

# Optics and Optics Laboratory

## Physics 5340 and 5341

### Winter 2017

**Lectures:**

Tuesdays and Thursdays, 11:30am to 12:45pm in 177 Physics Building

**Labs and Discussion Sections:**

All Sections meet in 125 Physics Building

Section 2:      Thursdays      1:00 pm to 3:50 pm      GTA: Brendon Waters

Section 4:      Wednesdays      9:30 am to 12:20 pm      GTA: Abir Kabbani

**Final Exam:**

**Thursday, April 27th** from 12:30 pm to 2:30 pm in 177 Physics Building

**Required Texts:****1) Physics of Light and Optics by Peatross and Ware (PLO)**

Free PDF at <http://optics.byu.edu/textbook.aspx>

Order a hard copy delivered for <\$20

**2) Any introductory physics text with the following subjects:**

-Electromagnetic Waves

-Optical Instruments

-Polarization

-Interference and Diffraction

-Reflection and Refraction of Light

-Maxwell's Equations

Examples: Physics by Giambattista, Richardson, and Richardson;

University Physics by Sears, Zemansky and Young;

University Physics by Bauer and Westfall; or

**Fundamentals of Physics** by Holliday, Resnick, and Walker

**Recommended Texts:**

These texts and others are available from our university library.

**3) Optics by Hecht**

Hecht's book is more wordy and covers relevant material in its first 6 chapters. However, it soon becomes far too complex for us and incorporates too much mathematics. This is a common undergraduate/graduate level text for students with more mathematical training required by the Biomedical Physics major.

**4) Lasers by Seigman**

This text is a graduate level text that I recommend for those wishing to get a much deeper understanding of the material.

**Lecturer:**

Professor Christopher V. Kelly

Office: 283 Physics Building

Email: [cvkelly@wayne.edu](mailto:cvkelly@wayne.edu)

Office Hours: I am generally happy to answer quick questions on a drop-in basis. But for longer discussions, please shoot me an email and let's make an appointment. I will aim to respond quickly and find a time that works well for all interested students.

**Teaching Assistants:**

Brendon Waters      Email: brendon.waters@wayne.edu

Abir Kabbani      Email: abir.maarouf@wayne.edu

Our teaching assistant will be primarily in charge of grading, running discussion sections, hosting office hours, and helping your laboratory experiments run smoothly. I expect them to be a good reference for you to learn about the material from a complementary perspective to mine.

**Course Web Page:** WSU Blackboard @ blackboard.wayne.edu

**Pre-requisites:** PHY 2140 or PHY 2180; MAT 2030 or PHY 3700

**Co-requisites:** PHY 5341 for BMP majors

**How to be successful in this course:**

The key to being successful in this course is to engage at all levels. Read the relevant sections of the text before lectures/labs, be attentive during lectures, be a leader during labs, ask questions during discussion sections, learn from your mistakes on homework, quizzes, and exams, and follow up during office hours. Students who display a strong desire to thrive will display their efforts via detailed questions from the readings or assignments that reflect their individual effort to understand the subject matter. Utilize the numerous resources available to you (namely your textbook and material on Blackboard) and recognize that success in this course will not be achieved solely through passive observation of the lectures and labs.

**Course Content:**

This course will introduce the principles of optics both theoretically and practically. All sections will be covered by the cumulative final exam. Supplemental reading material will be put on Blackboard. This course will be broken into four sections:

Section 1: Introductory material, PLO chapter 0

Section 2: PLO chapters 1-4, 6

Section 3: PLO chapters 7-10

Section 4: Selections from PLO chapters 11-13 and supplemental reading

**Learning Objectives:**

- 1) Demonstrate a conceptual understanding of optics with ray diagrams and the ability to explain how various optical components affect light.
- 2) Use multivariable calculus to analytically describe light experiencing diffraction, dispersion, polarization, and refraction.
- 3) Demonstrate an understanding of the capabilities and limitations of modern microscopes, cameras, and telescopes.

**Homework:**

Homework will be assigned and submitted on a weekly basis. Often, showing one's work will be necessary to get full marks. Diagrams and derivations are often required. Occasionally, only a selection of the required homework answers will be graded. Homework questions will mostly be graded on a 0, check-, check, check+ scale while some problems will be graded in greater detail.

0 : The question was not seriously attempted. 0 Points.

Check- : A strong effort and significant errors were made. 1 Point.

Check : The answer is close but with minor mistakes OR the answer is correct but insufficient work was shown to demonstrate student understands. 2 Points.

Check+: The answer is perfect. The answer clearly shows that the student well understands the subject . 3 Points.

Homework solutions will be provided and the students are strongly encouraged to compare their answers to the solutions. Some questions can be answered in multiple ways and comparing your answers to the solution may often be informative.

Students are encouraged to work together on the homework via small study groups. However, each student is required to write their own answers without copying or plagiarizing others. Your homework is expected to be a reflection of your effort and your understanding. Any copying or plagiarizing will be considered cheating, result in no credit, and possibly university-level disciplinary actions. ([http://www.otl.wayne.edu/wsu\\_integrity.php](http://www.otl.wayne.edu/wsu_integrity.php))

### Participation in Lecture:

Your participation in all activities of the course will help you and other students learn the material. Participation points will be given for pre-class surveys, in-class activities, and out-of-class study-group participation. Participation points may count for up to 20% of your final grade in 5340.

A portion of your participation grade will come from an end-of-the-semester presentation. This presentation will be done individually to the whole class, as indicated in the schedule below. Details of the presentation will come later in the semester.

### Exams:

There will be 3 mid-semester exams and 1 final. All exams will be cumulative, with an emphasis on the most recent section. The exams may include multiple choice, short answer, or long answer problems. The final exam will be worth double each of the mid-semester exams towards your final grade. Exams will be given during the lecture time.

You are allowed to only bring writing implements and a single-sided 8.5"x11" page of personally made, hand-written equations and diagrams for use on the exam. No complete non-math sentences are allowed on your equation sheet. You may not use any notes other than the single page of single-sided hand-written equation sheet that you made yourself. These notes will be handed in immediately following the exams.

No calculators, computers, phones, or non-preapproved textbooks are allowed for use on the exams. **Any use of telephones during an exam is strictly forbidden and may result in the assessment of cheating.** For the exams, any use of non-sanctioned assistance (e.g., electronic devices, other people, non-sanctioned cheat-sheets, or non-required books) will be considered cheating, result in no credit, and possibly university-level disciplinary actions.

Make-up exams are not available barring exceptional circumstances as assessed solely by the lecturer. A re-grading of some exam answers may or may not be permitted if requested. However, any re-grading may result in an increase, decrease, or no change in the grade given with a final decision made by the lecturer.

### Surveys and Quizzes:

Surveys and Quizzes will be given regularly in the discussion sections and lectures. The primary purpose of the quizzes is for assessment of your knowledge by the lecturer, teaching assistants, and yourself. Some of the quizzes will be graded and some will not but all quizzes will

count towards your participation in the course. (Hint: some questions from the quizzes may come up again on exams!)

### Participation in Lab:

Physical participation in the experiment is required for all students within each group. Participation points will be awarded or reduced to the whole group based on their involvement of all group members. Effort should be taken by all students to get each group member involved with the setup of the experiment, the acquisition of data, and the analysis of the results. Groups who fail to get all members involved in the hands-on aspects of the experiments will receive reduced participation points. Most laboratory experiments will require individual students to prepare via specialized reading and/or homework assignments. If preparatory homework is assigned, it will be graded similarly to homework associated with the lecture; however, the lab homework grade will contribute to the total grade for that lab.

Up to 40% of your final grade in 5341 will be based on whether or not you (1) show up to lab and discussion on time and ready to engage, (2) participate throughout the discussion section and the lab time, (3) ask questions, (4) physically engage with the experimental systems, and (5) act as a valuable team member to your lab group and the class as a whole. The lab supervisors will assess these points themselves and provide regular feedback on your performance. Should your participation in lab prove to be distracting or disruptive, you may be asked to leave for the day and come to the lecturer's office hours to discuss the situation.

### Lab Reports:

**You are required to turn in 4 of your own detailed lab reports. You may not turn in the same detailed lab reports as your lab partner – you and your partner must turn in detailed lab reports for different labs. Each of these lab reports will be graded in detail and contribute 10% of your final grade in 5341.** Lab reports should be no longer than 6 pages in total length and clearly display your understanding of the experiment. Each lab report will be graded on (1) Clarity and presentation, (2) Description of the experiment, (3) Data quality, and (4) Analysis and interpretation. You cannot write a lab report for "Lab 1: Introduction to Optics;" for lab 1 you must write a lab summary instead.

Greater detail of how a lab report should be written will be given later and examples can be found on Blackboard. The following qualities will be required of all lab reports:

- Your lab partner's name must be listed on your report, but since this is solely your lab-report and will only count towards your grade, make sure it is clear who's lab report it is
- Lab reports must be typed.
- No font size smaller than 11 within the main text.
- All axes must be well labeled with units and of legible size.
- Significant figures must be reasonable.
- Uncertainty must be calculated and reported correctly whenever possible.
- No margins smaller than 1 inch.
- Pictures, diagrams, and graphs are strongly encouraged and often necessary for full marks.

Paper copies of your lab reports must be turned in to the TAs within 1 week after the lab was performed. Lab reports submitted late will be subjected to the following reduction in grade:

Laboratory experiments will be performed in pairs. However, each individual will be responsible for his/her own lab reports. Classmates are encouraged to discuss the experiment and how their data compares to the expected data. However, you are responsible for

| Days Late Turning in Report | Reduction in Lab Report Grade |
|-----------------------------|-------------------------------|
| 1                           | 10%                           |
| 2-3                         | 25%                           |
| 4-7                         | 35%                           |
| >7                          | 50%                           |

creating each of your own graphs of the results/analysis and writing the content of your own report. Any copying or plagiarizing will be considered cheating, result in no credit, and possibly university-level disciplinary actions. ([http://www.otl.wayne.edu/wsu\\_integrity.php](http://www.otl.wayne.edu/wsu_integrity.php))

### Lab Summaries:

For each lab that you do not write a 6-page lab report, you must instead turn in a 1-page lab summary digitally on Blackboard as directed by your GTA. These lab summaries must be typed with well-written English. They are to include a basic summary of 1) what you did, 2) what you learned, 3) what went right, 4) what went wrong, 5) what you are proud of accomplishing, and 6) what you would do differently if you were to do the lab again. Pictures, diagrams, and graphs are strongly encouraged. Lab summaries are due 1 week after the lab was performed. The six lab summaries will compromise 20% of the final grade for 5341. If your lab partner is writing a 6-page lab report, you are required to write a 1-page lab summary. You and your lab partner may not both turn in 6-page lab reports for the same lab.

It would be helpful if you would also include a brief summary of how well you like the lab and how you think it could be improved for next year.

### Final Grade for 5340:

The final grade for 5340 will be a combination of the grades from the homework (HW), Participation (P) the three mid-semester exams (E1, E2, E3), and the final exam (F). However, to accommodate the different learning methods of different students, final grades (FG) may be calculated according whichever of the following methods results in the highest final grade for each student.

$$FG = (P+HW+E1+E2+2*F) / 6$$

$$FG = (P+HW+E1+E3+2*F) / 6$$

$$FG = (P+HW+E2+E3+2*F) / 6$$

$$FG = (P+HW+E1+E2+E3+F) / 6$$

$$FG = (P+E1+E2+E3+2*F) / 6$$

Final Grades may be scaled and converted to a final letter grade with the following scale:

| FG      | Letter Grade |
|---------|--------------|
| 85-100% | A-/A         |
| 70-84%  | B-/B/B+      |
| 60-69   | C-/C/C+      |
| 50-59   | D-/D/D+      |
| <50     | E            |

### Final Grade for 5341:

The final score for each student comes is made up according to:

- 40% from four 6-page lab report,
- 40% from active participation in discussion sections, experiment setup, and data collection, etc.
- 10% from six 1-page summaries of each lab.
- 10% from pre-lab quizzes that can be found on Blackboard and submitted electronically before each lab session.

### Students with disabilities:

If you have a documented disability that requires accommodations, you will need to register with Student Disability Services for coordination of your academic accommodations. The Student Disability Services (SDS) office is located at 1600 David Adamany Undergraduate Library in the Student Academic Success Services department. SDS telephone number is 313-577-1851 or 313-577-3365 (TTD only). Once you have your accommodations in place, I will be glad to meet with you privately during my office hours or at another agreed upon time to discuss your needs. Student Disability Services' mission is to assist the university in creating an accessible community where

students with disabilities have an equal opportunity to fully participate in their educational experience at Wayne State University.

### Honors Option:

Students who wish to get honors credit with this course should fill out all the paperwork required by the honors college and write a 10 page research paper. You are encouraged to write on the same subject which you present to the class in mid-April. Everyone will give a presentation. You will additionally submit a paper.

### Syllabus Modifications:

I will be trying a number of teaching techniques throughout this semester, some of which are described in this syllabus. As I learn what is working and what is not, I will be modifying the policies of this course. And so, this syllabus is a dynamic document that may be updated as the semester progresses.

### Tentative Lab Schedule:

| Week | Date        | Lab |   |
|------|-------------|-----|---|
| 1    | 1/11 & 1/12 |     | Discussion Section only                 |
| 2    | 1/18 & 1/19 | 1   | Introduction to Optics                  |
| 3    | 1/25 & 1/26 | 2   | Detection of Light                      |
| 4    | 2/1 & 2/2   | 3   | Attenuation of Light                    |
| 5    | 2/8 & 2/9   | 4   | Polarization of Light                   |
| 6    | 2/15 & 2/16 | 5   | Brewster's Law                          |
| 7    | 2/22 & 2/23 |     | <b>Review</b>                           |
| 8    | 3/1 & 3/2   | 6   | Michelson Interferometer                |
| 9    | 3/8 & 3/9   | 7   | Total Internal Refraction               |
| 10   | 3/22 & 3/23 |     | <b>Review</b>                           |
| 11   | 3/29 & 3/30 | 8   | Fiber Optics                            |
| 12   | 4/5 & 4/6   | 9   | Diffraction through Slits and Apertures |
| 13   | 4/12 & 4/13 | 10  | Microscopy                              |
| 14   | 4/19 & 4/20 |     | <b>Review</b>                           |

**THIS SCHEDULE IS SUBJECT TO CHANGE**

**Tentative Lecture Schedule:**

| Week | Date |   | Topics and Activities                               | Readings                |
|------|------|---|---|-------------------------|
| 1    | 1/10 | T | Syllabus, Waves, Refraction                         | Introductory Text       |
|      | 1/12 | R | Lenses, Dispersion                                  | Introductory Text       |
| 2    | 1/17 | T | Maxwell's Eqs., Reflection, Refraction, Diffraction | Introductory Text       |
|      | 1/19 | R | Math  | PLO Chapter 0           |
| 3    | 1/24 | T | Practice Problems                                   | Intro. Text & PLO Ch. 0 |
|      | 1/26 | R | Review  | Intro. Text & PLO Ch. 0 |
| 4    | 1/31 | T | <b>EXAM 1</b>                                       |                         |
|      | 2/2  | R | Electromagnetic Phenomena, Maxwell's Eqs.           | PLO Ch. 1               |
| 5    | 2/7  | T | Plane Waves and Refractive Index                    | PLO Ch. 2               |
|      | 2/9  | R | Reflection and Refraction                           | PLO Ch. 3               |
| 6    | 2/14 | T | Multiple Parallel Interfaces - (CVK out of town)    | PLO Ch. 4               |
|      | 2/16 | R | Polarization of Light                               | PLO Ch. 6               |
| 7    | 2/21 | T | Superposition of Quasi-Parallel Plane Waves         | PLO Ch. 7               |
|      | 2/23 | R | Review  | PLO Chs. 1-4, 6         |
| 8    | 2/28 | T | <b>EXAM 2</b>                                       | PLO Chs. 1-4, 6         |
|      | 3/2  | R | Coherence Theory                                    | PLO Ch. 8               |
| 9    | 3/7  | T | Light as Rays                                       | PLO Ch. 9               |
|      | 3/9  | R | Diffraction   | PLO Ch. 10              |
| --   | 3/14 | T | <i>Spring Break</i>                                 |                         |
| --   | 3/16 | R | <i>Spring Break</i>                                 |                         |
| 10   | 3/21 | T | Diffraction, continued                              | PLO Ch. 10              |
|      | 3/23 | R | Diffraction Applications                            | PLO Ch. 11              |
| 11   | 3/28 | T | Review  | Supplemental Material   |
|      | 3/30 | R | <b>Exam 3</b>                                       | PLO Chs. 7-11           |
| 12   | 4/4  | T | Microscopy  | Supplemental Material   |
|      | 4/6  | R | Photography   | Supplemental Material   |
| 13   | 4/11 | T | Medical Technology                                  | Supplemental Material   |
|      | 4/13 | R | Presentations                                       | Supplemental Material   |
| 14   | 4/18 | T | Presentations                                       | Supplemental Material   |
|      | 4/20 | R | Review  | Intro, PLO 1-4, 6-11    |
| 15   | 4/27 | F | <b>FINAL EXAM – 12:30pm - 2:30pm in PHY 177</b>     |                         |

**THIS SCHEDULE IS SUBJECT TO CHANGE**