OSE-5203 Geometrical Optics and Imaging Science

Time: Monday and Wednesday 1:30 PM – 2:45 PM  
August 22, 2016 – December 12, 2016

Location: CREOL-A214

Credit Hours: 3 hours

Prerequisite: Graduate standing or consent of instructor


Course Description:

Learning Outcomes:
- Upon completion of this course, students should understand the basic principles of modern geometrical optics.
- The students should also be able to solve analysis and design problems for basic optical systems:
- The students should be able to perform an exact ray tracing and evaluate the system 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.

Reference Materials:
- Class notes
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 3, 2016 1:30 PM - 2:45 PM
- **Midterm Exam II**: 25%
  - Monday, November 7, 2016 1:30 PM - 2:45 PM
- **Final Exam**: 40%
  - Monday, December 12, 2016 1:00 PM - 3:50 PM

Exams are comprehensive and are closed book and notes. All exams are held in CREOL A-214.

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:
Plus and minus grades will be used.

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

Calendar:

<table>
<thead>
<tr>
<th>August (3)</th>
<th>September (8)</th>
<th>October (8)</th>
<th>November (8)</th>
<th>December (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 (MT) 5 2</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3 (MT) 5 2</td>
<td>12 14 17 19 14 16</td>
<td>21 23 (C)</td>
<td>28 30</td>
<td></td>
</tr>
<tr>
<td>22 24 19 21 24 25 21 23</td>
<td>22 24 19 21 24 25 21 23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29 31 26 28 31</td>
<td>22 24 19 21 24 25 21 23</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **National Holiday-University Closed**: September 5, 2016
- **Withdrawal deadline**: October 31, 2016
- **Class Cancelled**: November 23, 2016
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 questions, out of office hours. E-mail me and I will get back to you within a reasonable time.

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, student must complete the academic participation verification question posted on Webcourses no later than week after the first class. 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) for further details. Violation 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) 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, angular, and visual magnifications
  - 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
  - Newtonian imaging equation

- **ABCD Matrix Transformation**
  - Matrix formulation for refraction and for translation
  - The conjugate matrix
  - Object and image planes

- **Real ray tracing**
  - Ray transfer between spherical surfaces
  - Refraction of a general ray
  - Meridional and skew rays

- **Stops and Pupils**
  - System stop and entrance and exit pupils
  - Marginal and edge rays
  - Vignetting
  - Optical invariant
  - Field stop and entrance and exit windows
  - Field of view
  - Numerical aperture and number
  - Depth of focus and depth of field

- **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

- **Aberrations**
  - Optical material dispersion
  - Chromatic aberrations
  - Chromatic aberrations correction - Achromats
  - Monochromatic aberrations
  - The wave aberration function and classification of aberration
  - The Seidel aberration coefficients
  - Longitudinal and transverse Focus shifts
  - Primary aberrations: spherical, coma, astigmatism, distortion, field curvature
  - 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**
  - Objectives, telescopes, microscopes, projection systems, the eye