations, Applications  |
| <b>Saturday, May 18, 3:30-5:30pm, Final Exam</b>     |                |  |

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## LABORATORY

### **INTRODUCTION:**

You are a research physicist during the 21st century. Your job is to conduct experiments, make discoveries, and publish results. You hope to become famous and win a Nobel Prize before the age of thirty, so the quality of your publications is very important. The results of your research are to be published in Optics Letters. As the name implies this journal accepts results published in “scientific letter” style (see attached example). You are to publish your results in Optics Letters and orally defend your experimental results in 10 minute scientific presentations (see attachment). Good luck making history!

### **INSTRUCTOR'S NOTES:**

**Philosophy of Reports** - I want you to take your role as a research physicist seriously! I am the editor of the journal in which you are trying to get your papers published. Whether or not your papers are accepted for publication (and your lab grade) depend on how well the paper is written and the quality of the scientific evidence you present to support your findings. You must convince me that your results are real and not just experimental noise!

**Freedom** - This method of conducting a laboratory has been chosen to give you considerable freedom in the planning, execution, and presentation of experiments. I wanted to avoid “cookbook labs”. You decide what to present or include in your paper and what not to. One laboratory/research notebook is to be kept by each group - it will be collected for grading at midterm and at the end of the semester. Full points will be given for an Experimental Modern acceptable notebook.

**Supplemental Material** – For each lab, there is a central question that you will be addressing in the lab, and will be presented in your Optics Letter paper. There are generally additional measurements or questions that are addressed in the lab handout. Each group will create a Google Drive Folder that is shared with the instructor. Within that shared folder, create a folder for each lab. Store raw data files, graphics, programs, etc. in that folder. Also make a Google Document that addresses these questions including measurements, graphics, etc. Don’t worry about the format of that document – just make sure that it is complete and answers the questions addressed in the lab.

**Group Size** - You are to work in groups of two. One joint paper per group.

**Safety** - Observe safety precautions at all times. You will be taught appropriate laboratory safety procedures the first day of lab.

**Equipment** - The equipment is expensive and in short supply, so I ask you to treat it with appropriate respect. You will be taught correct handling procedures. Each group will be issued an “optics tool kit” which will be inventoried at the beginning and end of the

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course. It is your responsibility to care for and keep track of all equipment and optical components in your kit.

**Final Project** - Each group will do a laboratory project during the final weeks of the semester. The results of this project will be presented orally and submitted in letter format.

Described below are the two methods that you will use to present your experimental results.

**I. Scientific Letter Format** - The scientific letter style of presenting experimental results is a short paper used to announce significant new findings or discoveries (see example which follows). The paper should be no longer than three typed pages or its equivalent and should contain the following items. The paper should have a title, statement of authorship, abstract, body, and a reference list. The abstract is a brief summary statement about what was done and the significant results that were obtained. The body of the paper should contain an introductory paragraph that places the work in context and states why it is important. Next the experimental setup (no procedure information), results, data analysis, and theory are described. You are trying to convince the reader that you know what you are talking about. Include anything that you feel supports your conclusions, for example, data tables, diagrams, graphs with captions, and equations. Finally, the body of the text should include a concluding paragraph which restates the most important results or findings. Any references used should then be listed. All figures should have complete captions so that the reader can understand what is being shown without referring back to the main text.

**II. Oral Presentation of Experimental Results** - Due to the large number of scientists working today a brief oral presentation style has been developed, called “the 10 minute talk”. This is an oral presentation in which the scientist is given 10 minutes to state his or her case and the audience is then given 5 minutes for questions. The presentations usually include very short text, graphs, tables, and equations as appropriate. These talks are usually given using overhead transparencies. Practice your talk before giving it to the class since ten minutes goes by very quickly and you will therefore only have time to include the most essential things (8 to 12 slides is usually appropriate).

### Preliminary Laboratory Schedule

|            |                            |
|------------|----------------------------|
| Feb 5, 12  | Introduction to Optics Lab |
| Feb 19, 26 | Waves At An Interface      |
| Mar 4      | Superposition of Waves     |
| Mar 11, 18 | Polarization               |



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Apr 1, 8

Interference

**April 8**

**One Page Project Proposal Due**

Apr 15

Diffraction

Remainder of semester

Project of Student's Choice