CREOL, THE COLLEGE OF OPTICS AND PHOTONICS

Course Syllabus
OSE 3200 Geometric Optics

Instructor:	Dr. Kyu Young Han	**Term:**	Spring 2018
Email:	kyhan@creol.ucf.edu	**Class Meeting Days:**	Monday/Wednesday
Phone:	407-823-6922	**Class Meeting Time:**	09:00-10:15AM
Office:	162, CREOL Bldg.	**Class Location**	102

Website: **Materials available on UCF Webcourses system**

Office Hours: Monday, Wednesday 10:15-11:45am (after class)

TA: Jialei Tang (A311, CREOL)

Course Catalog Description: Introductory optics course that describes the behavior of light as rays. Reflection, refraction, and transmission. Light in nature (rainbows, mirages, halos). Lenses, mirrors and prisms. Wavefront shaping and image formation. Optical design and systems (cameras, telescopes, 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.

<u>Detailed Course Description and Learning Outcomes:</u>

Detailed Description:

Geometric optics is the study of light in its simplest form by treating light as rays. Light rays travel in straight lines until they encounter an interface (such as a mirror or a lens) where they may be redirected by reflection and refraction. This course describes the physical principles that determine how rays behave at various interfaces. These principles are then used to model simple optical systems with varying degrees of fidelity. Natural optical phenomena (rainbows, mirages, total-internal reflection, etc.) and classic optical systems (prisms, telescopes, cameras, etc.) will be analyzed throughout the course. Linear systems will be introduced to analyze more complex optical systems. This course provides the fundamentals needed for optical engineering and optical system design.

Learning Outcomes:

Upon completion of this course, students should understand the physical principles underlying geometrical optics, especially the relationship between rays, wavefronts and electromagnetic waves. They should understand how light propagates through “most” optical systems – where “most” refers to optical systems that are not affected by the wave nature of light. They should be able to analyze and design simple optical systems such as telescopes, imagers, luminaires and concentrators. For example, students should be able to:

- Determine the behavior of a ray (reflection/refraction angles and amplitudes) at any optical surface.
- Design an imaging system with a desired resolution, field-of-view and magnification.
- Model a complex optical system using paraxial ray tracing.
- Identify fundamental limits and aberrations in an optical system.

Topics: (A detailed schedule with dates follows at the end of this document.)

1) Introduction to Geometric Optics – Light as Rays: Wave nature of light, propagation in homogeneous media, wavefronts and rays, radiometry, limits of geometrical optics.
2) Planar Optical Surfaces: Refractive index, optical path length, Fermat's principle, Snell's law, reflection and refraction, plane parallel plates, prisms, optical materials.
3) Curved Optical Surfaces: Image formation, lenses, optical spaces, image types, shape of optical surfaces, ray tracing, paraxial approximation.
4) Imaging: Lens design, thin lens model, magnification, ZZ' diagram, cardinal points, Gaussian optics, thick lenses, mirrors.
5) Apertures: Aperture stop, field stop, F-number, numerical aperture, depth of focus.
6) Example Optical Systems: Telescopes, cameras, microscopes, luminaires, concentrators, displays.
7) Aberrations: Diffraction limit, chromatic and monochromatic aberrations.

Relationship of Course to ABET Criteria

ABET Criteria	**Level of Emphasis During Course (Low, Medium, High)**
(a) An ability to apply knowledge of mathematics, science, and engineering.	High
(b) An ability to design and conduct experiments, as well as to analyze and interpret data.	Low
(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.	Medium
(d) An ability to function on multidisciplinary teams.	Low
(e) An ability to identify, formulate, and solve engineering problems.	High
(f) An understanding of professional and ethical responsibility.	Low
(g) An ability to communicate effectively.	Low
(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.	Medium
(i) A recognition of the need for, and an ability to engage in life-long learning.	Low
(j) A knowledge of contemporary issues.	Low
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	High

Textbook:
Geometrical and Trigonometric Optics, 1st ed., E. L. Dereniak, and T. D. Dereniak, Cambridge University Press 2008.

Reference Books:
Introduction to Optics, 3rd ed., F. L. Pedrotti, L.S. Pedrotti and L. M. Pedrotti, Prentice-Hall, 2009.
Geometrical Optics and Optical Design, P. Mouralis and J. Macdonald, Oxford University Press, 1997.

Course Grading and Requirements for Success:

Criteria	Grade Weighting
Homework	30%
Quizzes	10%
Midterm Exam I	15%
Midterm Exam II	15%
Final Exam	30%
Total	100%

Final Exam Date: 4/30/2018

Make Up Policy: If an emergency arises and a student cannot submit assigned work on or before the scheduled due date or cannot take an exam on the scheduled date, the student **must** give notification to the instructor **no less than 24 hours before** the scheduled date and **no more than 48 hours after the** scheduled

Financial Aid and Attendance: As of Fall 2014, 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 the provided academic activity by the end of the first week of classes, or as soon as possible after adding the course, but no later than January 12. Failure to do so will result in a delay in the disbursement of your financial aid.

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.
> B ≥	Good, has a strong understanding of most or all of the concepts and is able to apply them to stated and defined situations.
> C ≥	Satisfactory, has a basic understanding of the major concepts of the course and is able to apply to basic situations.
> D ≥	Below satisfactory, has a basic understanding of only the simple concepts and is able to apply to only a limited number of the most basic situations.
> 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 work in question.
Objections made after this period has elapsed will **not** be considered – NO EXCEPTIONS.

Homework Policy:
Late homework will be accepted with a penalty of 10 points lost per day the assignment is late.

Class Website:
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.

Teaching vs. Learning:
Most people learn things for themselves. As a teacher, my job is to help students to learn the material. In order to help you learn in depth, I plan to use a significant amount of class time for detailed discussion of concepts, and problem-solving. Students are expected to read and understand the textbook in addition to attending class. I will occasionally set 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 in the UCF Student Handbook (www.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 require 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 Disability Services can be contacted at www.sds.sdes.ucf.edu or at (407)823-2371.

Dates:

First Day of Class:	1/8/2018
Last Day to Drop Classes:	1/11/2018
Last Day to Add Classes:	1/12/2018
Withdrawal Deadline:	3/21/2018
Last Day of Class:	4/23/2018
Final Exam:	4/30/2018

OSE 3200 Geometric Optics, Spring 2018, Dr. Kyu Young Han Daily Schedule (subject to change)			
Week	Date	Concepts Presented:	Textbook chapter
1	1/8/2018	Intro. Geometrical Optics: Course overview, nature of light, electromagnetic waves	1
	1/10/2018	Intro. Geometrical Optics: Rays and wavefronts, limits of geometrical Optics, radiometry	1
2	1/15/2018	Martin Luther King Jr. Day (no class)	N/A
	1/17/2018	Planar Optics: Refractive index, optical path length, reflection and refraction, Snell's law	1
3	1/22/2018	Planar Optics: Fermat's principle, reversibility, total internal reflection, Fresnel coefficients	2
	1/24/2018	Planar Optics: Brewster angle, plane parallel plates, plane mirrors, image parity, prisms, dispersion	4
4	1/29/2018	Planar Optics: Optical materials, abbe number, Sellmeier equation	4
	1/31/2018	Curved Optical Surfaces: Pinhole camera, image formation, refraction at curved surfaces | Quiz#1	3
5	2/5/2018	Curved Optical Surfaces: Focusing, curvature, optical power, graphical ray tracing	5
	2/7/2018	Curved Optical Surfaces: Objects and images, optical spaces, spherical surfaces	5
6	2/12/2018	Curved Optical Surfaces: Paraxial ray tracing, transfer equations, focal length	5
	2/14/2018	Imaging 1: Lens shapes, thin lenses, lens-maker's equation, Gaussian equation	5
7	2/19/2018	Midterm Exam I	N/A
	2/21/2018	Imaging 1: Mapping object-to-image space, magnification	6
8	2/26/2018	Imaging 1: Sequential imaging	6
	2/28/2018	Imaging 1: ABCD matrices	6
9	3/5/2018	Imaging 2: Combinations of thin-lenses, Gullstrand's equation, principle points	6/7
	3/7/2018	Imaging 2: Thick lenses, cardinal points | Quiz#2	7
10	3/12/2018	Spring Break (no class)	N/A
	3/14/2018	Spring Break (no class)	N/A
11	3/19/2018	Imaging 2: Multiple lenses, Gaussian optics	7
	3/21/2018	Imaging 2: Curved mirrors	7
12	3/26/2018	Imaging 2: Curved mirrors	8
	3/28/2018	Midterm Exam II	N/A
13	4/2/2018	Apertures: Aperture stop and field stop, entrance and exit pupils	9
	4/4/2018	Apertures: Chief and marginal rays, determining stops and pupils	9/10
14	4/9/2018	Apertures: F-number, numerical aperture, field-of-view, resolution	9
	4/11/2018	Apertures: Depth of focus/field, hyperfocal distance, vignetting	9/10
15	4/16/2018	Aberrations: Diffraction, point-spread-function, chromatic aberrations	11
	4/18/2018	Aberrations: Monochromatic aberrations	11
16	4/23/2018	Final Exam Review	N/A
	4/25/2018	Study week (no class)	N/A
17	4/30/2018	Final Exam	N/A