**Optics and Optics Laboratory**

**Physics 5340 and 5341**

**Winter 2013**

**Lectures:**

Mondays, Wednesdays @4:05 – 5:30 PM. Room: 245 Physics Building

**Labs and Discussion Sections:**

All Sections meet on Fridays in 125 Physics Building

Section 1: Lab: 1pm to 3pm Discussion Section: 3pm to 4pm

Section 2: Lab: 3pm to 5pm Discussion Section: 2pm to 3pm

Section 3: Lab: 5pm to 7pm Discussion Section: 5pm to 6pm

**Required Texts:**

1. Principles of Physical Optics by Bennett.

ISBN: 978-0-470-12212-9 (AKA PhysOpt)

1. Any introductory physics text with the following subjects:

* Electromagnetic Waves
* Polarization
* Reflection and Refraction of Light
* Optical Instruments
* Interference and Diffraction
* 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

**Lecturer**:

Professor C.V. Kelly

Office: 283 Physics Building

Email: For submitting assignments when allowed: [cvkellyteaching@gmail.com](mailto:cvkellyteaching@gmail.com)

For general questions or concerns: [cvkelly@wayne.edu](mailto:cvkelly@wayne.edu)

Office Hours: Wednesdays 1pm to 2:30pm or by appointment

**Teaching** **Assistants**:

Edward Kramkowski and Anwesha Sarkar

Office Hours: TBD

Our teaching assistants will be primarily in charge of grading, running discussion sections, hosting office hours, and helping your laboratory experiments run smoothly in coordination with the lecturer.

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

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

**Co-requisites**: PHY 5341.

**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. This course will be broken into three sections:

Section 1: Introductory material and PhysOpt chapters 1-2

Section 2: PhysOpt chapters 3-6

Section 3: Selections from PhysOpt chapters 7-9 and Applications

There will be mid-semester exams following each of Section 1 and Section 2. All sections will be covered by the cumulative final exam. Supplemental reading material will be put on Blackboard, especially for Section 3.

**Learning Objectives:**

1. Demonstrate a conceptual understanding of optics with ray diagrams and the ability to explain how various optical components affect light.
2. Utilize complex, multivariable calculus to analytically describe light experiencing diffraction, dispersion, polarization, and refraction.
3. Demonstrate a understanding of the capabilities and limitations of modern microscopes, including confocal, total internal reflection, and super-resolution techniques.

**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 be graded on a 0, check-, check, check+ scale. The cumulative homework grade may contribute up to 25% of your final grade for 5430 and 5431.

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 check+ 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>)

**Quizzes**:

Quizzes will be given regularly in the discussion sections. 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. The quizzes scores will contribute up to 5% of the final grade for 5341. (Hint: some questions from the quizzes may come up again on exams!)

**Exams**:

There will be 2 mid-semester exams and 1 final. Exam 1 will focus on Section 1. Exam 2 will focus on Section 2, although have some components from Section 1. The Final Exam will be cumulative. 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 laboratory time on Fridays and they will contribute between 75% and 100% of your final grade for 5430.

You are allowed to bring only writing implements and a single-sided 8.5”x11” page of personally made, hand-written notes for use on the exam. You may not use any notes other than the single page of single-sided hand-written notes that you made yourself. These notes will be handed in immediately following the exams and later returned.

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.

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. (<http://www.otl.wayne.edu/wsu_integrity.php>)

**Lab Reports:**

You are required to turn in your own lab report for each of the 10 labs in 5341. Lab reports should be no longer than 4 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. Lab reports that exceed the 4 page limit will receive reduced marks on Clarity and Presentation.

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:

* 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 0.75 inches.

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

Lab reports are due 1 week after the lab was performed. Lab reports should be turned in electronically via email to [cvkellyteaching@gmail.com](mailto:cvkellyteaching@gmail.com). Lab reports submitted late will be subjected to the following reduction in grade:

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

**Lab Preparation:**

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.

**Lab Participation:**

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. The teaching assistants will be tasked with helping remind all groups to get group members physically involved. Groups who fail to get all members involved in the hands-on aspects of the experiments will receive reduced participation points. Any group that receives less than the full marks in participation points will be notified and may be asked to meet with the lecturer.

**Final Grade for 5340:**

The final grade for 5340 will be a combination of the grades from the homework (HW) the two mid-semester exams (E1, E2), and the final exam (FE). 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** | **Letter Grade** |
| 85-100% | A-/A |
| 70-84% | B-/B/B+ |
| 60-69 | C-/C/C+ |
| 50-59 | D-/D/D+ |
| <50 | E |

FG = ( E1+E2+2\*FE ) / 4.

FG = ( HW+E2+2\*FE ) / 4.

FG = ( HW+E1+2\*FE ) / 4.

FG = ( HW+E1+E2+FE ) / 4.

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

**Final Grade for 5341:**

Each lab for each student is given a score based 80% on his/her lab report, pre-lab assignments, and quizzes. 20% of each student’s grade will come from their active participation in the experiment and data collection. If you turn in all 10 lab reports on time, your top 9 lab grades will be averaged to create your final grade for 5341; otherwise, all 10 lab grades will be averaged to create your final grade for 5341.

## 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.

**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 Agenda:**

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| **Week** | **Date** |  | **Topics and Activities** | **Readings** |
| 1 | 1/7 | M | Syllabus, Waves, Polarization | Intro. Text |
|  | 1/9 | W | Waves, Superposition, Doppler Effect |
|  | 1/11 | F | **Discussion Sections. No labs.** | Lab Handout on Blackboard |
| 2 | 1/14 | M | Antennas, Maxwell's Equations | Intro. Text |
|  | 1/16 | W | Maxwell's equations, Reflection, Refraction, Diffraction |
|  | 1/18 | F | **Discussion Sections. Lab 1: Detection of Light** | Lab Handout on Blackboard |
| 3 | 1/21 | M | NO CLASS - MLK Day | Intro. Text |
|  | 1/23 | W | Snell's Law, Total internal reflection, Fiber Optics, Lenses |
|  | 1/25 | F | **Discussion Sections. Lab 2: Attenuation of Light** | Lab Handout on Blackboard |
| 4 | 1/28 | M | Superposition, Complex Numbers, Wave Equation | Intro. Text & PhysOpt Ch 1 |
|  | 1/30 | W | Waves in 3D, Electromagnetism | Intro. Text & PhysOpt Ch 1,2 |
|  | 2/1 | F | **Discussion Sections. Lab 3: Brewster's Law** | Lab Handout on Blackboard |
| 5 | 2/4 | M | Guest Lecturer TBD |  |
|  | 2/6 | W | Review | Intro. Text & PhysOpt Ch 1,2 |
|  | 2/8 | F | **Exam 1** |
| 6 | 2/11 | M | Maxwell's Equations, Brewster's Angle, Fresnel Equations | PhysOpt Ch 3 |
|  | 2/13 | W | Fermat's Principle, Evanescent Wave, Dispersion, Scattering |
|  | 2/15 | F | **Discussion Sections. Lab 4: Michelson Interferometer** | Lab Handout on Blackboard |
| 7 | 2/18 | M | Reflection and Refraction from non-planar surfaces | PhysOpt Ch 4 |
|  | 2/20 | W | Lenses, Aberrations, Matrix Methods |
|  | 2/22 | F | **Discussion Sections. Lab 5: Diffraction Through Slits** | Lab Handout on Blackboard |
| 8 | 2/25 | M | Superposition, Interference | PhysOpt Ch 5 |
|  | 2/27 | W | Fourier Analysis, Coherence |
|  | 3/1 | F | **Discussion Sections. Lab 6: Single Mode Fibers** | Lab Handout on Blackboard |
| 9 | 3/4 | M | Hugen's Principle | PhysOpt Ch 6 |
|  | 3/6 | W | Fraunhofer Diffraction |
|  | 3/8 | F | **Discussion Sections. Lab 7: Semiconductor Lasers** | Lab Handout on Blackboard |
| 10 | 3/11 | M |  |  |
|  | 3/13 | W | Spring Break |
|  | 3/15 | F |  |
| 11 | 3/18 | M | Fresnel Diffraction | PhysOpt Ch 6 |
|  | 3/20 | W | Review | Intro. Text & PhysOpt Ch 1-6 |
|  | 3/22 | F | **Exam 2** |
| 12 | 3/25 | M | Energy Levels in Lasers, Stimulated Emission | PhysOpt Ch 7.1-4,7,8 |
|  | 3/27 | W | Gaussian Beams |
|  | 3/29 | F | **Discussion Sections. Lab 8: Fiber Cutting and Losses** | Lab Handout on Blackboard |
| 13 | 4/1 | M | Imaging, Abby limit, PSF | PhysOpt Ch 8.1-4 & Blackboard readings |
|  | 4/3 | W | Modern Microscopes, Fluorescence |
|  | 4/5 | F | **Discussion Sections. Lab 9: Working with and Measuring Lasers** | Lab Handout on Blackboard |
| 14 | 4/8 | M | Confocal microscopy | Intro. Text & Blackboard readings |
|  | 4/10 | W | TIRF, Near-field, Localization microscopy |
|  | 4/12 | F | **Discussion Sections. Lab 10: Polarizers and Wave Plates** | Lab Handout on Blackboard |
| 15 | 4/15 | M | Polarization, Birefringence, Jones matrices | PhysOpt Ch 9.1-7 |
|  | 4/17 | W | Acousto-optical and electro-optical devices |
|  | 4/19 | F | **Discussion Sections. Exam Review. No labs.** | Practice Problems |
| 16 | 4/22 | M | Review | Intro. Text, PhysOpt Ch 1-9, Blackboard readings |
|  | 4/24 | W | **FINAL EXAM – 4:05pm to 6:05pm in PHY245** |
|  | **THIS SCHEDULE IS SUBJECT TO CHANGE** | | |  |