

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

COLLEGE of SCIENCE  
Chester F. Carlson Center for Imaging Science

Course : Optical Image Formation, 1051-738

- 1.0 Title:** Optical Image Formation **Date:** October 10,2006  
**Credit Hours:** 4  
**Prerequisite(s):** 1051-716, 1051-718  
**Corequisite(s):** none  
**Course proposed by:** Roger Easton

**2.0 Course information:**

	<b>Contact hours</b>	<b>Maximum students/section</b>
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)  
none

**Students who might elect to take this course:**  
Graduate students in Imaging Science, Color Science, and Electrical Engineering.

- 3.0 Goals of the course** (including rationale for the course, when appropriate)  
To describe the models of light propagation and their impact on imaging, the impact of the parameters of optical systems on image “quality,” and to consider how optical systems may be used to process image information.
- 4.0 Course description** (as it will appear in the RIT Catalog, including pre- and co-requisites, quarters offered)

**1051-738**

**Optical Image Formation**

This course presents a unified view of the formation of images and image quality of an optical system from an applications viewpoint, but with a strict mathematical development. Topics covered are: ray and wave theory of imaging, image quality

measurements, image formation with coherent and incoherent light, and optical information processing. (1051-716, 1051-718) **Class 4, Credit 4 (S)**

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

- 5.1 Introduction to Fourier Optics, by J.W. Goodman, Roberts & Company  
(text)
- 5.2 Course notes

## **6.0 Topics**

- 6.1 Review of the Wave Equation and Plane Wave Spectra
  - 6.1.1 Maxwell's equations
  - 6.1.2 Electromagnetic power
  - 6.1.3 Greens functions, Huyghens' principle, diffraction integrals
  - 6.1.4 Asymptotic evaluation of the diffraction integral in the Fresnel and Fraunhofer regions
  - 6.1.5 Quadratic phase factors
  - 6.1.6 Stationary phase method
  - 6.1.7 Fresnel integrals
  - 6.1.8 Effect of apertures and lenses on plane wave spectra: Abbé's theory
  - 6.1.9 Uncertainty in fields and transforms
  - 6.1.10 Coherence of light
- 6.2 Imaging Properties of Lenses from the Viewpoint of the Plane Wave Spectrum
  - 6.2.1 Plane wave spectrum analysis
  - 6.2.2 Transfer function in coherent light
  - 6.2.3 Transfer function in incoherent light
  - 6.2.4 Modulation transfer function (MTF) of a perfect lens
  - 6.2.5 Sampling of fields and transforms, relation to information theory
- 6.3 Imaging Properties of Lenses from Viewpoint of Diffraction Integral
  - 6.3.1 Thin lens as "quadratic phase plate"
  - 6.3.2 Fourier transforming property of lenses, shift-variant systems
  - 6.3.3 Action of lens for plane waves and spherical waves
- 6.4 Metrics of Optical Image Quality
  - 6.4.1 Optical transfer function and point spread functions in coherent and incoherent light
  - 6.4.2 Modulation Transfer Function
- 6.5 Optical Information Processing
  - 6.5.1 4f correlator
  - 6.5.2 Optical Transfer Function Synthesis
  - 6.5.3 Incoherent processing by geometrical optics
  - 6.5.4 Holography and computer-generated holography
  - 6.5.5 Optical matched filtering

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

<b>Learning Outcome</b>	<b>In class attendance and evaluation</b>	<b>Homework Assignments</b>
7.1 Calculate diffraction patterns of lens apertures	X	X
7.2 Calculate the point spread function and transfer function of lens apertures	X	X
7.3 Characterize the theoretical performance of an imaging system	X	X

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

8.1 Prepares students for research in imaging systems

**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