Course Syllabus

OSE 3052 Introduction to Photonics, Fall 2015

M, W 3:00 – 4:15 pm, CREOL 102

Instructor: Dr. Pieter G. Kik

Recitation section[1] Wednesday, 4:30 – 5:30 pm, CREOL 102

Recitation Instructor: Dr. M. G. Moharam

Office:	**Room 270 CREOL Building; email: kik@creol.ucf.edu**
Web site:	**Materials available on the UCF WebCourses system**
Office Hours:	**Monday, Wednesday 1:00 – 2:00 pm.**

Catalog Description
Introduction to light as rays, waves, and photons. Optical fibers. Interference and diffraction. Polarization. Image formation. LEDs and Lasers. Detectors. Optical systems (cameras, scanners, sensors).

Prerequisites
MAP 2302 Differential Equations. Also you will need to have competed PHY 2049C Physics for Engineers 2, and the other courses required for entry into the Photonic Science and Engineering major.

Detailed course description and learning outcomes:

Introduction
Some of the main growth areas in the high-tech sector are enabled by the branch of optics known as Photonics. Examples include displays, data storage, telecommunication systems. The continued growth of optics and photonics based industries means that there will be a growing and permanent need for engineers and scientists trained in optics. This course provides students with the strong foundation in optics that will be needed for the subsequent courses. We will frequently make reference to applications throughout the course. Other areas of optics, such as bio-photonics, laser machining, laser marking, infrared imaging, etc. are also growing strongly. Those topics are covered in the other courses in the *Photonic Science and Engineering* degree program.

Content
This course introduces the basic descriptions of light as rays (geometrical optics), waves (physical optics), and photons. Reflection and refraction of light rays and waves at planar and curved surfaces are introduced together with applications to basic optical systems such as single-lens imaging, microscopes, telescopes, scanning systems, and concentrators. Total internal reflection of rays is used to describe light propagation through optical fibers. Interference of optical waves is described along with interferometers and their

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[1] recitation time may be changed if students agree on an alternate time

applications to optical metrology and sensing. Diffraction of optical waves propagating through apertures is examined and the effects on the resolution of imaging systems and the spreading and focusing of optical beams are covered. Diffraction gratings and grating spectrometers are discussed. Regarding light as photons, a brief introduction to absorption, emission, and luminescence phenomena is followed by a description of light emitting diodes, lasers and optical detectors. The electromagnetic properties of light are mostly postponed to the next course in the sequence: *OSE 3053 Electromagnetic Waves for Photonics*.

Learning outcomes

Upon completion of this course, students should understand the basic principles of modern geometrical and physical optics and photonics. They should be able to read the specifications of commercial optical instruments such as a scanner for a laser printer, a telescope, or a spectrometer, and determine how these specifications impact the intended application. They should also be able to solve analysis and design problems for basic optical systems such as the following examples:

- Design an imaging system with prescribed magnification using a given lens, and determine the spatial resolution.
- Determine the critical angle for a given optical fiber and the angle of the cones of the incident and transmitted rays at the input and output of the fiber.
- Determine the changes in the Young's double-slit interference pattern that result from bringing the slits closer by some factor.
- Determine the changes in the Michelson interferogram that result from moving one of the mirrors or inserting a thin glass slab in one of the arms.
- Design an optical communication link.

Topics

- Geometrical optics: optical rays, refractive index, Fermat's principle, reflection and refraction from planar mirrors and boundaries between media of different refractive indexes, total internal reflection; *Applications: single-lens imaging, microscopes, telescopes, prism scanning systems, concentrators, optical fibers*
- Physical optics: wave propagation, planar and spherical waves, reflection and refraction from planar mirrors and planar boundaries between media of different refractive indexes, comparison between geometrical and wave optics
- Interference of light and optical interferometers; *Applications: optical sensing and metrology*
- Diffraction of light; *Applications: resolution of imaging systems, angular spreading and focusing of optical beams*
- Diffraction gratings and grating spectrometers
- Light as Photons: introduction to absorption, emission, and luminescence
- Optical devices: detectors, LEDs, and lasers

Textbook

Introduction to Optics, 3rd ed., F. L. Pedrotti, L.S. Pedrotti and L. M. Pedrotti, Prentice-Hall, 2009.
Chapters covered: 1 through 13.

Recommended Reference:
Schaum's Outline of Theory and Problems of Optics, Eugene Hecht, McGraw Hill, 1975, Ch. 1, 3-4, 6-7

Other Reference books
Optics, 4th ed., E. Hecht, Addison-Wesley, 2001.
Fundamentals of Photonics, B. Saleh and M. Teich, 2nd ed., Wiley, 2007.

Class Web site
Materials used for classes will be available on UCF WebCourses for download before each class. If you want a hard copy of the slides, print them. These are only printed for you for the first class. You are required to read or view materials prior to class. If you do not, you will not be able to do well in this class.

Teaching vs. Learning
Classes are intended to help you understand the topics in the course. That also means that the lectures will not be all-inclusive: you will need to read chapter sections before class independently, and rather than going though each chapter topic in detail, we may spend significant class time discussing e.g. an important concept more deeply, or going through an example problem. In addition there will be in-class quizzes to ensure that students come to class prepared.

Professionalism and Ethics
Per university policy and plain classroom etiquette, mobile phones, etc. must be silenced during all classroom lectures, unless you are specifically asked to make use of such devices for certain activities.

Academic dishonesty in any form will not be tolerated. If you are uncertain as to what constitutes academic dishonesty, please consult The Golden Rule, the University of Central Florida's Student Handbook (http://goldenrule.sdes.ucf.edu/) for further details. As in all University courses, The Golden Rule Rules of Conduct will be applied. Violations of these rules will result in a record of the infraction being placed in your file and the student receiving a zero on the work in question AT A MINIMUM. At the instructor's discretion, you may also receive a failing grade for the course. Confirmation of such incidents can also result in expulsion from the University.

Students with Special Testing/Learning Needs
Students with special needs and requiring special accommodations must be registered with UCF Student Disability Services prior to receiving those accommodations. Students must have documented disabilities requiring the special accommodations and must meet with the instructor to discuss the special needs as early as possible in the first week of classes. UCF Student Accessibility Services can be contacted at http://sas.sdes.ucf.edu or at (407) 823-2371.

Financial Aid and Attendance
Each semester, all faculty members are required to document students' academic activity at the beginning of each course. In order to document that you began this course, please complete and submit the first homework assignment by the due date of August 26, 5 pm. Failure to do so will result in a delay in the disbursement of your financial aid.

Final Exam: Wednesday, December 9, 2015, 1:00 PM – 3:50 PM, CREOL 102/103

Preliminary course schedule

Date	Subjects covered	Ch
Aug 24	Course overview/Introduction to Photonics/Nature of light	1
Aug 26	Introduction to geometric optics; reflection, refraction	2
Aug 31	Introduction to imaging, paraxial imaging with spherical mirrors	2
Sep 2	Spherical refractive interfaces and lenses, imaging with thin lenses	2
Sep 7	Labor Day (no lecture)	
Sep 9	Imaging with multiple lenses; compound lenses, eyesight correction	2
Sep 14	Aperture stop, pupils, chief and marginal rays	3
Sep 16	Vignetting, Field of View and Aberrations; Magnifiers and eyepieces	3
Sep 21	Prisms	3
Sep 23	Cameras	3
Sep 28	Microscopes and telescopes	3
Sep 30	Recap	
Oct 5	**Mid Term Exam**	
Oct 7	Harmonic waves, wave equation, radiometry	1,4
Oct 12	Electromagnetic waves, light as photons, polarization	4
Oct 14	Superposition of waves, interference, coherence	5
Oct 19	Light sources, lasers, and LEDs	6
Oct 21	Interference, double slit experiment	7
Oct 26	Thin film interference, Newton's rings	7
Oct 28	Multi-beam interference, etalon	7
Nov 2	Recap	
Nov 4	**Mid Term Exam**	
Nov 9	Interferometry and interferometers	8
Nov 11	Veterans Day (no lecture)	
Nov 16	Coherence	9
Nov 18	Fiber optics	10
Nov 23	Fraunhofer diffraction	11
Nov 25	Diffraction from multiple slits, gratings	11
Nov 30	Grating spectrometers	12
Dec 2	Fresnel Diffraction	13
Dec 7	Recap	
Dec 9	**FINAL EXAM : 1pm-3.50pm, room 102/103**	

Relationship of Course to ABET Criteria:

ABET Criteria	Level of Emphasis (Low, Medium, High)
(a) An ability to apply knowledge of mathematics, science, and engineering.	H
(b) An ability to design and conduct experiments, as well as to analyze and interpret data.	L
(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	L
(d) An ability to function on multidisciplinary teams.	L
(e) An ability to identify, formulate, and solve engineering problems.	H
(f) An understanding of professional and ethical responsibility.	L
(g) An ability to communicate effectively.	M
(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.	L
(i) A recognition of the need for, and an ability to engage in life-long learning.	L
(j) A knowledge of contemporary issues.	M
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	H

Grading:

Activity	Grade weight
Homework	20%
Quizzes	5%
In class work,	10%
Mid-terms, each 20% of grade	40%
Final exam	25%
TOTAL	**100%**

Grading Scale (%)					Rubric Description
100	≥	A	≥	90	Excellent, has a strong understanding of all concepts and is able to apply the concepts in all and novel situations. Has full mastery of the content of the course.
90	>	B	≥	80	Good, has a strong understanding of most or all of the concepts and is able to apply them to stated and defined situations.
80	>	C	≥	70	Average, has a basic understanding of the major concepts of the course and is able to apply to basic situations.
70	>	D	≥	60	Below average, has a basic understanding of only the simple concepts and is able to apply to only a limited number of the most basic situations.
60	>	F	≥	0	Demonstrates no understanding of the course content.

Grade Objections: All objections to grades should be made **in writing within one week** of the grade being posted for the work in question.

Note: Withdrawal Deadline is Monday, November 2, 2015 11:59 PM.