Rochester Institute of Technology
Rochester, New York

COLLEGE of SCIENCE
Chester F. Carlson Center for Imaging Science

Fourier Imaging Mathematics, 1051-716

1.0 Title: Fourier Methods for Imaging **Date:** May 16, 2005
Credit Hours: 4 Revised title 7/07 sjc
Prerequisite(s): Graduate standing in a science or engineering program or permission of instructor.
Corequisite(s):
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)
____X______**Fall** ______**Winter** _____**Spring** ______**Summer**

Students required to take this course: (by program and year, as appropriate)
Graduate students in Imaging Science, PhD track.

Students who might elect to take this course:
Graduate students in Imaging Science, MS track. Graduate students in the College of Science or College of Engineering.

3.0 Goals of the course (including rationale for the course, when appropriate)
To introduce students to concepts of linear mathematics that are essential for graduate study in Imaging Science.

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

1051-716 Fourier Methods for Imaging

This course develops the mathematical methods required to describe continuous and discrete linear systems, with special emphasis on tasks required in the analysis or synthesis of imaging systems. The classification of systems as linear/nonlinear and shift variant/invariant, development and use of the convolution integral, Fourier methods as applied to the analysis of linear systems. The physical meaning and interpretation of transform methods are emphasized. Within the context of image analysis, imaging systems as linear filters and image enhancement and information extraction **Class 4, Credit 4 (F)**

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

5.1 Gaskill, J.D., *Linear Systems, Fourier Transforms, and Optics*
5.2 Bracewell, R.N., *The Fourier Transform and its Applications*
5.3 Easton, R.L., *Linear Mathematics with Applications to Imaging*

6.0 **Topics**

- 6.1 Signals, Operators, and Imaging Systems
  - 6.1.1 Imaging “chain”
  - 6.1.2 Three imaging “tasks”
  - 6.1.3 Examples of the imaging chain and tasks
- 6.2 Operators and Functions
- 6.3 Representations of systems, inputs, and outputs by functions
  - 6.3.1 Symmetry properties of functions
  - 6.3.2 Projections of functions onto “reference” functions, orthogonality
  - 6.3.3 Complex functions
  - 6.3.4 Special functions
    - 6.3.4.1 Definitions of deterministic special functions
    - 6.3.4.2 Dirac delta function
    - 6.3.4.3 Stochastic functions
- 6.4 Classes of Imaging Operators
  - 6.4.1 Linearity
  - 6.4.2 Shift-invariance
  - 6.4.3 Crosscorrelation
  - 6.4.4 Convolution
- 6.5 Fourier analysis and synthesis
  - 6.5.1 Projection of functions onto sinusoidal “reference” functions
  - 6.5.2 Projections onto combinations of “reference” functions
    - 6.5.2.1 Hartley transform
    - 6.5.2.2 Fourier transform
  - 6.5.3 Fourier synthesis, Inverse Fourier transform
- 6.6 Theorems of the Fourier transform
  - 6.6.1 Transform of transform

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

Learning Outcome	In class attendance and evaluation	Homework Assignments
7.1 Differentiate between linear and nonlinear systems	X	X
7.2 Differentiate between shift-variant and shift-invariant imaging systems	X	X
7.3 Apply the concepts of Fourier analysis and synthesis to imaging systems	X	X

8.0 Program or general education goals supported by this course

8.1 Satisfies one of the core course Requirements for the M.S. and Ph.D. degrees in Imaging Science.

8.2 Prepares graduate students in science and engineering for work in any area of imaging science.

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

9.1 Classroom with computer projection system and internet access.

10.0 **Supplemental information**

Laboratory exercise in convolution to be integrated into course.