ROCHESTER INSTITUTE OF TECHNOLOGY
COURSE OUTLINE FORM

COLLEGE OF SCIENCE

Chester F. Carlson Center for Imaging Science

NEW COURSE: COS-IMGS-766 – Geometrical Optics and Lens Design

1.0 Course Approvals

Required course approvals:	**Approval request date:**	**Approval granted date:**
Academic Unit Curriculum Committee	9/15/2010	9/30/2010
College Curriculum Committee	9/28/2011	10/4/11

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

2.0 Course information:

Course title:	Geometrical Optics and Lens Design
Credit hours:	3
Prerequisite(s):	IMGS-633 Optics for Imaging or permission of instructor
Co-requisite(s):	None
Course proposed by:	Robert MacIntyre
Effective date:	Fall 2013

	Contact hours	**Maximum students/section**
Classroom	2	20
Lab	2	20
Studio		
Other (specify)		

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

X	Semester Equivalent (SE) Please indicate which quarter course it is equivalent to: 1051-736 Geometric Optics and First Order Design
	Semester Replacement (SR) Please indicate the quarter course(s) this course is replacing:
	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: N/A

2.3 Student Requirements

Students required to take this course: Imaging Science students in the Optics track
Students who might elect to take the course: Graduate students in science or engineering.

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

3.1 To learn effective, practical, and technical information on optical systems and their design.
3.2 To analyze and design optical components in a photonic system.

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:

IMGS-766 Geometrical Optics and Lens Design

This course leads to a thorough understanding of the geometrical properties of optical imaging systems and detailed procedures for designing any major lens system. Automatic lens design, merit functions, and optimization are applied to real design problems. The course will utilize a modern optical design program and examples carried out on a number of types of lenses to illustrate how the process of design is carried out. (IMGS-633 Optics for Imaging or permission of instructor) **Class 2, Lab 2, Credit 3 (F)**

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

5.1 Smith W., *Modern Lens Design*, SPIE Press Book, Bellingham, WA
5.2 OSLO optical system design software (and User's Guide) or equivalent.

6.0 Topics (outline):

6.1 Image Evaluation
- 6.1.1 Introduction
- 6.1.2 Optical Path Difference: Focus Shift
- 6.1.3 Optical Path Difference: Spherical Aberration
- 6.1.4 Aberration Tolerances
- 6.1.5 Image Energy Distribution (Geometric)
- 6.1.6 Spread Functions—Point and Line
- 6.1.7 Geometric Spot Sizes Due to Spherical Aberration
- 6.1.8 The Modulation Transfer Function
- 6.1.9 Computation of the Modulation Transfer Function
- 6.1.10 Special Modulation Transfer Functions: Diffraction-Limited Systems
- 6.1.11 Radial Energy Distribution
- 6.1.12 Point Spread Functions for the Primary Aberrations

6.2 Stops, Pupils, Apertures

6.2.1 Introduction
6.2.2 The Aperture Stop and Pupils
6.2.3 The Field Stop
6.2.4 Vignetting
6.2.5 Glare Stops, Cold Stops, and Baffles
6.2.6 The Telecentric Stop
6.2.7 Apertures and Image Illumination—*f* -Number and Cosine-Fourth
6.2.8 Depth of Focus
6.2.9 Diffraction Effects of Apertures
6.3 Lens Design Data
6.3.1 Lens Prescriptions, Drawings, and Aberration Plots
6.3.2 Estimating the Potential of a Redesign
6.3.3 Scaling a Design, its Aberrations, and its Modulation Transfer Function
6.3.4 Interpretation of Ray Intercept Plot and Various Plots
6.4 Optical Merit Functions
6.4.1 Optimization
6.4.2 Local Minima
6.4.3 Types of Merit Functions
6.4.4 Stagnation
6.4.5 Generalized Simulated Annealing
6.4.6 Spectral Weighting
6.5 Infrared & Ultraviolet Systems
6.5.1 Infrared Optics
6.5.2 IR Objective Lenses
6.5.3 IR Telescopes
6.5.4 Laser Beam Expanders
6.5.5 Ultraviolet Systems
6.5.6 Microlithographic Lenses
6.6 Zoom Lenses
6.6.1 Zoom Lenses General
6.6.2 Zoom Lenses for Point and Shoot Cameras
6.6.3 A 20x Video Zoom Lens
6.6.4 Zoom Lens Design Procedures
6.7 Tolerance Budgeting
6.7.1 The Tolerance Budget
6.7.2 Additive Tolerances
6.8 Examples of Lens Types to be Studied
6.8.1 Telescope objectives
6.8.2 Cooke triplet anastigmats
6.8.3 Double-meniscus anastigmats, the Biotar or Double-gauss
6.8.4 Telephoto lenses, Reversed telephoto (retrofocus and fish-eye) lenses
6.8.5 Microscope Objectives
6.8.6 Mirror and Catadioptric systems
6.8.7 Zoom Lenses

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

Course Learning Outcome	Laboratory Assignments	Examinations
7.1 Implement widely utilized principles of geometrical optics	X	X
7.2 Demonstrate application of widely utilized principles of optical design	X	X
7.3 Design a number of lenses and/or optical systems (i.e. Triplets, Double Gauss, Telephoto, Microscope, Zoom, Catadioptic)	X	

8.0 Program outcomes and/or goals supported by this course

8.1 To demonstrate important concepts of optics. 8.2 To apply concepts to design optical systems, given a coherent set of requirements. 8.3 To apply knowledge of the science and technology of imaging.

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		
	Explain basic principles and concepts of one of the natural sciences	
	Apply methods of scientific inquiry and problem solving to contemporary issues	
	Comprehend and evaluate mathematical and statistical information	
	Perform college-level mathematical operations on quantitative data	
	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