



# College of Optics & Photonics

Fall 2015

## OSE-5203 Geometrical Optics and Imaging Science

**Time:** Monday and Wednesday 1:30 PM – 2:45 PM  
August 24, 2015 – December 14, 2015

**Location:** CREOL-102

**Credit Hours:** 3 hours

**Prerequisite:** Graduate standing or consent of instructor

**Description:** Fundamentals of Geometrical Optics, Geometrical Theory of Image Formation and Aberrations.

**Instructor:** Dr. Jim Moharam, Professor

- Office CREOL – 274
- **Email:** moharam@creol.ucf.edu

**Office Hours:** Monday and Wednesday 3:00 PM - 4:00 PM or by appointment

**Class Website:** Course materials (syllabus, notes, problem sets, solutions, and old exams) will be available on <https://webcourses.ucf.edu/>

- Lectures are “video streamed” through the **PANOPTO** system.
- A link to the lectures is available on Webcourses.

**Reference Materials:**

- Class notes
- P. Mouroulis and J. MacDonald, “Geometrical Optics and Optical Design” Oxford Press 1997. (could be useful but not required)

**Course Requirements and Grading Policy:**

- **Problem sets: 10%**
  - Problem sets are to be submitted before the beginning of the class on the due date in person or by e-mail.
  - Late homework will not be accepted.
  - You may work with others but the submission must be all yours.
- **Midterm Exam I: 25%**
  - Monday, October 5, 2015 1:30 PM -2:45 PM
- **Midterm Exam II: 25%**
  - Monday, November 9, 2015 1:30 PM -2:45 PM
- **Final Exam: 40%**
  - Monday, December 14, 2015 1:00 PM -3:50 PM

**Exams are comprehensive and are closed book and notes.  
All exams are held in CREOL 102/103.**

**Make up Work/Exam Policy:**

If an emergency arises and a student cannot submit assigned work by the due date or cannot take an exam on the scheduled date, the student must notify the instructor no less than 24 hours before and no more than 48 hours after the scheduled date.

**Grading Scale:**

(%)	Rubric Description
$A \geq 90$	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.
$90 > B \geq 70$	Good, has a strong understanding of most or all of the concepts and is able to apply them to stated and defined situations.
$70 > C \geq 60$	Average, has a basic understanding of some of the major concepts of the course and is able to apply to basic situations.
$60 > D \geq 50$	Below average, has a basic understanding of only the simple concepts and is able to apply to only a limited number of the basic situations.
$F < 50$	Demonstrates no understanding of the course content.

**Plus and minus grades will be used.**

**Calendar:**

August (3)		September (8)		October (8)		November (8)		December (1)	
			2	5 (MT)	7	2	4		2
		7 (H)	9	12	14	9 (MT)	11 (H)	7	
		14	16	19	21	16	18	14 (F)	
24	26	21	23	26	28	23	25		
31		28	30			30			

- **Withdrawal deadline November 2, 2015**

**General Information:**

- Students in the on-campus sections are required to attend the class in person.
- Your e-mail of record at UCF will be used for communication.
- My preferred method of communication (other than in person) is e-mail. It is checked regularly including on weekends.
- If you have any questions, do not wait for office hours. E-mail me and I will get back to you within a reasonable time.
- If it is not possible to satisfactorily answer your questions, a time will be arranged to meet at my office.

**Information for Distant Learning Students:**

- Students in the distant learning section located within 150 miles from UCF must take the Midterms and the Final Exam with the students in the face-face section.
- It is extremely important to review the class videos in a timely manner.
- Problem sets are to be submitted by class time on the due date by e-mail (pdf format preferred). Graded problem sets and exams will be e-mailed back.

**Financial Aid and Attendance:**

Students' academic activity at the beginning of each course must be documented. In order to document that you began this course, students must complete the ***academic participation verification question*** posted on ***Webcourses*** no later than **September 2**. Failure to do so will result in a delay in the disbursement of financial aid.

**Class Attendance:**

Regular class attendance is necessary for students to fully grasp the course concepts. If you miss a class session, it will be your responsibility to find out the materials that were covered.

**Professionalism:**

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. You should be present in class before the lecture begins.

**Ethics:**

As in all university courses, The Golden Rule of Conduct will be applied. 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](http://www.goldenrule.sdes.ucf.edu)) for further details. Violations of these rules will result in a record of the infraction being placed in your file and additional sanctions may be applied.

**Students with Special Testing/Learning Needs:**

Students with documented special needs and requiring special accommodations must be registered with UCF Student Disability Services ([www.sds.sdes.ucf.edu](http://www.sds.sdes.ucf.edu)) or at (407) 823-2371 prior to receiving those accommodations. Students must inform the instructor of their special needs as early as possible in the first week of classes.

## Course Outline:

- **The Foundations of Geometrical Optics**
  - Waves, wave fronts, and rays
  - Propagation of wave fronts, reflection, refraction
  - Fermat's principle
  - Irradiance and the inverse-square law
  - The basic postulates of geometrical optics
- **Elementary Ray Optics**
  - Plane surfaces
  - Curved surfaces: focusing
- **Imagery by a Single Surface and a Thin Lens**
  - The sign convention
  - The paraxial approximation
  - Imagery by a single surface
  - Imagery by a thin lens
  - Imagery of an extended object
  - Magnification: longitudinal magnification, the angular size of an object, visual magnification
  - Imagery of a volume
- **Gaussian Optics**
  - The paraxial height and angle variables
  - Paraxial ray tracing for systems of many surfaces
  - Principal planes and back and front focal planes
  - Thick lenses: power and location of principal planes
  - Nodal points, measurement of focal length
- **Stops and Pupils**
  - Marginal and pupil rays
  - System stop and entrance and exit pupils
  - Optical invariant
  - Numerical aperture and number
  - Depth of focus and depth of field
  - Field stop and entrance and exit windows
  - Field of view
- **ABCD Matrix Transformation**
  - Matrix formulation for refraction and for translation
  - The conjugate matrix
  - Object and image planes
- **Radiometry and Photometry**
  - Light flux transmission through optical systems
  - Solid angle and projected area
  - Radiant flux, irradiance, radiance, Lambertian sources
  - Radiometry of imaging systems
  - Extended sources, distant sources

- **Real ray tracing**  
Ray transfer between spherical surfaces  
Refraction of a general ray  
Meridional and skew rays
- **Aberrations**  
Chromatic aberration  
Monochromatic aberrations  
The wave aberration function and classification of aberration  
The Seidel aberration coefficients  
Focus shift and primary aberrations  
The Seidel Sums  
Primary aberrations of a reflecting prism (plane parallel plates)  
Primary aberrations of a spherical mirror  
Thin lens central aberrations (stop at the lens)  
Thin lens aberration with a remote stop
- **Gaussian Optics of Optical Instruments and Components**  
The telescope, the microscope, projection systems, the eye, reflecting prisms, cylindrical and anamorphic optics, gradient index optics