UCF CREOL, THE COLLEGE OF OPTICS AND PHOTONICS

Course Syllabus

OSE 3200 Geometric Optics

Instructor: Dr. Kyle Renshaw
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Term: Fall 2020
Class Meeting Days: T/Th
Class Meeting Time: 9:00-10:15AM
Class Location online

Website: Course materials will be provided through UCF's Webcourse system
Office Hours: Will be held online. Day and time will be posted during the first week.

Additional Notes: Outside of these hours, please contact me via webcourses or e-mail to ask questions or schedule a virtual meeting. Often, I get questions via e-mail that can be quickly answered.

Course Catalog Description: Fundamentals of geometrical optics. Geometrical theory of image formation. Chromatic and monochromatic aberrations. Optical systems.

Prerequisites: You must have completed PHY 2049C (Physics for Engineers 2) and 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 (mirages, total-internal reflection, rainbows, 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 representation of light paths using rays. 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 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.
- Analyze a complex optical system using paraxial ray tracing.
- Identify fundamental limits and aberrations in an optical system.

Online Learning:

Because of the continued remote instruction requirement due to the COVID-19 pandemic, this course will use Zoom for synchronous ("real time") meetings during every class period. Meeting dates and times will be scheduled through Webcourses@UCF. Please take the time to familiarize yourself with Zoom by visiting the UCF Zoom Guides at <https://cdl.ucf.edu/support/webcourses/zoom/>.

Things to Know About Zoom:

- You must sign in to my Zoom session using your UCF NID and password.
- The Zoom sessions are recorded.
- Improper classroom behavior is not tolerated within Zoom sessions and may result in a referral to the Office of Student Conduct.
- You can contact Webcourses@UCF Support at <https://cdl.ucf.edu/support/webcourses/> if you have any technical issues accessing Zoom.

COVID-19 and Illness Notification

Students who believe they may have a COVID-19 diagnosis should contact UCF Student Health Services (407-823-2509) so proper contact tracing procedures can take place. Students should not come to campus if they are ill, are experiencing any symptoms of COVID-19, have tested positive for COVID, or if anyone living in their residence has tested positive or is sick with COVID-19 symptoms. CDC guidance for COVID-19 symptoms is located here: (https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html). Students should contact their instructor(s) as soon as possible if they miss class for any illness reason to discuss reasonable adjustments that might need to be made. When possible, students should contact their instructor(s) before missing class. If the instructor falls ill during the semester, there may be changes to this course, including having a backup instructor take over the course. Please look for announcements or mail in Webcourses@UCF or Knights email for any alterations to this course.

Integrated Learning:

MATLAB is a critical computational tool for scientists and engineers. The PSE program uses MATLAB throughout the curriculum. This course provides a structured opportunity for students to gain initial proficiency in Matlab sufficient to perform basic calculations. No prior experience with MATLAB is required.

Personalized Adaptive Learning (PAL):

This course uses PAL for part of the course. The PAL content is online and uses RealizeIT software deployed through webcourses. Students will be responsible for completing the assigned module before class and ready for discussion and examples during the designated class period. See the PAL page in webcourses for more information.

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) 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

Course Grading and Requirements for Success:

Criteria	Grade Weighting
PAL Content/Assessment	10%
Participation	5%
Homework	25%
Quizzes	10%
Matlab Exam	5%
Midterm Exam	15%
Final Exam	30%
Total	100%

Final Exam Date: 7-9:50AM on 12/10/2020

Grading Scale	Rubric Description
A	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	Demonstrates no understanding of the course content.

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.

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.

Assignments: All assignments must be submitted online through webcourses. Responses on paper must be photographed or scanned for uploading; it must be clearly readable or will not be graded. Quizzes and exams will be proctored virtually, using ProctorHub, which requires you work seated in front of a camera for the duration of the assignment. Late homework will be accepted with a penalty of 10 points lost per day.

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)*

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. Failure to do so will result in a delay in the disbursement of your financial aid.

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 hold 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:	8/24/2020
Last Day to Drop Classes:	8/28/2020
Withdrawal Deadline:	10/30/2020
Last Day of Class:	12/4/2020
Labor Day	9/7/2020
Veterans Day	11/11/2020
Thanksgiving Break (no class)	11/25 - 11/27
Midterm	10/14/2020
Final Exam:	12/10/2020, 7-9:50am

OSE 3200 Geometric Optics, Fall 2020, Dr. Kyle Renshaw
Weekly Schedule (subject to change)

Week	Starts	Concepts Presented:	Book[1] chapter	HW[2]	Assessment[3]
1	8/24	Module 1: Ray description of light fields, radiant flux, solid angle, collection efficiency	1	1	
2	8/31	Module 2: Refractive index, optical path length, reflection and refraction, Fresenel coefficients, Fermat's principle, total internal reflection	2	2	Quiz 1 Rays, Power
3	9/7	Module 2: plane parallel plates, mirrors and prisms, optical materials and dispersion	2/4	3	Quiz 2 Refraction
4	9/14	In class: Matlab tutorial, curved surface examples and discussion PAL Module 3: Nodes 1-4	3/5		
5	9/21	In class: Paraxial ray tracing examples and ABCD matrices PAL Module 3: Node 5 (Paraxial Ray Tracing)	5	4	Quiz 3 Curves
6	9/28	Module 4: Thin lenses, lens shapes, lens-maker's equation, sequential imaging	6	5	Quiz 4 Paraxial
7	10/5	Module 5: Curved Mirrors	8	6	Quiz 5 Sequential
8	10/12	Review, midterm and Matlab session	N/A		
9	10/19	Module 6: Combinations of thin-lenses, Gullstrand's equation, principle points	6/7	7	
10	10/26	Module 6: Thick lenses, cardinal points, lens systems	7	8	Quiz 6 Combination
11	11/2	Apertures: stops and pupils, diffraction limit, F-number, resolution, depth of focus/field	9	9	Quiz 7 Thick
12	11/9	Apertures: Ray trace worksheets, chief and marginal rays, scaling	9/10	10	Quiz 8 Apertures
13	11/16	Apertures: Characterize paraxial properties from a ray trace, vignetting	9/10	11	Quiz 9 Worksheets
14	11/23	Aberrations, no class W/Th/F	11		Quiz 10 Characterize
15	11/30	Final Review	N/A		

1: Read relevant sections before class
2: HW typically assigned Monday covering current week and due following Wednesday
3: Take home quizzes typically assigned on Wednesday and due on Friday