EE 529 Optics **Fall, 2015**

Course Summary

Abstract

This course is designed to be the first course of the optics program core sequence. As such, the course focuses on geometrical optics, optical system design, and an introduction to the principles of physical optics. The principal phenomenon investigated is the interaction of light with optical materials (such as dielectrics and metals), optical elements (such as simple and compound lenses, prisms, and mirrors) and combinations of optical elements (optical systems such as microscopes and telescopes) in the geometrical optics limit, including the effects of absorption, dispersion, polarization, and interference. Emphasis is placed throughout on a balanced combination of fundamental principles and practical system design considerations.

Topics to be covered include: Wave motion, electromagnetic theory, the quantum nature of light (including the photoelectric effect and wave-particle duality), light propagation (including the laws of reflection and refraction), the paraxial approximation central to the geometrical optics model, thin lenses, mirrors, prisms, thick lenses (introduction), optical instrument design and optimization, the human eye as an optical instrument (including the neurobiological basis of low-level vision), the origins and control of optical aberrations, wave superposition (if time permits), polarization phenomena (including a treatment of the generation, analysis, and utilization of polarized light for both scientific and technological applications), linear and circular dichroism, linear and circular birefringence (optical activity), and form birefringence.

Related topics of interest (covered in other courses) include diffraction theory (based on the Kirchhoff scalar diffraction approximation, and including the Fresnel and Fraunhofer regimes), Fourier optics (particularly as applied to optical information processing and computing), and the theory of full and partial coherence.

Potential follow-on courses include Optical Materials, Instruments, and Devices; Physical Optics; Advanced Geometrical Optics; Advanced Physical Optics; Integrated and Fiber Optics; Optical Information Processing (Fourier Optics and Holography); Optical Computing; Nonlinear Optics; and Optical Fiber Communication Systems.

Instructor

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Course Requirements

1. Homework Sets

Homework sets will be designed to increase problem solving aptitudes and skills, to illustrate concepts discussed in lecture, and to investigate certain critical phenomena in depth. They will be given out approximately once every two weeks, due in approximately two weeks, with due dates as given in the Course Calendar. If due dates are changed during the semester, the new dates will be discussed in class and posted to the course web site. A separate weekly workshop session will be arranged for review of the homework solutions, and to provide a forum for discussion of questions regarding the course material.

Students are strongly encouraged to make use of additional references and to ask questions of the Instructor and Teaching Fellow, but are required to produce their own independent solutions to the problems. Discussions among students regarding the subject matter covered by the course is highly encouraged. Collaboration among students regarding specific homework problems is not expressly forbidden, but is discouraged. Copying of solutions, though, or reading another student's homework paper while doing one's own homework, is expressly forbidden. The principal value of the homework sets is to develop your own problem solving methods and skills.

Within each homework set, several of the problems will be straightforward, and designed to familiarize students with a particular key concept. Often, these problems will couple together more than one concept, in order to demonstrate the multifaceted nature of the subject matter, and to forge connections among seemingly unrelated topics that do in fact have a common underpinning or conceptual root.

Two unusual features will be noted and stressed in the various homework sets. First, in consideration of the fact that real-life problems in science and engineering are almost never well-specified, some problems will either present data that is unnecessary for the solution of the problem, or will not present enough information for a satisfactory solution. In the former case, you are expected to identify the extraneous piece(s) of information, and explain why it is (or they are) not needed. In the latter case, you are expected to make a reasonable assumption, carefully justify your rationale for the assumption you've made, and then proceed to solve the problem.

Second, the course will include numerous design problems, in which you will be asked to consider a particular design goal, make necessary assumptions, couple concepts together as necessary, develop a coherent design that satisfies the design goals, and in some cases analyze the system performance given your particular design. Examples of such design problems might include a wavelength dispersing prism design, an optical imaging system design, or a polarization component design.

2. Midterm Examination

The midterm examination will be approximately one and one half hours in length, and will be open textbook, open notes, and open homework.

3. Term Project

A term project will be required on a pre-approved problem statement developed by you and of relevance to the course. The principal purpose of the project is to learn how to develop well-formulated questions or problems, in order to develop critical skills in the learning process. The project will include an explanation of the basic features of a given phenomenon, technique, or device, and will then utilize the methods developed in the course to extract additional useful information concerning the topic by solving the well-formulated problem.

The term project when completed must clearly articulate (a) the topic of interest, (b) the well-formulated question or problem concerning the topic, (c) the solution to the question or problem, and (d) a discussion of follow-on questions, or future research directions.

Further details will be provided as the course proceeds, including specific instructions on how to choose a topic, formulate a problem, execute a viable solution, reformulate the problem if necessary, and articulate the essence of the problem and its solution.

4. Oral Presentation of Term Project

To gain extremely important experience in the oral presentation of research and engineering results, each student will present a twenty minute summary of the term project, followed by a five minute question and answer period. All registered students will participate in the oral presentation sessions, which will be scheduled in separate sessions on several days near the end of the semester.

Further details will be provided as the course proceeds, including specific tips and pointers on how to prepare, practice, and deliver excellent presentations. These tips and pointers will also be very useful in other courses, conference presentations, and job interview presentations, as well as in preparation for the Graduate Qualifying Examination (for those pursuing the Ph.D. degree).

5. Final Examination

The final examination will be approximately two hours in length, and will be open textbook, open notes, and open homework.

Grading Policy

The course grade will be derived from all of the course requirements, and will be weighted in approximately the following manner:

- Homework, 20%
- Midterm Examination, 25%
- Final Examination, 30%
- Term Project; Oral Presentation of Term Project, 25%

Statement on Academic Integrity

Students who violate University standards of academic integrity are subject to disciplinary sanctions, including failure in the course and suspension from the University. Since dishonesty in any form harms the individual, other students, and the University, policies on academic integrity will be strictly enforced. You are expected to familiarize yourself with the Academic Integrity guidelines found in the current *Scampus (http://scampus.usc.edu/)*, as well as throughout this course summary and as presented in class.

Course Textbooks

Required:	Hecht, E., *Optics*, Addison-Wesley, Reading, Massachusetts, (2002), 4th Ed.
Recommended:	Klein, M. V. and T. E. Furtak, *Optics*, Wiley, New York, (1986), 2nd Ed.

Course Calendar

24 August, 2015 (Monday)	First Day of Classes
7 September, 2015 (Monday)	Labor Day (University Holiday)
9 September, 2015 (Wednesday)	Homework Set 1 Due
11 September, 2015 (Friday)	Last Day to Register and Add Classes
11 September, 2015 (Friday)	Last Day to Drop Without a "W"
11 September, 2015 (Friday)	Last Day to Change Enrollment Option: (Pass/No Pass or Audit)
16 September, 2015 (Wednesday)	Term Project Problem Statement Due (Draft Version)
23 September, 2015 (Wednesday)	Homework Set 2 Due
30 September, 2015 (Wednesday)	Term Project Problem Statement Due (Final Version)
7 October, 2015 (Wednesday)	Homework Set 3 Due
21 October, 2015 (Wednesday)	Homework Set 4 Due
26 October, 2015 (Monday)	Midterm Examination
4 November, 2015 (Wednesday)	Homework Set 5 Due
13 November, 2015 (Friday)	Last Day to Drop With a "W"
16 November, 2015 (Monday)	Homework Set 6 Due
25–28 November, 2015	Thanksgiving Recess
2 December, 2015 (Wednesday)	Homework Set 7 Due
2 December, 2015 (Wednesday)	Last Day of EE 529 Class
4 December, 2015 (Friday)	Fall Semester Classes End
5 December, 2015 (Saturday)	EE 529 Project Presentations
5–8 December, 2015	Stop Period (Study Days)
9–16 December, 2015	Final Examination Period

14 December, 2015 (Monday)	EE 529 Final Examination, 2:00 p.m. - 4:00 p.m. (5:00 p.m.)
17 December, 2015 (Thursday)	EE 529 Project Presentations
18 December, 2015 (Friday)	EE 529 Project Presentations
19 December, 2015 (Saturday)	EE 529 Project Presentations
17 December, 2015 – 10 January, 2016	Winter Recess