ROCHESTER INSTITUTE OF TECHNOLOGY
COURSE OUTLINE FORM

COLLEGE OF SCIENCE

Chester F. Carlson Center for Imaging Science

NEW COURSE: COS-IMGS-322 – Physical Optics

1.0 Course Approvals

Required course approvals:	**Approval Requested Date:**	**Approval Granted Date:**
Academic Unit Curriculum Committee	11/1/2010	11/20/2010
College Curriculum Committee	12/1/2010	

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:	Physical Optics
Credit hours:	3
Prerequisite(s):	COS-PHYS-212; COS-IMGS-261 or both COS-PHYS-283 and COS-PHYS-320
Co-requisite(s):	None
Course proposed by:	Grover Swartzlander
Effective date:	Fall 2013

	Contact hours	**Maximum students/section**
Classroom	2	24
Lab	3	8
Studio		
Other		

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: Physical Optics 1051-455 (cross-listed with 1017-455)
	Semester Replacement (SR) Please indicate the quarter course(s) this course is replacing:
	New

2.2 Semester(s) offered (check)

Fall	Spring X	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 majors
Students who might elect to take the course: Physics majors (this is one of a set of elective courses for these majors) Students required to complete additional science electives, students pursuing a minor in Imaging Science or Physics, or other students with the appropriate background

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

3.1	To develop a foundational understanding of the physics of propagating light waves
3.2	To apply the principles of Fourier transforms and apply them to diffractive wave phenomena
3.3	To exercise important skill of the scientific profession, e.g., graphical representations, analytical derivations, numerical computations, and scientific writing
3.4	To develop practical laboratory knowledge and skills

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-322 **Physical Optics** Light waves having both amplitude and phase will be described to provide a foundation for understanding key optical phenomena such as interference, diffraction, and propagation. Starting from Maxwell's equations the course advances to the topic of Fourier optics. (COS-PHYS-212; COS-IMGS-261 or both COS-PHYS-283 and COS-PHYS-320) **Class 2, Lab 3, Credit 3 (S)**

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

5.1	Fowles, G., *Introduction to Modern Optics*, Dover Publications, New York, NY
5.2	Hecht, E., *Optics*, Pearson Addison-Wesley, San Francisco, CA
5.3	Easton, R., *Fourier Methods in Imaging*, John Wiley & Sons, Chichester, UK.
5.4	Korn, G.A. and Korn, T.A., *Mathematical Handbook for Scientists and Engineers*, Dover, New York, NY
5.5	Image processing software

6.0 Topics (outline):

- 6.1 Wave theory
  - 6.1.1 Derivation of the wave equation from Maxwell's equations
  - 6.1.2 Attributes of a one-dimensional wave
  - 6.1.3 Three-dimensional plane waves
  - 6.1.4 Proof of the transverse nature of light waves
  - 6.1.5 Energy and momentum density of light
- 6.2 Superposition principle
  - 6.2.1 Michelson interferometer
  - 6.2.2 Superposition of two plane waves
  - 6.2.3 Group velocity of a wave packet
- 6.3 Review of Fourier transforms
  - 6.3.1 Periodic functions: Fourier series
  - 6.3.2 Functions of finite extent: Fourier integral
- 6.4 Diffraction
  - 6.4.1 Huygens' theory of spherical wavelets
  - 6.4.2 Fraunhofer (far-field) diffraction
    - 6.4.2.1 Single-slit diffraction
    - 6.4.2.2 Double-slit diffraction
    - 6.4.2.3 Infinite square grating
      - 6.4.2.3.1 Spatial diffraction pattern
      - 6.4.2.3.2 Spectral characteristics
    - 6.4.2.4 Two-dimensional apertures
      - 6.4.2.4.1 Rectilinear two-dimensional Fourier transforms
      - 6.4.2.4.2 Circular two-dimensional Fourier transforms
      - 6.4.2.4.3 Bessel functions, resolving power
      - 6.4.2.4.4 Point spread function
- 6.5 Fourier optics
  - 6.5.1 Fast Fourier transform
  - 6.5.2 Lowpass and highpass filters
  - 6.5.3 Fourier convolution theorem
  - 6.5.4 Autocorrelation and crosscorrelation
  - 6.5.5 Modulation transfer function
- 6.6 Dispersion
  - 6.6.1 Atomic polarizability
  - 6.6.2 Cauchy and Sellmeier dispersion formulas
  - 6.6.3 Prelude to dispersion of diffraction grating
  - 6.6.4 Dispersion compensation with grating pair
- 6.7 Polarization
  - 6.7.1 Linear polarization
  - 6.7.2 Circular polarization
  - 6.7.3 Waveplates
  - 6.7.4 Jones calculus
- 6.8 Reflection and refraction at a dielectric interface
  - 6.8.1 Derivation of the law of reflection and Snell's law
  - 6.8.2 Derivation of transmission and reflection coefficients

7.0 Intended course learning outcomes and associated assessment methods of those outcomes (please include as many Course Learning Outcomes as appropriate, one outcome and assessment method per row).

Course Learning Outcome	Homework	Computer Projects	Examinations	Laboratories
7.1 Demonstrate skills in reaching conclusions using mathematical methods	X	X	X	X
7.2 Use appropriate verbal, graphical and mathematical descriptions of physical phenomena	X		X	X
7.3 Explain and apply the principles of Fourier optics	X		X	X
7.4 Develop and practice optical alignment and measurement skills				X
7.5 Exercise use of computer programming skills and represent outcomes in graphical and written forms	X	X		
7.6 Assess and judge the valid use of approximation methods in problem solving	X		X	X

8.0 Program outcomes and/or goals supported by this course

8.1 To develop a foundational understanding of the physics of propagating, diffracting and interfering light waves.
8.2 To apply the principles of Fourier transforms to diffracted wave phenomena.
8.3 To gain hands-on experience setting up and conducting modern optics experiments.
8.4 To exercise essential skills of the scientific profession:
- 8.4.1 Graphical representations (including plots, figures, labels, captions)
- 8.4.2 Analytical computing (theoretical proofs and determination of numerical values
- 8.4.3 Computer programming
- 8.4.4 Scientific writing

8.5 Apply knowledge of imaging systems, physics, mathematics, and digital processing to formulate, analyze, and solve practical problems in imaging science.

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		
X	Review, assess, and draw conclusions about hypotheses and theories	Lab reports
	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	Lab reports Exams
X	Apply methods of scientific inquiry and problem solving to contemporary issues	Homework, Lab reports
X	Comprehend and evaluate mathematical and statistical information	Homework, Lab reports
X	Perform college-level mathematical operations on quantitative data	Lab reports, Homework
	Describe the potential and the limitations of technology	
X	Use appropriate technology to achieve desired outcomes	Lab reports
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.)

10.1 Smart classroom
10.2 Laboratory space