Rochester Institute of Technology
Rochester, New York

COLLEGE of Science
Department of Imaging Science

NEW (or REVISED) COURSE: 1051-XXX

1.0 Title: **IMAGING SYSTEMS II: Resolution, MTF, and Spatial Artifacts**
Date: ___________
Credit Hours: __4__
Prerequisite(s): SIMG-xxx (Imaging Systems I: TTF)

Corequisite(s): ____
Course proposed by: ____

2.0 Course information:

	Contact hours	Maximum students/section
Classroom	3	30
Lab	3	12
Studio		
Other (specify ________)		

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: ______________________

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

To provide students with practical skills in the mathematical analysis and modeling of spatial characteristics of complex imaging systems. Students will be able to apply these skills to the practical analysis of image quality, information content, and resolution. Students will learn to measure MTF and CTF and to apply convolution and Fourier techniques to both linear and non-linear sequences of imaging processes for both discrete and continuous processes.

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

1051-5xx Imaging Systems II: Resolution, MTF, and Spatial Artifacts

This course applies the mathematical and computational skills acquired in previous courses to the analysis and modeling of spatial properties of both linear and non-linear imaging systems of both discrete and continuous processes. Experimental techniques for measuring resolution, MTF, CTF, PSF and LSF of individual and complex systems will be described. These functions will be modeled mathematically for both individual imaging processes and for sequences of linear and non-linear processes. Physical mechanisms (including finite detectors and sampling, optical turbidity, and electronic time constants) will be treated mathematically for their impact on MTF. (1051-5xx) **Class 3, Lab 1,Credit 4 (W)**

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

5.1 Lecture notes provided by the instructor

5.2 Reading assignments from:

5.2.1 *Linear Mathematics and its Application to Imaging*, by R. L. Easton (Cambridge University Press).

5.2.2 *Fundamentals of Electronic Imaging Systems*, 2nd Ed. by W.F. Schreiber, (Springer-Verlag, 1991).

6.0 Topics (outline):

6.1 Experimental measurement of resolution

6.1.1 USAF Resolution test target, and etc.
6.1.2 The impact of gamma on resolution

6.2 Signal Modulation in Continuous Systems

6.2.1 The PSF and LSF
6.2.2 Fourier analysis and the MTF
6.2.3 Linearity
6.2.4 Shift variant and shift-invariant systems

6.3 Imaging Systems as Spatial Filters

6.3.1 Convolution and the Fourier transform
6.3.2 Impulse responses functions
6.3.3 Low pass, high pass, and band pass filters
6.3.4 Phase filters

6.4 Signal Modulation in Discrete systems
- 6.4.1 Infinite-support DFT
- 6.4.2 Finite-support DFT, leakage
- 6.4.3 Efficient algorithms, FFT

6.5 Propagation of Modulation through Multiple Systems

- 6.5.1 Propagation through liner systems
- 6.5.2 Simple non-linearity and backing modulation through the TTF
- 6.5.3 Intrinsic non-linearity and stepwise modeling of modulation.
- 6.5.4 Simplifying approximations and the CTF.

6.6 Laboratory Exercises

- 6.7.1 Techniques for MTF measurement:
  - 6.7.1.1 Sinusoid technique
  - 6.7.1.2 Impulse (edge) techniques
  - 6.7.1.3 White noise techniques.
- 6.7.2 End-to End Analysis and Model of a System
  - 6.7.2.1 Lens MTF
  - 6.7.2.2 Video camera MTF
  - 6.7.2.3 MTF of printing process: A PSF in terms of ink mass
  - 6.7.2.4 Optical MTF of paper.
  - 6.7.2.5 Stepwise modeling of the system

7.0 Intended learning outcomes and associated assessment methods of those outcomes

The successful student will be able to:

7.1 Describe and mathematically model the factors governing resolution in a sequence of imaging processes. (homework, exams, labs)

7.2 Perform mathematical analysis of spatial properties of imaging processes using both Fourier and convolution techniques. (homework, exams)

7.3 Make experimental measurements of resolution, MTF, CTF, point and line spread functions; and be able to relate the transfer functions to the observed resolution of a system. (labs)

7.4 Model MTF based on underlying mechanistic properties such as optical diffraction, impulse response time constants, and finite detector sampling. (homework, exams, labs)

8.0 Program or general education goals supported by this course

This course provides students with quantitative skills in the experimental and mathematical analysis of the modulation transfer functions of systems of imaging processes.

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

Teaching laboratories on the 3rd floor of building 76 will be used.

10.0 Supplemental information