

**Rochester Institute of Technology
Rochester, New York**

COLLEGE of SCIENCE
Department of Physics
Chester F. Carlson Center for Imaging Science

Course : Optical Physics and Imaging, 1051-455

- 1.0 Title:** Optical Physics and Imaging **Date:** October 10, 2006
Credit Hours: 4
Prerequisite(s): 1017-312, 1017-313, and 1017-480 or 1051-320
Corequisite(s): none
Course proposed by: Roger Easton

2.0 Course information:

	Contact hours	Maximum students/section
Classroom	4	30
Lab		
Studio		
Other (specify _____)		

Quarter(s) offered (check)

_____ Fall _____ Winter X Spring _____ Summer

Students required to take this course: (by program and year, as appropriate)
Physics Majors, Imaging Science Majors.

Students who might elect to take this course:
Electrical Engineering majors.

- 3.0 Goals of the course** (including rationale for the course, when appropriate)
Apply the basic physical concepts associated with light, recognize the fundamental physical limitations on image formation, analyze basic optical phenomena, and characterize the resolution of imaging systems.
- 4.0 Course description** (as it will appear in the RIT Catalog, including pre- and co-requisites, quarters offered)

1051-455

Optical Physics and Imaging

Physical principles are used to develop a firm fundamental understanding of optics and imaging. Main topics include light as an electromagnetic wave, light at an interface, polarization, interference, and diffraction. Also includes a brief

introduction to modern optics. Emphasis is placed on the fundamental limitations of an optical system on resulting images. **Class 4, Credit 4 (W)**

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

- 5.1 Optics, E. Hecht, Addison-Wesley.
- 5.2 Introduction to Modern Optics G. Fowles, Dover.
- 5.3 Elementary Wave Optics, Robert H. Webb, Dover.

6.0 Topics

- 6.1. Mathematics of light as a wave (estimate 1.5 weeks)
 - 6.1.1. Wave equation and traveling wave solutions
 - 6.1.2. Harmonic waves
 - 6.1.3. Plane waves, spherical waves
 - 6.1.4. Principle of superposition
 - 6.1.5. Addition of waves as phasors
 - 6.1.6. Coherent vs. incoherent light sources
 - 6.1.7. Phase velocity and group velocity
 - 6.1.8. Dispersive media, dispersion curves

- 6.2. Electromagnetic waves (2 weeks)
 - 6.2.1. Maxwell's equations in vacuum
 - 6.2.2. Electromagnetic wave equation
 - 6.2.3. Poynting vector, energy transport by EM wave
 - 6.2.4. Superposition and phasors
 - 6.2.5. Propagation of light in transparent medium; index of refraction

- 6.3. Light at an interface (1.5 weeks)
 - 6.3.1. Huygens principle
 - 6.3.2. Reflection and refraction, boundary conditions
 - 6.3.3. Fresnel equations for TE and TM Polarizations
 - 6.3.4. Reflectance and transmittance curves, phase change on reflection
 - 6.3.5. Total internal reflection
 - 6.3.6. Brewster angle
 - 6.3.7. Polarization Angle; Brewster Windows
 - 6.3.8. Reflection from Metals

- 6.4. Polarization of light (1 week)
 - 6.4.1. Types of polarization
 - 6.4.2. Linear polarizers and Malus' Law
 - 6.4.3. Retarding elements, wave plates
 - 6.4.4. Polarization by scattering
 - 6.4.5. Jones vectors and matrices

- 6.5. Interference (1.5 weeks)
 - 6.5.1. Division of wavefront: two-slit and multiple-slit interference
 - 6.5.2. Gratings, resolving power

- 6.5.3. Division of amplitude, Michelson interferometer
- 6.5.4. Thin-film interference

6.6. Diffraction (1.5 weeks)

- 6.6.1. Single-slit diffraction
- 6.6.2. Fresnel diffraction, impulse response of light propagation
 - 6.6.2.1. Straight edge
 - 6.6.2.2. Rectangular aperture
 - 6.6.2.3. Circular aperture, Airy disk
 - 6.6.2.4. Fresnel zone plates
- 6.6.3. Fraunhofer diffraction and Fourier transforms

6.7. Optical Imaging (1 week)

- 6.7.1. Point spread functions, image formation
- 6.7.2. Resolution, Rayleigh criterion.
- 6.7.3. Modulation transfer functions
- 6.7.4. Fourier-transform holography

7.0 Intended learning outcomes and associated assessment methods of those outcomes

Learning Outcome	In class attendance and evaluation	Homework Assignments
7.1 Calculate behavior of electromagnetic waves	X	X
7.2 Calculate action of light at an interface	X	X
7.3 Calculate polarization state of light	X	X
7.4 Calculate interference phenomena	X	X
7.5 Calculate diffraction patterns from apertures	X	X
7.6 Calculate metrics associated with various imaging systems	X	X

8.0 Program or general education goals supported by this course

- 8.1 Satisfies one requirement for the B.S. degree in Imaging Science
- 8.2 Satisfies one requirement for the B.S. degree in Physics

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

- 9.1 Smart classroom
- 9.2 Access to optics laboratory for demonstrations

10.0 **Supplemental information**
none