UCF CREOL, THE COLLEGE OF OPTICS AND PHOTONICS

Course Syllabus-REVISED VERSION DUE TO HURRICANE IRMA

OSE 3200 Geometric Optics

Instructor: Dr. Kyle Renshaw
Email: krenshaw@creol.ucf.edu
Phone: 407-823-2807
Office: A209, CREOL Bldg.

Term: Fall 2017
Class Meeting Days: Tuesday/Thursday
Class Meeting Time: 9:00-10:15AM
Class Location 102

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

Office Hours: Tuesday, Thursday 10:30-11:00pm (after class).
Thursday, 4-5pm (This time may be rearranged to best meet the needs of the students – will be discussed in class).

Additional Notes: I will be in my office at these times, but of course I will be happy to discuss the material with you anytime; drop by my office or contact me in advance to make an appointment. Often, I get questions via e-mail that can be quickly answered.

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: You must have completed or currently taking MAP 2302 (Differential Equations), have competed PHY 2049C (Physics for Engineers 2), and have completed the other courses required for entry into the Photonic Science and Engineering major.

Detailed Course Description and Learning Outcomes:

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.

The digital version of the course textbook is available for free through the UCF Libraries. You can view it on the Web or download a PDF version to read offline. Accessing the text off-campus requires that you authenticate as a UCF student. Link: https://www.cambridge.org/core/books/geometrical-and-trigonometric-optics/41792CC511FABC71B070C0747CBB42D0

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: 12/7/2017

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 or deadline.

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 **August 25**. 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:
All homework must be submitted electronically as a ".pdf" file through the class website. You can easily scan your homework using one of the copiers around CREOL. Late homework will be accepted with a penalty of 10 points lost per day the assignment is late.

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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 will use class time to introduce the material/concepts and work examples using these concepts to solve problems. It is your responsibility to learn the material and much of this learning will come outside of class time, e.g. by working homework problems, studying for quizzes/exams and discussing

concepts or problems with fellow students and myself. 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:
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Dates:

First Day of Class:	8/21/2017
Last Day to Drop Classes:	8/24/2017
Withdrawal Deadline:	10/30/2017
Last Day of Class:	11/30/2017
Final Exam:	12/7/2017

OSE 3200 Geometric Optics, Fall 2017, Dr. Kyle Renshaw **Daily Schedule (subject to change)**			
Week	Date	Concepts Presented:	Textbook chapter
1	8/22/2017	Intro. Geometrical Optics: Course overview, nature of light, electromagnetic waves	1
	8/24/2017	Intro. Geometrical Optics: Rays and wavefronts, limits of geometrical Optics, radiometry	1
2	8/29/2017	Planar Optics: Refractive index, optical path length, reflection and refraction, Snell's law	1
	8/31/2017	Planar Optics: Fermat's principle, reversibility, total internal reflection, Fresnel coefficients	2
3	9/5/2017	Planar Optics: Brewster angle, plane parallel plates, plane mirrors, image parity	2, 4
	9/7/2017	Cancelled	N/A
4	9/12/2017	Cancelled	N/A
	9/14/2017	Cancelled	N/A
5	9/19/2017	Planar Optics: Prisms, dispersion	4
	9/21/2017	Optical materials and curved surfaces (pinhole camera, image formation)	4, 3
6	9/26/2017	Midterm I	N/A
	9/28/2017	Curved Optical Surfaces: refraction at curved surfaces, focusing, curvature, optical power	5
7	10/3/2017	Curved Optical Surfaces: graphical ray tracing, objects and images, spaces	5
	10/5/2017	Curved Optical Surfaces: spherical surfaces, paraxial ray tracing, transfer equations	5
8	10/10/2017	Imaging 1 (thin lenses): Lens shapes, thin lenses, lens-maker's equation	6
	10/12/2017	Imaging 1 (thin lenses): Gaussian equation, object/image space, magnification	6
9	10/17/2017	Imaging 1 (thin lenses): Sequential imaging and ray tracing	6
	10/19/2017	Imaging 2 (thick lenses): combinations of thin-lenses, Gullstrand's equation, principle points	6/7
10	10/24/2017	Imaging 2 (thick lenses): thick lenses, cardinal points	7
	10/26/2017	Midterm Exam II	N/A
11	10/31/2017	Imaging 2 (thick lenses): multiple lenses, Gaussian optics	7
	11/2/2017	Imaging 2 (curved mirrors): imaging with curved reflectors, negative index	8
12	11/7/2017	Imaging 2 (curved mirrors): conic sections, telescopes, catadioptric systems	8
	11/9/2017	Apertures: Aperture stop and field stop, entrance and exit pupils	9/10
13	11/14/2017	Apertures: Chief and marginal rays, ray trace worksheets	9/10
	11/16/2017	Apertures: F-number, numerical aperture, field-of-view, resolution	9/10
14	11/21/2017	Apertures: Depth of focus/field, hyperfocal distance, vignetting	9/10
	11/23/2017	Thanksgiving Break: NO CLASS	-
15	11/28/2017	Aberrations: Diffraction/point-spread-function, resolution	11
	11/30/2017	Aberrations: Chromatic and monochromatic aberrations	11
16	12/5/2017	Study Week: NO CLASS	N/A
	12/7/2017	Final Exam	N/A

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Course Syllabus-ORIGINAL VERSION (please follow revised above)

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2	8/29/2017	Planar Optics: Refractive index, optical path length, reflection and refraction, Snell's law	1
	8/31/2017	Planar Optics: Fermat's principle, reversibility, total internal reflection, Fresnel coefficients	2
3	9/5/2017	Planar Optics: Brewster angle, plane parallel plates, plane mirrors, image parity	2
	9/7/2017	Planar Optics: Prisms, dispersion	4
4	9/12/2017	Planar Optics: Optical materials, abbe number, Sellmeier equation	4
	9/14/2017	Curved Optical Surfaces: Pinhole camera, image formation, refraction at curved surfaces	3
5	9/19/2017	Midterm Exam I	N/A
	9/21/2017	Curved Optical Surfaces: Focusing, curvature, optical power, graphical ray tracing	5
6	9/26/2017	Curved Optical Surfaces: Objects and images, optical spaces, spherical surfaces	5
	9/28/2017	Curved Optical Surfaces: Paraxial ray tracing, transfer equations, focal length	5
7	10/3/2017	Imaging 1: Lens shapes, thin lenses, lens-maker's equation, Gaussian equation	6
	10/5/2017	Imaging 1: Mapping object-to-image space, magnification	6
8	10/10/2017	Imaging 1: Sequential imaging	6
	10/12/2017	Imaging 1: ABCD matrices	N/A
9	10/17/2017	Review for Midterm II	N/A
	10/19/2017	Midterm Exam II	N/A
10	10/24/2017	Imaging 2: Combinations of thin-lenses, Gullstrand's equation, principle points	6/7
	10/26/2017	Imaging 2: Thick lenses, cardinal points	7
11	10/31/2017	Imaging 2: Multiple lenses, Gaussian optics	7
	11/2/2017	Imaging 2: Curved mirrors	8
12	11/7/2017	Imaging 2: Curved mirrors	8
	11/9/2017	Apertures: Aperture stop and field stop, entrance and exit pupils	9/10
13	11/14/2017	Apertures: Chief and marginal rays, determining stops and pupils	9/10
	11/16/2017	Apertures: F-number, numerical aperture, field-of-view, resolution	9/10
14	11/21/2017	Apertures: Depth of focus/field, hyperfocal distance, vignetting	9/10
	11/23/2017	Thanksgiving Break: NO CLASS	-
15	11/28/2017	Aberrations: Diffraction, point-spread-function, chromatic and monochromatic aberrations	11
	11/30/2017	Final Exam Review	N/A
16	12/5/2017	Study Week: NO CLASS	N/A
	12/7/2017	Final Exam	N/A