

PHYS331: Optics

Fall 2016: August 22–December 16
MWF 12:00 PM–12:50 AM, Room: STB 210

Version 8: December 1, 2016 (subject to change)

Professor: Kathy Cooksey, Ph.D., STB 219; kcooksey@hawaii.edu; 808-932-7195
Office Hours: M 1–2 PM, W 9–10 AM, R 2–3 PM, and by appointment
Website: Lualima PHYS-180-001 (HIL.12201.FA16)
Textbook: *Introduction to Optics, 3rd. Ed.* by Pedrotti, Pedrotti, & Pedrotti (not at bookstore; on reserve at Mookini Library)

Course Description: Intermediate optics. Topics include plane waves, multiple interfaces, polarization, light propagation in real material, Fourier optics, coherence theory, paraxial rays, diffraction and blackbody radiation.

Pre-requisites: PHYS171 and MATH231

Learning Objectives:

- Broad course goals:
 1. Understand when optics are well described as geometric (AKA paraxial, Gaussian) versus when accounting for the wave nature of light is necessary (AKA physical optics).
 2. Develop intuition for the behavior of a compound optic—composed of diverging and/or converging lenses and/or mirrors—and be able to predict whether there is a final image and if it is real or imaginary, inverted or upright, and magnified or not.
 3. Optics has a wide range of sub-fields (see the table of contents of *Introduction to Optics* by Pedrotti³). This course should lay a foundation from which the students may pursue many of the not-covered sub-fields.
 4. Practice and improve problem-solving skills, especially in how an approach is motivated, how a solution is formatted, and how the answer is verified to be reasonable.
- Specific content goals:
 1. Ray tracing and computation of a geometric-optic system are two independent methods for determining what the system does. Thus they must be consistent and can be used to check the results of the other.
 2. Superposition is a common and important aspect of waves. It is the foundation for optical systems using diffraction and interference (e.g., Fourier optics, diffraction gratings).
 3. Application of computational/numerical techniques to understanding of optics and solving of problems.

Email, Textbook, and Website:

- UHH considers email and Lualima an official form of communication; students are responsible for receiving and returning information in a timely manner.
- The professor will email students at their hawaii.edu accounts only.
- The required textbook is *Introduction to Optics, 3rd. Ed.* by Pedrotti, Pedrotti, & Pedrotti.
- The Lualima course website is listed under PHYS-331-001 (HIL.12201.FA16). This site will be the hub for all course information.

Class Rules:

- Students are responsible for their own learning, which includes preparing for class, submitting work, asking questions, and seeking additional help.
- Students must respect and support their peers' learning, which means helping each other with difficult concepts but not just giving the answer.
- Students need to convey (either in person, by email, through an intermediary, or somehow) to the professor questions, comments, and concerns about the course.
- The professor will be receptive to and respectful of the students' needs and interests and must generally follow the class rules as detailed for the students (also see next section).
- Group work is encouraged in class and for homework assignments. However, all submitted work must be the original work of the student with reference to any homework partners.
- All references (e.g., websites, books other than the official course textbook, etc.) used to complete assignments must be cited, including numbers, techniques, facts, etc.
- Students need to sign the attendance sheet each class.
- A non-smart-phone calculator is required for every class. Students should practice with the calculator they will use for quizzes and the final exam.
- It is recommended to own a ruler and use graph paper.

Good-to-Know about the Professor:

- She enjoys teaching and wants to be better at it, and she really cares about helping students be better. These aspects combined mean she is on the students' side; trust in that and knowledge that she is receptive to feedback will smooth over rough patches.
- She chooses teaching techniques based on physics-education research to support student learning as best as possible. This means she has one or more reasons for nearly every component of and action in a course. She'll gladly motivate these choices whenever necessary or asked.
- Her primary goal is to help students improve *how* they learn with the logic that if students learn how to learn, they can master any content. The related goal is to focus on transferrable skills so that time and effort spent for the class yield benefits beyond the course and semester.
- Generally, she does not answer questions directly. A student making connections and constructing a solution her- or himself will ingrain the answer more effectively, and the professor facilitates the process by asking leading questions. Since the motivation is to help the students, they should embrace and engage with this process. (It is also a transferrable skill to discuss ideas and answer questions on the fly.)
- She designs quizzes and exams so that no one gets 100% and no one gets 0% because either score would not be useful in assessing what the students understand and how to help. The rule-of-thumb is to score above the median (see Grading below). She has no interest in failing students who make good-faith effort in the class (e.g., good attendance, submit completed work, ask questions in and out of class).
- She thinks no single resource is comprehensive, so the expectation is that the student will have to work with the professor, her materials, the textbook, and the wealth of material available on the internet.
- The expectation is that a course requires 2–3 hr outside-of-class time per credit per week. Hence a 15-cr semester equals 30–45 hr per week (i.e., a full-time job).

General Course Outline

The schedule given in the table below is highly likely to change. Significant changes will be announced on the Laulima course website, and the new copy of the syllabus will be there, under Resources. Homework (in *italics*) are due every two weeks, on Wednesdays, by class time. Quizzes are after the homework covering the same topic have been returned (to give a chance for review), but all previous material is fair game.

Students are expected to read the textbook chapter, section(s), and/or figures before class. The “lectures” will rely on students having given a good faith effort to understanding the material. It is assumed that the students will read the brief introduction to each chapter, no matter the number of sections actually assigned. If figures without corresponding section are assigned, students should read any necessary surrounding text to understand the figure.

| Date | Topic | Activity |
|--------------------------------------|--|---|
| M 22 Aug W 24 Aug F 26 Aug | L1. PHYS331 L2. Nature of Light (Ch. 1, Fig. 3-19) L3. Fermat's Principle (§2-2–§2-3) | Pre-quiz |
| M 29 Aug W 31 Aug F 2 Sep | L4. Reflection & Refraction w/Planar Optics (§2-4–§2-5, Fig. 3-18, 10-3) Hurricane woes (no class) L6. Ray-tracing w/Spherical Mirror (Fig. 3-34a) | L5. Reflection at Spherical Surface (§2-6–§2-7) |
| M 5 Sep W 7 Sep F 9 Sep | Labor Day (no class) L7. Refraction at Spherical Surface (§2-8) L8. Thin Lenses (§2-9, Fig. 3-20, 3-22) | |
| M 12 Sep W 14 Sep F 16 Sep | L9. Ray-tracing w/Thin Lens (Fig. 3-20, 3-22, 3-24) L10. Ray-tracing w/Multiple Optics I (Fig. 3-25–3-28, 3-31–3-32, 3-34, 3-36) Nat. Sci. 495A/B Seminar “Is Science a Meritocracy?: Issues of Diversity & Equity” (STB225) | <i>HW#1: Geometric Optics I (due 28 Sep)</i> Hands-on optics: ray boxes |
| M 19 Sep W 21 Sep F 23 Sep | L11. Ray-tracing w/Multiple Optics II L12. Power, Newton, & Cylindrical Lenses (§2-10–§2-12) L13. Stops, Pupils, & Windows (§3-1) | |
| M 26 Sep W 28 Sep F 30 Sep | L14. Aberrations (§3-2, §20-3–§20-7) L15. The Eye (§19-1, Fig. 19-2, §19-3–§19-5) L16. Simple Magnifiers & Eyepieces (§3-5) | <i>HW#2: Geometric Optics II (due 12 Oct)</i> Hands-on optics: refractor |
| M 3 Oct W 5 Oct F 7 Oct | L17. Telescopes (§3-6) L18. The Thick Lens (§18-1) | Quiz #1: Geometric Optics I |
| M 10 Oct W 12 Oct F 14 Oct | L19. Matrix Method I (§18-2–§18-4) L20. Matrix Method II (§18-5–§18-6) L21. System Ray-Transfer Matrix I (§18-7–§18-8) | <i>Mid-term Course Eval. (Laulima Survey; due 17 Oct)</i> <i>HW#3: Geometric Optics III (due 26 Oct)</i> |
| M 17 Oct W 19 Oct F 21 Oct | L22. System Ray-Transfer Matrix II L23. Cardinal Points of Optical System (§18-9–§18-10) L23.5. Cardinal Points (cont'd) | “Hands-on” optics: numerical method (STB206) |
| M 24 Oct W 26 Oct F 28 Oct | L24. Wave Equation (§4-1–§4-8) L25. Superposition of Waves (§5-1–§5-2, §7-1–§7-2) L26. Coherence & Standing Waves (§5-3–§5-4) | <i>HW#4: Matrix Method (due 9 Nov)</i> |
| M 31 Oct W 2 Nov F 4 Nov | L27. Fourier Analysis (§9-1) L28. Fourier Series I (§9-2) | Quiz #2: Geometric Optics II |
| M 7 Nov W 9 Nov F 11 Nov | L29. Fourier Series II L30. Fourier Optics (§21-1) Veteran's Day (no class) | <i>HW#5: Wave Equation & Fourier Analysis (due 23 Nov)</i> |
| M 14 Nov W 16 Nov F 18 Nov | L31. Single-Slit Diffraction & Beam Spreading (§11-1–§11-2) L32. Diffraction, Apertures, & Resolution (§11-3–§11.4) L33. Two or More Slit Diffraction (§11-5–§11-6) | |
| M 21 Nov W 23 Nov F 25 Nov | L34. Diffraction Grating I (§12-1–§12-2) Thanksgiving break (no class) | Hands-on optics: diffraction gratings (STB205) <i>HW#6: Physical Optics (due 7 Dec)</i> |
| M 28 Nov W 30 Nov F 2 Dec | L35. Diffraction Grating II (§12-4) L36. Course Synthesis I | Quiz #3: Matrix Method & Fourier Analysis |
| M 5 Dec W 7 Dec | L37. Course Synthesis II | Hands-on optics: Review (STB205) Course evaluations & Post-quiz |
| M 12 Dec | Final Exam | 11:50 AM–01:50 PM, STB210 |

Grading:

- The grade depends on the following items: homework assignments (35%); completing pre- and post-quizzes (5%); quizzes (40%); and the final exam (20%). The lowest homework grade will be dropped.
- There will be no make-up work other than the final exam.
 - If a student were excused, the graded work will not be included in her/his final grade.
 - If a student must miss a class for a reasonable reason, s/he must email the professor before the start of class time.
 - If a student were unable to email in advance due to extreme circumstances, s/he should contact the professor as soon as possible. Such instances will be judged on a case-by-case basis.
 - If a student were excused from all points in a given category, the percentage of the other categories will be increased to fill the void.
- Homework assignments are never excused since their due dates are known in advance. It is the student's responsibility to turn in the homework somehow, either by giving it to another student to submit or by scanning and emailing it to the professor.
- Late homework is accepted within 24 hours of the deadline for 75% credit.
- Cheating is not tolerated. Any question of cheating will be tested with an oral exam, to see whether the student(s) involved understand the material. Cheating will result in a zero for the item in question and a report to the University. It may result in immediate failure of the course.
- The final letter grade will be given based on the class statistics (e.g., the 25th, 50th/median, 75th percentiles). The goal is to score higher than the median on all graded work. The expectation is that final grades higher than the median will pass with at least a C (likely B-) and that the 25th to 50th percentiles will likely earn something in the C range.

Campus-wide Information

Disability Support: Any student with a documented disability who would like to request accommodation should contact the Disability Services Office—Student Services Center, E215; 932-7623 (V), 932-7002 (TTY), uds@hawaii.edu—as early in the semester as possible.

Advising: Advising is a very important resource designed to help students complete the requirements of the University and their individual majors. Students should consult with their advisor at least once a semester to decide on courses, check progress towards graduation, and discuss career options and other educational opportunities provided by UH Hilo. Advising is a shared responsibility, but students have final responsibility for meeting degree requirements.

Kilohana Academic Success Center: The KASC provides academic support opportunities for all UH Hilo students that foster their development into independent, self-motivated learners. Students who visit Kilohana have access to subject-specific and academic skills tutoring from UHH students selected for their academic achievement and dedication to helping others succeed. Kilohana is located on the lower level of the Mookini Library and on the web at <http://hilo.hawaii.edu/kilohana/>.

Human Rights: The University of Hawai'i at Hilo prohibits discrimination in its education programs based on race, national origin, color, creed, religion, sex, age, disability, veteran status, sexual orientation, gender identity or associational preference. If at any time during class you feel uncomfortable about what is being talked about, or feel that your human rights have been violated, please feel free to leave the room. However, the professor asks that you confer with her as soon as possible about what happened so that appropriate action can be taken if necessary to avoid future problems. If you are uncomfortable speaking with the professor about your concern, please contact Kalei Rapoza (kaleihii@hawaii.edu), Interim EEO/AA Director, at 932-7626.

UH Hilo Title IX Policy: The University of Hawaii is committed to providing a learning, working and living environment that promotes personal integrity, civility, and mutual respect and is free of all forms of sex discrimination and gender-based violence, including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence, and stalking. If you or someone you know is experiencing any of these, the University has staff and resources on your campus to support and assist you. Staff can also direct you to resources that are in the community. Here are some of your options:

If you wish to remain anonymous, speak with someone confidentially, or would like to receive information and support in a confidential setting, contact: • UH Hilo Counseling Services: SSC, room E-203, 932-7465; • UH Hilo Medical Services: Campus Center, room 212, 932-7369; and/or • Hawai'i Island YWCA, 935-0677.

If you wish to report an incident of sex discrimination or gender-based violence including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence, or stalking as well as receive information and support,[†] contact: • Libby Bailey, Title IX Coordinator, 932-7818, libby.bailey@hawaii.edu; • Jennifer Stotter, Director of the Office of Equal Opportunity & Deputy Title IX Coordinator, 932-7641, jstotter@hawaii.edu; and/or • Kalei Rapoza, Interim Director of Human Resources, 932-7626, kaleihii@hawaii.edu.

[†]Please note that you do not have to file a report with the University to receive institutional support or assistance.

As a member of the University faculty, the professor is required to immediately report any incidence of sex discrimination or gender-based violence to the campus Title IX Coordinator. Although the Title IX Coordinator and professor cannot guarantee confidentiality, the student will still have options about how the case will be handled. The goal is to make sure the student is aware of the range of options available and has access to the necessary resources and support. For more information regarding sex discrimination and gender-based violence, the University's Title IX resources and the University's Policy, Interim EP 1.204, go to: <http://www.hawaii.edu/titleix>.

Student Conduct: Students are expected to follow the University of Hawai'i at Hilo Student Code of Conduct available at the following URL: <http://www.uhh.hawaii.edu/catalog/student-conduct-code.html>.