

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

COLLEGE of Science  
Department of \_\_Imaging Science

REVISED COURSE: 1051-313

**1.0 Title:** Interactions between light & matter      **Date:** Jan. 15, 2004

**Credit Hours:**        4  

**Prerequisite(s):** Calculus III, Physics II, Intro to Imaging Systems

**Corequisite(s):**

**Course proposed by:**      \_\_\_\_\_  
Jon Arney, Rich Hailstone

**2.0 Course information:**

	<b>Contact hours</b>	<b>Maximum students/section</b>
Classroom	4	35
Lab	0	
Studio	0	
Other (specify _____)	0	

**Quarter(s) offered (check)**

\_\_\_\_\_ **Fall**      X   **Winter**    \_\_\_\_\_ **Spring**    \_\_\_\_\_ **Summer**

**Students required to take this course:** (by program and year, as appropriate)  
SIMG majors

**Students who might elect to take the course:**

Students pursuing a Minor in Imaging Science

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

To provide the student with practical knowledge of the physical mechanisms governing the properties of radiometric detectors and the imagewise detection of electromagnetic energy. This knowledge is prerequisite to other courses required for the BS in Imaging Science.

**4.0 Course description** (as it will appear in the RIT Catalog, including pre- and co-requisites, quarters offered)

**1051-313**

**Interactions Between Light & Matter**

Fundamental aspects of the interaction of electromagnetic radiation and materials. The course is designed to provide students with an understanding of the physical mechanisms underlying instruments used to detect, measure, and image electromagnetic energy (CCDs, silver halide film, OPC, vidicon, etc.). Basic concepts

of quantum theory, atomic structure and the particle/wave duality of light and matter are introduced. Electronic transitions in materials and the physical and chemical results of light absorption are explored, with practical examples in image detection. Applications in detector spectral sensitivity, spectroscopy, human vision, and colorimetry will be touched on. (1016-253, 1017-312, 1051-204) **Class 4, Credit 4 (W)**

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

5.1 Lecture notes provided by the instructor

5.2 Readings assignments from:

5.2.1 *Fundamentals of Optics*, Jenkins & White

5.2.2 *Principles of Color Technology*, R. Berns

5.2.3 *Polymer Photophysics and Photochemistry*, J. Guillet

## **6.0 Topics (outline):**

### 6.1. Experimental basis of quantum theory

6.1.1 discovery of the X-ray and electron

6.1.2 determination of electron charge

6.1.3 line spectra

6.1.4 quantization

6.1.5 blackbody radiation

6.1.6 photoelectric effect

### 6.2. Early attempts at understanding atomic structure

6.2.1 models of Rutherford and Thomson

6.2.2 classical atomic model

6.2.3 Bohr model of H atom

6.2.4 successes and failures of the Bohr model

### 6.3. Wave properties of matter

6.3.1 electron scattering

6.3.2 de Broglie waves

6.3.3 wave motion

6.3.4 waves-particle duality

6.3.5 relationship between probability and wave function

6.3.6 uncertainty principle

### 6.4. Quantum theory

6.4.1 the Schrodinger wave equation

6.4.2 expectation values

6.4.3 infinite square-well potential

6.4.4 finite square-well potential

6.4.5 QM math

## 6.5. H atom and many electron atoms

- 6.5.1 application of the Schrodinger equation to the H atom
- 6.5.2 quantum numbers
- 6.5.3 intrinsic spin
- 6.5.4 energy levels
- 6.5.5 application of the Schrodinger eqn to He
- 6.5.6 many electron atoms
- 6.5.7 lasers

## 6.6. Molecular structure

- 6.6.1 atoms vs molecules
- 6.6.2 forming molecular orbitals
- 6.6.3 semi-quantitative view
- 6.6.4 excited states in carbon-based compounds
- 6.6.5 singlet vs triplet states
- 6.6.6 selection rules
- 6.6.7 molecular vibrations
- 6.6.8 molecular rotations
- 6.6.9 lasers

## 6.7. Interaction between light and matter

- 6.7.1 nature of light
- 6.7.2 interaction of light with matter
- 6.7.3 photophysics
- 6.7.4 transitions between states

## 6.8. Crystalline solids

- 6.8.1 crystal structure
- 6.8.2 energy levels
- 6.8.3 band theory
- 6.8.4 light absorption
- 6.8.5 Fermi-Dirac statistics
- 6.8.6 Semiconductors
- 6.8.7 semiconductor doping

## 6.9. Elastic interactions between light & matter: first surface reflection

- 6.9.1 Fresnel's laws of reflection and polarization
- 6.9.2 practical gloss meters
- 6.9.3 angular scattering and gloss variations

## 6.10. Elastic interactions between light & matter: bulk scattering

- 6.10.1 Rayleigh scattering
- 6.10.2 Mie scattering

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

The successful student will be able to:

- 7.1 describe and calculate quantitatively the macroscopic absorption, transmission, and reflection of light as a function of wavelength and geometry. (HOMEWORK ASSIGNMENTS, EXAMS, QUIZES)
- 7.2 describe the physical and chemical laws governing the practical behavior of light detectors and image capture devices. (HOMEWORK ASSIGNMENTS, EXAMS, QUIZES)
- 7.3 be prepared to learn and understand electromagnetic detectors not described in the course, based on background knowledge obtained from this course. (HOMEWORK ASSIGNMENTS, EXAMS, QUIZES)

**8.0 Program or general education goals supported by this course**

This course provides students with a practical understanding of the physical mechanisms that govern the characteristics of image capture devices.

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

**10.0 Supplemental information**