PH 495/ECE: Optics

Spring 2011

3 Credit Hours
Primary Instructor: Dr. Patrick Leclair
Note: This syllabus contains one or more sections which have restricted viewing. Some content may require only a valid university login, while other content may be limited to students registered for the class.

Click here to authenticate via myBama.

Prerequisites

From the Student Records System

No prerequisites found.

Prerequisites: MATH 126 or MATH 146; and PH 102 or PH 106 or PH 126.

Strongly suggested: MATH 227

Course Description

Optics. Three hours. Electromagnetic wave theory, propagation, superposition, photons and light. Geometrical optics, lenses, mirrors, and other optical instruments. Polarization, interference, diffraction, coherence, matrix method, transfer functions. Lasers, optical fibers and holography.

Student Learning Outcomes

General learning outcomes for 100- and 200-level courses

1. Recognizing physics concepts that involve developing mathematical models of ordinary phenomena, such as weights and measures, moving objects and forces. [knowledge, evaluation, analysis]

2. Knowing the scientific method and the process of critically evaluating scientific information. [knowledge, comprehension, evaluation]

Learning outcomes for this course

The overall course objective is to study the concepts of electromagnetic waves in the optical regime, including photons and light, to describe components that can affect their propagation in a medium, to study phenomena such as interference, diffraction, and to explain their application in lasers, including laser optoelectronic devices. At the end of this course, students are expected to be able to:

1. Apply knowledge of mathematics to analyze optical systems, including:
    a. Geometrical determination of light propagation through lenses, mirrors, prisms, and other optical systems.

b. Geometrical formulation of reflection and refraction.
c. Geometrical determination of polarization of light.

2. Design and conduct experiments, analyze and interpret data using optical systems.

3. Apply complex, linear and matrix algebra to the propagation of optical electromagnetic waves.
   a. Determination of reflection and transmission coefficients.
   b. Formulation and analysis of their propagation characteristics in linear media.
   c. Formulation and analysis of interference and diffraction patterns.

Assessment of outcomes

1. Homework questions which encourage students to think through the principles they have learned rather than making rote application of basic equations and standard approaches. This includes questions which require in part or in whole discursive answers.

2. Hour examinations periodically during the semester to assess the students' cumulative knowledge of the material to date.

3. A comprehensive final examination at the end of the course.

4. Laboratory experiments in which the students must apply the principles they have learned from recent lectures.

Outline of Topics

Topics covered during class

1. Electromagnetic theory, photons, light (3.0 hrs)
2. Propagation of light (6.0 hrs)
3. Geometrical optics (7.5 hrs)
4. Polarization (4.5 hrs)
5. Interference (4.5 hrs)
6. Diffraction (4.5 hrs)
7. Modern optics: lasers, fiber optics, holography (3.0 hrs)
8. Midterm Examinations (2) (3.0 hrs)

Total: 36.0 hrs, plus 2.5 hrs final exam

Laboratory experiments

Six (6) laboratory experiments related to the course material are performed throughout the semester, as follows:

1. Introduction to optics and components (1.5 hrs)
2. Refractive index (1.5 hrs)
3. Interferometry (1.5 hrs)
4. Diffraction (1.5 hrs)
5. Spectral composition of light (1.5 hrs)
6. Optical devices (1.5 hrs)

Total: 9.0 hrs

Tentative Schedule

During sessions with laboratory experiments, the class will be split into two groups, A and B. Group A receives a lecture during the first class period while group B peforms the laboratory, and during the subsequent week the groups reverse roles

Date	Primary topic	Secondary topic	Reading	Instructor
13 Jan	Review: wave motion	superposition of waves	2.1-2.9; 7.1-2	PL
18	Electromagnetic theory	Photons, light	3.1-3	PL
20	Radiation	Scattering	3.4-6	PL
25	Propagation of light 1	Reflection & refraction	4.2-5	PL
27	Propagation of light 2		4.6-8	PL
1 Feb	Propagation of light 3		4.9-11	PL
3	Geometric optics 1		5.1-4	PK
8	Geometric optics 2 (A)	Lab 1: optics components (B)	5.4-7	PK / PL
10	Class canceled			
15	Polarization 1		8.1-6	PL
17	Geometric optics 2 (B)	Lab 1: optics components (A)	5.4-7	PK / PL
22	Geometric optics 3 (A)	Lab 2: refractive index (B)	6.1-4	PK / PL
24	Geometric optics 3 (B)	Lab 2: refractive index (A)	6.1-4	PK / PL
1 Mar	Polarization 2		8.7-12	PK
3	EXAM 1			
8	Interference 1		9.1-3	PL
10	Interference 2		9.4-6	PL
22	Interference 3 (A)	Lab 3: interferometry (B)	9.7-8	PL/PK
24	Interference 3 (B)	Lab 3: interferometry (A)	9.7-8	PL/PK
29	Diffraction 1		10.1-2	PL
31	Diffraction 2 (A)	Lab 4: diffraction (B)	10.3-5	PL/PK
5 April	Diffraction 2 (B)	Lab 4: diffraction (A)	10.3-5	PL/PK
7	EXAM 2			
12	Lasers 1 (A)	Lab 5: optical devices (B)	13	PK/PL
14	Lasers 1 (B)	Lab 5: optical devices (A)	13	PK/PL
19	Lasers 2 (A)	Lab 6: spectral composition of light (B)	13	PK/PL
21	Lasers 2 (B)	Lab 6: spectral composition of light (A)	13	PK/PL
26	Fiber optics		13	PK
28	Holography		13	PK
3 May	8-10:30am FINAL			

Exams and Assignments

Exams

There will be two “hour” exams, each covering several thematically consistent chapters, and one comprehensive final exam. The “hour” exams will be administered during regular class periods, while the final exam will be administered during the usual period at the end of the semester.

For all exams, you are allowed only the following items:

• Writing implement(s)

• Calculator (no cell phones or PDAs)

• one prepared 8.5 × 11 inch formula sheet(s) for hour exams, two for the final exam

The hour exams will both have slightly different formats, but each one is worth an equal amount (viz. 30% of your total grade each). The exam dates will be listed on the course calendar during the first week of classes. The final exam will also be worth 30% of your total grade, and will be scheduled according to the published registrar's schedule.

Homework

There is homework due essentially every week. Homework will be posted on the course web site as a linked PDF file (available in hard copy upon request). Late problems will be assessed a per-day penalty of 25%. The lowest homework grade will be dropped at the end of the semester.

Problem sets may be turned in by hard copy or electronically. You must show your work for every problem to receive credit. Answers alone – even correct ones – will not receive credit without work shown. You may collaborate on problem sets, and are encouraged to, but each student must turn in their own work.

Occasionally, short in-class quizzes may be given without prior notice. These quizzes will count as an additional homework grade.

Grading Policy

Each of component of your grade is described above, and their relative weights in determining your overall grade are shown in the table below. The lowest single homework grade for the semester will be dropped.

Grading breakdown	
Homework	15%
Labs	15%
Hour exams (2)	40%
Final exam	30%

The grading scale used is detailed below.

Grading scale		
Letter	Numerical	Min. %
A+	4.33	97.5
A	4.00	92.5
A-	3.67	90
B+	3.33	87.5
B	3.00	82.5
B-	2.67	80
C+	2.33	77.5
C	2.00	72.5
C-	1.67	70

D+	1.33	67.5
D	1.00	62.5
D-	0.67	60
F	0.00	0

Policy on Missed Exams & Coursework

If you have a legitimate reason for missing a homework assignment or quiz, you will be given the option to make up the homework set at a later date, or receive a 'bye' on that particular assignment. The reason must be documented in writing, and whether it is acceptable or not will be judged on a case-by-case basis. If possible, inform the instructor as soon as possible before the assignment is due.

If you have a legitimate reason for missing a major exam, then you must inform the instructor as soon as possible before the exam occurs. If the reason is acceptable, either the exam will be dropped for you, and the final exam will count proportionately more, or you may make up the exam at a slightly earlier or later date. We reserve the right to administer a modified make-up exam slightly differing from the exam the rest of the class has taken. There is no makeup possible for missing the final exam.

Acceptable reasons must be documented, if possible in advance, and may include but are not limited to: prior athletic commitments, medical issues, off-campus academic commitments, prior commitments to on-campus academic events, band travel, standardized testing, graduate school interviews, and certain personal/family issues. Unacceptable reasons are fairly numerous. Among the least likely to be accepted are oversleeping, leaving early for academic breaks, and fan travel to ‘away’ athletic events.

Attendance Policy

In-class exercises or quizzes will be the (very) rare exception rather than the rule. It is expected that students will attend class having found some utility in it, rather than out of a sense of coercion or obligation. We will not waste your time while you are there.

Required Texts

UA Supply Store Textbook Information

- **HECHT (RENTAL) / (RENTAL) OPTICS**
  (RENTAL)
- **HECHT / OPTICS**
  (Required)

A basic scientific calculator with trigonometric and logarithmic functions is required. Access to a spreadsheet or scientific plotting program will also be required for some homework assignments (e.g., MS Excel, Originlab, Sigma Plot).

Other Course Materials

Course web site/blog: http://ph253-255.blogspot.com/

Features atom/rss feeds, anonymous comments. Online calendar (Google Calendar) available.

Extra Credit Opportunities

Probably not.

Policy on Academic Misconduct

All students in attendance at the University of Alabama are expected to be honorable and to observe standards of conduct appropriate to a community of scholars. The University expects from its students a higher standard of conduct than the minimum required to avoid discipline. Academic misconduct includes all acts of dishonesty in any academically related matter and any knowing or intentional help or attempt to help, or conspiracy to help, another student.

The Academic Misconduct Disciplinary Policy will be followed in the event of academic misconduct.

Disability Statement

If you are registered with the Office of Disability Services, please make an appointment with me as soon as possible to discuss any course accommodations that may be necessary. If you have a disability, but have not contacted the Office of Disability Services, please call 348-4285 or visit 133-B Martha Parham Hall East to register for services. Students who may need course adaptations because of a disability are welcome to make an appointment to see me during office hours. Students with disabilities must be registered with the Office of Disability Services, 133-B Martha Parham Hall East, before receiving academic adjustments.

Severe Weather Protocol

In the case of a tornado warning (tornado has been sighted or detected by radar; sirens activated), all university activities are automatically suspended, including all classes and laboratories. If you are in a building, please move immediately to the lowest level and toward the center of the building away from windows (interior classrooms, offices, or corridors) and remain there until the tornado warning has expired. Classes in session when the tornado warning is issued can resume immediately after the warning has expired at the discretion of the instructor. Classes that have not yet begun will resume 30 minutes after the tornado warning has expired provided at least half of the class period remains.

UA is a residential campus with many students living on or near campus. In general classes will remain in session until the National Weather Service issues safety warnings for the city of Tuscaloosa. Clearly, some students and faculty commute from adjacent counties. These counties may experience weather related problems not encountered in Tuscaloosa. Individuals should follow the advice of the National Weather Service for that area taking the necessary precautions to ensure personal safety. Whenever the National Weather Service and the Emergency Management Agency issue a warning, people in the path of the storm (tornado or severe thunderstorm) should take immediate life saving actions.

When West Alabama is under a severe weather advisory, conditions can change rapidly. It is imperative to get to where you can receive information from the National Weather Service and to follow the instructions provided. Personal safety should dictate the actions that faculty, staff and students take. The Office of Public Relations will disseminate the latest information regarding conditions on campus in the following ways:

- Weather advisory posted on the UA homepage
- Weather advisory sent out through Connect-ED--faculty, staff and students (sign up at myBama)
- Weather advisory broadcast over WVUA at 90.7 FM

- Weather advisory broadcast over Alabama Public Radio (WUAL) at 91.5 FM
- Weather advisory broadcast over WVUA 7. WVUA 7 Storm Watch provides a free service you can subscribe to that allows you to receive weather warnings for Tuscaloosa via e-mail, pager or cell phone. Check http://www.wvua7.com/stormwatch.html for details.