ROCHESTER INSTITUTE OF TECHNOLOGY
COURSE OUTLINE FORM

COLLEGE OF SCIENCE

Chester F. Carlson Center for Imaging Science

NEW COURSE: COS-IMGS-321 Geometric Optics

1.0 Course Designations and Approvals

Required course approvals:	**Approval request date:**	**Approval granted date:**
Academic Unit Curriculum Committee	7/23/10	8/17/10
College Curriculum Committee	10/19/10	11/4/2010

Optional designations:	**Is designation desired?**		***Approval request date:**	****Approval granted date:**
General Education:	Yes			
Writing Intensive:		No		
Honors		No		

2.0 Course information:

Course title:	Geometric Optics
Credit hours:	3
Prerequisite(s):	COS-PHYS-212
Co-requisite(s):	none
Course proposed by:	Roger Dube
Effective date:	Fall 2013

	Contact hours	**Maximum students/section**
Classroom	2	30
Lab	3	12
Studio	n/a	n/a
Other (specify)	n/a	n/a

2.1 Course Conversion Designation (Please check which applies to this course)

	Semester Equivalent (SE) Please indicate which quarter course it is equivalent to:
X	Semester Replacement (SR) Please indicate the quarter course(s) this course is replacing: 1051-303 Geometric Optics
	New

2.2 Semester(s) offered (check)

Fall X	Spring	Summer	Other

All courses must be offered at least once every 2 years. If course will be offered on a bi-annual basis, please indicate here:

2.3 Student Requirements

Students required to take this course: (by program and year, as appropriate) Third-year Imaging Science
Students who might elect to take the course: Applied Mathematics, Physics, Imaging and Photographic Technology, Digital Cinema

3.0 Goals of the course (including rationale for the course, when appropriate):

3.1 Determine locations and sizes of images produced by optical systems with multiple elements 3.2 Understand the concepts of various types of aberrations 3.3 Design, characterize, and optimize simple imaging systems

4.0 Course description (as it will appear in the RIT Catalog, including pre- and co-requisites, and quarters offered). Please use the following format:

COS-IMGS-321 **Geometric Optics** This course introduces the analysis and design of optical imaging systems based on the ray model of light. Topics include reflection, refraction, imaging with lenses, stops and pupils, prisms, magnification and optical system design using computer software. (COS-PHYS-211) **Class 2, Lab 3, Credit 3 (F)**

5.0 Possible resources (texts, references, computer packages, etc.)

5.1 E. Hecht, *Optics* , Addison-Wesley, Reading MA 5.2 D. Loshin, *The Geometrical Optics Workbook*, Butterworth-Heinemann, Oxford UK 5.3 M. Keating, *Geometrical, Physical and Visual Optics*, Butterworth-Heinemann, Oxford UK 5.4 OSLO lens design software, Lambda Research Corp., Littleton, MA

6.0 Topics (outline):

6.1. Wave and ray representation of light
  6.1.1 Review of wave properties
  6.1.2 Huygens' principle
  6.1.3 Rays and sign conventions
  6.1.4 Vergence
  6.1.5 Pinhole cameras and shadows
6.2. Laws of Reflection and refraction
  6.2.1 Refractive index, dispersion
6.3. Fresnel diffraction
  6.3.1 Fermat's Principle for light propagation
  6.3.2 Snell's law and derivation
  6.3.3 Refraction through multiple surfaces
6.4. Prisms
  6.4.1 Apical, incident, internal, and emergent angles
  6.4.2 Relationships among internal, external, apical, and deviation angles
  6.4.3 Limiting conditions on prisms
  6.4.4 Dispersive power of prisms
6.5. Lenses
  6.5.1 Radius of curvature, sag, and sagittal approximation
  6.5.2 Radius and surface power
  6.5.3 Reduced vergence
6.6. Paraxial approximation and Gaussian imaging
  6.6.1 Focal points, lateral magnification, extrafocal distance
  6.6.2 Ray tracing for positive and negative refracting surfaces
  6.6.3 Thin lenses
  6.6.4 Lens maker's equation and lens power
  6.6.5 Vergence equation for thin lenses
  6.6.6 Real and virtual images; location and magnification; symmetrical planes
  6.6.7 Chromatic aberrations
  6.6.8 Two-lens imaging systems
    6.6.8.1 Telescopes and microscopes
    6.6.8.2 Multi-element ray tracing
  6.6.9 Equivalent power
  6.6.10 Thick lenses
    6.6.10.1 Surface and net powers, focal lengths
    6.6.10.2 Principal planes; nodal points
    6.6.10.3 Thin lens combinations
    6.6.10.4 Thick lenses as thin lens combinations
    6.6.10.5 Ray tracing – element by element method
6.7. Mirrors
  6.7.1 Plane mirrors; ray deviation, image formation
  6.7.2 Curved mirrors, power, focal points
  6.7.3 Vergence equation for curved mirrors
  6.7.4 Image-object relationships
  6.7.5 Spherical aberration

6.7.6 Stops and Pupils
6.7.6.1 Aperture stops and field stops, entrance pupils and exit pupils
6.7.6.2 Depth of field
6.7.6.3 Effect of aperture stop on radiometry
6.7.6.4 Diffraction limit
6.8. Introduction to modulation transfer function (MTF)
6.8.1 Aberrations and MTF
6.8.2 Diffraction and MTF
6.9. Optical ray tracing software

7.0 Intended course learning outcomes and associated assessment methods of those outcomes

Course Learning Outcome	Assessment 1	Assessment 2
7.1 Determine locations and sizes of images produced by optical systems with multiple elements	Homework assignments and examination	Laboratories
7.2 Explain the concepts of aberrations	Homework assignments	Exams, Labs
7.3 Design, characterize, and optimize simple imaging systems	Homework assignments	Laboratories

8.0 Program outcomes and/or goals supported by this course

8.1 Apply knowledge of imaging systems, physics, mathematics, and digital processing to formulate, analyze, and solve practical problems in imaging science.
8.2 The student will have the basic understanding of the means and limitations of optical systems when used to create images.
8.3 The student will be prepared for the upper-level required and elective courses in imaging science that require understanding of optical systems.

9.0

	General Education Learning Outcome Supported by the Course	Assessment Method
Communication		
	Express themselves effectively in common college-level written forms using standard American English	
	Revise and improve written and visual content	
	Express themselves effectively in presentations, either in spoken standard American English or sign language (American Sign Language or English-based Signing)	
	Comprehend information accessed through reading and discussion	
Intellectual Inquiry		
	Review, assess, and draw conclusions about hypotheses and theories	
	Analyze arguments, in relation to their premises, assumptions, contexts, and conclusions	
	Construct logical and reasonable arguments that include anticipation of counterarguments	
	Use relevant evidence gathered through accepted scholarly methods and properly acknowledge sources of information	
Ethical, Social and Global Awareness		
	Analyze similarities and differences in human experiences and consequent perspectives	
	Examine connections among the world's populations	
	Identify contemporary ethical questions and relevant stakeholder positions	
Scientific, Mathematical and Technological Literacy		
X	Explain basic principles and concepts of one of the natural sciences	Homework, laboratory reports
	Apply methods of scientific inquiry and problem solving to contemporary issues	
	Comprehend and evaluate mathematical and statistical information	
X	Perform college-level mathematical operations on quantitative data	Laboratory reports
	Describe the potential and the limitations of technology	
	Use appropriate technology to achieve desired outcomes	
Creativity, Innovation and Artistic Literacy		
	Demonstrate creative/innovative approaches to course-based assignments or projects	
	Interpret and evaluate artistic expression considering the cultural context in which it was created	

10.0 Other relevant information (such as special classroom, studio, or lab needs, special scheduling, media requirements, etc.)

Smart classroom