PHYS331: Optics
Fall 2014: August 25–December 17
TR 2:00 PM–3:15 PM, Room: STB 205

Version 4: September 8, 2014 (subject to change)

Instructor:	Kathy Cooksey, Ph.D., STB 219; kcooksey@hawaii.edu; 808-932-7195
Office Hours:	M 1–2 PM, T 12–1 PM, W 10–11 AM, and by appointment
Websites:	Laulima PHYS-331-001 (HIL.13320.FA14)
Textbooks:	*Introduction to Optics, 3rd. Ed.* by Pedrotti, Pedrotti, & Pedrotti (not at bookstore)
	QED: The Strange Theory of Light and Matter by Feynman (on reserve at Mookini Library)

Course Description:

The UHH Course Catalog describes PHYS331 as follows: "Intermediate optics. Topics include plane waves, multiple interfaces, polarization, light propagation in real material, Fourier optics, coherence theory, paraxial rays, diffraction and blackbody radiation." (CRN: 13320, Section: 001)

The primary focus of this Fall 2014 class will be on optics most useful to astronomy, since the professor is biased. The broad topics are hence: geometric/paraxial optics, superposition, Fourier analysis, diffraction, and computational/physical optics.

The table of contents of *Introduction to Optics* by Pedrotti[3] shows how wide-ranging the topic of optics actually is. The whole book will most definitely not be covered. However, each student will teach a section(s) of her/his own choosing (mostly) so as to follow the students' interests and expand the scope of the content.

Dr. Christoph Baranec, assistant professor at IfA-Hilo, will be teaching the first two chapters of *QED: The Strange Theory of Light and Matter* by Feynman towards the end of the course; the book is on reserve at Mookini Library. Homework #6 corresponding to this section will be based on numerically solving optics problem(s). Hence, the students will be required to apply their programming skills or learn programming.

Pre-requisites: PHYS171: General Physics II and MATH231: Calculus III

Learning Objectives:

- Understand the basic properties of light by detailing how an image is formed.
- Understand and describe geometric/paraxial optics by teaching the class about an optical instrument
- Be able to apply the superposition principle and Fourier analysis to e.g., diffraction gratings.
- Apply analytic and numerical solutions to optics.

Email, Textbook, and Websites:

- UHH considers email and Laulima an official form of communication; students are responsible for receiving and returning information in a timely manner.
- The student must ensure that the instructor has her/his correct email address.
- The required textbook is *Introduction to Optics, 3rd. Ed.* by Pedrotti, Pedrotti, & Pedrotti. There will also be a section on (and required reading from) *QED: The Strange Theory of Light and Matter* by Richard Feynman.

- The Laulima course website is listed under PHYS-331-001 (HIL.13320.FA14). This site will be the hub for all course information.

Class Rules:

1. Students are responsible for their own learning, which includes preparing for class, submitting work, asking questions, and seeking additional help.
2. Students should be respectful and supportive of their peers' learning, which means helping each other with difficult concepts but not just giving the answer.
3. Students should convey (either in person, by email, through an intermediary, or somehow) to the professor questions, comments, and concerns about the course.
4. The professor should be receptive to and respectful of the students' needs and interests and should generally follow the class rules as detailed for the students.
5. Sign in each class on the attendance sheet.

General Course Outline (subject to change):

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.

Students are expected to read the textbook section(s) before class. The "lectures" will rely on students having given a good faith effort to understanding the material. Naturally, this will not apply to the first week of class. It is assumed that the students will read the brief introduction to each chapter, no matter the number of sections actually assigned.

In the schedule below, broad topics are **bolded**, and student assignments are *italicized*. Homeworks will be due every two weeks, on Thursdays, at class time. One problem will be graded in detail, the rest will be graded for completeness. The problem graded in detail will be worth half of the total homework points; the other problems will be worth the other half.

Quizzes are given after the homework covering the same topic have been returned (to give a chance for review). Homework #3: Wave Equation (Ch 4) is the outlier; it is inserted to support the students learning/reviewing waves in advance of using waves to discuss superposition.

Each student will teach the class twice. The peer instruction (PI) topics will be assigned to groups the first time, early in the semester. The groups will be assigned; the group members may decide how to teach the material. The second PI topics will be chosen by individual students, for the end of the semester. The topics the students may select include the following chapters or sections thereof:

- Ch 6 Properties of Lasers
- Ch 7 Interference of Light
- Ch 8 Optical Interferometry
- Ch 10 Fiber Optics
- Ch 11 Fraunhofer Diffraction
- Ch 13 Fresnel Diffraction
- Ch 15 Production of Polarized Light
- Ch 16 Holography
- Ch 17 Optical Detectors and Displays
- Ch 19 Optics of the Eye
- Ch 20 Aberration Theory
- Ch 21 Fourier Optics
- Ch 25 Optical Properties of Materials
- Ch 27 Characteristics of Laser Beams

Claiming a topic is first come, first serve. Part of the peer instruction is to develop appropriate quiz/exam questions (problems) and solutions.

Date	Topic	Activity
T 26 Aug	Ch 1 Nature of Light	
R 28 Aug	**Ch 2 Geometric Optics** §2-2 Fermat's Principle; §2-3 Principle of Reversibility; §2-4 Reflection in Plane Mirrors	
T 2 Sep	§2-5 Refraction through Plane Surfaces; §2-6 Imaging by an Optical System	
R 4 Sep		Hands-on optics
T 9 Sep	§2-7 Reflection at a Spherical Surface; §2-8 Refraction at a Spherical Surface	
R 11 Sep	§2-9 Thin Lenses	*Laulima survey: peer instruction groups "voting" due; HW #1: Geometric Optics I assigned (due R 25 Sep)*
T 16 Sep		Hands-on optics
R 18 Sep	§2-10 Vergence and Refractive Power; §2-11 Newtonian Equation for the Thin Lens; §2-12 Cylindrical Lenses	
T 23 Sep	**Ch 3 Optical Instrumentation** *[All groups should be prepared to go today]*	*PI—A*: §3-1 Stops, Pupils, and Windows; *All group's quiz questions & solutions due*
R 25 Sep		*PI—B*: §3-3 Prisms; *C*: §3-4 The Camera; *HW #2: Geometric Optics II assigned (due R 9 Oct)*
T 30 Sep		*PI—D*: §3-5 Simple Magnifiers and Eyepieces; *E*: §3-7 Telescopes
R 2 Oct	§3-2 A Brief Look at Aberrations; Modern astronomical instrumentation quickie	Quiz #1: Geometric Optics
T 7 Oct		Hands-on optics; *Mid-term course evaluation on Laulima (due R 9 Oct)*
R 9 Oct	**Ch 18 Matrix Methods in Paraxial Optics** §18-1 The Thick Lens	*HW #3: Wave Equation (Ch 4) assigned (due R 23 Oct)*
T 14 Oct	§18-2 The Matrix Method; §18-3 The Translation Matrix; §18-4 The Refraction Matrix	*Quiz #2: Instrumentation (take home, due R 16 Oct)*
R 16 Oct	§18-5 The Reflection Matrix; §18-6 Thick-Lens and Thin-Lens Matrices; §18-7: System Ray-Transfer Matrix	
T 21 Oct	§18-8 Significance of System Matrix Elements; §18-9 Location of Cardinal Points for an Optical System; §18-10 Examples Using the System Matrix and Cardinal Points; §18-11 Ray Tracing	
R 23 Oct	**Ch 5 Superposition of Waves** §5-1 Superposition Principle; §5-2 Superposition of Waves of the Same Frequency	*HW #4: Matrix Methods assigned (due R 6 Nov)*
T 28 Oct	§5-3 Random and Coherent Sources; §5-4 Standing Waves	Quiz #3: Wave Equation
R 30 Oct	**Ch 9 Coherence** §9-1 Fourier Analysis; §9-2 Fourier Analysis of a Finite Harmonic Wave Train; §9-3 Temporal Coherence and Line Width; §9-5 Spatial Coherence	
T 4 Nov	Election day (no class)	
R 6 Nov	**Ch 12 The Diffraction Grating** §12-1 The Grating Equation; §12-2 Free Spectral Range of a Grating; §12-4 Resolution of a Grating	*Fix peer instruction self-selected topics; HW #5: Superposition & Fourier Analysis assigned (due R 20 Nov)*
T 11 Nov	Veteran's Day (no class)	*Quiz #4: Matrix Methods (take home, due R 13 Nov)*
R 13 Nov	***QED* by Richard Feynman** (Christoph Baranec) *QED*: Ch 1 Introduction; Ch 2 Photons: Particles of LIght	
T 18 Nov	*QED* (cont'd)	
R 20 Nov	*QED* (cont'd)	*HW #6: QED, requires programming (due R 4 Dec)*
T 25 Nov	*QED* (cont'd)	
R 27 Nov	Thanksgiving (no class)	
T 2 Dec	**Students' Choice**	*PI—X*: §TBD; *X's exam questions & solutions due*
R 4 Dec		*PI—Y*: §TBD; *Y's exam questions & solutions due*
T 9 Dec		*PI—Z*: §TBD; *Z's exam questions & solutions due*
R 11 Dec	Course synthesis (last class)	Course evaluations
R 19 Dec	Final Exam	2:00 PM–4:00 PM

Grading:

- The grade depends on the following items: homework assignments (35%); quizzes (35%); peer instruction (20%); and the final exam (10%). The lowest homework and quiz grades 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.
- 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.
- 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.
- The letter grade will be given based on the chart below:

Grade	% Required
A	≥ 93
A−	$[90, 93)$
B+	$[87, 90)$
B	$[83, 87)$
B−	$[80, 83)$
C+	$[77, 80)$
C	$[73, 77)$
C−	$[70, 73)$
D	$[60, 70)$
F	< 60

where e.g., $[90, 93)$ means $\geq 90\%$ and $< 93\%$.

Disability Support: Any student with a documented disability who would like to request accommodation should contact the University Disability Services Office at 932-7623 (V) or 932-7002 (TTY), 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 932-7641.

UH Hilo Sexual Assault Policy: UH Hilo provides confidential assistance for victims of sexual assault. Counseling Services on-campus and the YWCA Sexual Support Services off-campus offer guidance regarding medical assistance and emotional help and can discuss options for reporting sexual assaults to law enforcement. All conversations are private and confidential. The UH Hilo Sexual Assault Policy can be found at: `http://hilo.hawaii.edu/uhh/vcsa/documents/UHHSexualAssaultPolicy.pdf` For assistance during the day, contact UH Hilo Counseling Services at (808) 932-7465; or, after hours and on weekends, contact the YWCA Sexual Assault Support Services at (808) 935-0677.

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`.