



Course Syllabus

OSE 3200 Geometric Optics

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Term: Fall 2019
Class Meeting Days: M/W/F
Class Meeting Time: 3:30-4:20PM
Class Location: 102

Website: Materials available on UCF Webcourses system

Office Hours: Wednesday, 2-3pm (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 completed 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.

Integrated Learning:

MATLAB is a critical computational tool for scientists and engineers. The PSE program has adopted teaching and using 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.

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
Participation	10%
Homework	30%
Quizzes	5%
Matlab Exam	5%
Midterm Exam I	10%
Midterm Exam II	10%
Final Exam	30%
Total	100%

Final Exam Date: 12/6/2019 from 1:00-3:50PM

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
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.

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.

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 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:

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:	8/26/2019
Last Day to Drop Classes:	8/29/2019
Withdrawal Deadline:	11/1/2019
Last Day of Class:	12/4/2019
Labor Day	9/2/2019
Veterans Day	9/11/2019
Thanksgiving Break (no class)	11/28-11/29
Midterm 1	9/18/2019
Midterm 2	10/23/2019
Final Exam:	12/6/2019, 1-3:50pm

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Weekly Schedule (subject to change)			
Week	Week of	Concepts Presented:	Textbook chapter
1	8/26	Introduction to Geometrical Optics course and content: Ray description of light fields, radiometry and Matlab	1
2	9/2	Planar Optics: Refractive index, optical path length, reflection and refraction, Fresnel coefficients, Fermat's principle, total internal reflection	2
3	9/9	Planar Optics: plane parallel plates, mirrors and prisms, optical materials and dispersion	2/4
4	9/16	Review, midterm and Matlab session	N/A
5	9/23	Curved Optical Surfaces: Image formation, pinhole camera, refraction by curved surfaces, focusing and power, graphical ray tracing, optical spaces	3/5
6	9/30	Curved Optical Surfaces: Spherical surfaces, paraxial ray tracing, transfer equations, focal length and Gaussian equation	5
7	10/7	Imaging 1: Lens shapes, thin lenses, lens-maker's equation, Gaussian imaging	6
8	10/14	Imaging 1: Sequential imaging, ABCD matrices, curved mirrors	6/8
9	10/21	Review, midterm and Matlab session	N/A
10	10/28	Imaging 2: Combinations of thin-lenses, Gullstrand's equation, principle points	7
11	11/4	Imaging 2: Thick lenses, cardinal points, lens systems	7
12	11/11	Apertures: stops and pupils, diffraction limit, F-number, resolution, depth of focus	9/10
13	11/18	Apertures: Ray trace worksheets, chief and marginal rays, determining stops and pupils, vignetting	9/10
14	11/25	Review on Monday, no class W/F	N/A
15	12/2	Aberrations, Review, Final exam on Friday	N/A