UCF CREOL, THE COLLEGE OF OPTICS AND PHOTONICS

Course Syllabus

OSE 4240 Intro To Optical Design

Instructor: Dr. Kyle Renshaw
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Term: Spring 2022
Class Meeting Days: M/W
Class Meeting Time: 6:00-7:15PM
Class Location A214

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

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

Course Catalog Description: Introduction of the main concepts in optical system design. Discussion on aberration theory. Analysis of the performance of optical systems. Assessment of image quality using optical design software.

Prerequisites: OSE 3052 Introduction to Photonics and OSE 3200 Geometric Optics.

Detailed Course Description and Learning Outcomes:

Detailed Description:

Analysis of optical systems consisting of lenses, mirrors, and apertures. Image plane, principal planes, and entrance and exit pupils. Magnification, field of view, F number, image-plane irradiance. Assessment of image quality resulting from diffraction and geometrical and chromatic aberrations, using optical design software. Analysis and design of photonic systems including systems consisting of waveguides and integrated-optic components. Numerical simulation using photonic design software.

Learning Outcomes:

Upon completing this course, the students will:

- Master the concept of ray-tracing and understand the aberration theory.
- Evaluate the performance for imaging optical system based on aberration theory.
- Understand the major design constraints in manufacturing and properties in optical materials.
- Get familiar with common lens-based imaging instruments and design criteria.
- Design simple imaging optical systems using commercially available software (Zemax).

COVID-19 Impact:

I recognize and understand the difficult times we are all in. The COVID-19 pandemic impacts us all in many ways, including physically, mentally, emotionally, financially, academically, and professionally. I will work with you on challenges you may be encountering and to provide support to help you succeed. However, please

keep in mind that I will hold you accountable, especially in terms of class attendance, participation, and contributions. UCF expects that all members of our campus community who are able to do so get vaccinated, and we expect all members of our campus community to wear masks indoors, in line with the latest CDC guidelines. Masks are required in approved clinical or health care settings. If the instructor falls ill during the semester, there may be temporary changes to this course, including having a backup instructor take over the course or going remote for a short time. Please look for announcements or mail in Webcourses@UCF or Knights email for any temporary alterations to this course. Students who believe they may have been exposed to COVID-19 or who test positive must 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 or have tested positive for COVID-19. Students should contact their instructor(s) as soon as possible if they miss class for any illness to discuss reasonable adjustments that might need to be made. When possible, students should contact their instructor(s) before missing class.

Integrated Learning:

MATLAB is a critical computational tool for scientists and engineers. The PSE program uses MATLAB throughout the curriculum. Some homework assignments will require Matlab (or another computational tool). Please contact the instructor if you need help with these assignments.

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

- Analysis of optical systems consisting of lenses, mirrors, and apertures.
- Image plane, principal planes, and entrance and exit pupils. Magnification, field of view, F number, image-plane irradiance.
- Ray tracing invariants. Ray tracing using a spread sheet and optical design software.
- Wave front aberration and assessment of image quality resulting from diffraction.
- Seidel's 3rd order aberrations and chromatic 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.	Medium
(b) An ability to design and conduct experiments, as well as to analyze and interpret data.	Medium
(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.	Medium
(g) An ability to communicate effectively.	Medium
(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.	Medium
(j) A knowledge of contemporary issues.	Medium
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	High

Course Grading and Requirements for Success:

Homework: 5 problem sets.
Exams: Midterm exam on lens design
Quizzes: ~3 quizzes
Participation:
Final Project: Oral presentation on optical design

Criteria	Grade Weighting
Homework	50%
Quizzes and Participation	10%
Midterm Exam	20%
Final Project	20%
Total	100%

Final Exam Date: 4-6:50PM on 4/28/2020

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: None, but the following books are recommended for reference.

- Introduction to Lens Design: With Practical Zemax Examples, Willmann-Bell, 2002
- Introduction to Lens Design, Jose Sasian, Cambridge, 2019 (free @ UCF: link)
- A Course in Lens Design, Chris Velzel, Spring, 2014 (free @ UCF: link)
- Optical System Design, 2nd ed., Robert Fisher, MacGraw-Hill, 2008

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:	1/10/2022
Last Day to Drop Classes:	1/14/2022
Withdrawal Deadline:	3/25/2022
Last Day of Class:	4/25/2022
Martin Luther King Jr. Day (no class)	1/17/2022
Spring Break (no class)	3/6 - 3/13
Midterm	3/17/2022
Final Exam:	4/27/2022, 4-6:50pm

OSE 4240 Intro to Optical Design, Spring 2022, Dr. Kyle Renshaw
Weekly Schedule (subject to change)

Week	Starts	Concepts Presented:	Slides
1	1/10	Introduction, Ray Propagation, Eikonal	1
2	1/17	(No class M) Review of paraxial ray tracing	2
3	1/24	Review of geometric optics, Gaussian equations, thin lenses & systems, cardinal points, stops and pupils	3
4	1/31	Matrix representation, Invariants, Ray trace spreadsheet	4
5	2/7	Zemax, Exact Ray Tracing	5, 6
6	2/14	Introduction to aberrations, lens characterization (spot analysis, MTF, PSF) and scaling	7, 8
7	2/21	3rd order aberrations (Seidel)	9, 10
8	2/28	Lens Design Process	11
9	3/7	Spring Break (no class)	
10	3/14	Midterm Review and Exam	
11	3/21	Lens Design Examples (landscape, field flattener)	12
12	3/28	Chromatic Aberrations	13
13	4/4	Achromat and Apochromat lenses	14
14	4/11	Example Lens Designs (double Gauss, telescope, fisheye)	15
15	4/18	Guest Lectures	