

**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 I: Tone Transfer Function Date: _____
Credit Hours: 4
Prerequisite(s): SIMG-320 (Linear Mathematics for Imaging),
 SIMG-211 (Computing for Imaging)
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)

 X **Fall** _____ **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 of tone transfer through complex imaging systems. Students will acquire skills in the mathematical modeling of imaging systems based both on phenomenological and mechanistic properties. This knowledge is prerequisite to other courses required for the BS in Imaging Science.

This course introduces the concepts of continuous and discrete linear systems to imaging systems. Emphasis is placed on understanding the underlying mathematical principles and their connection to imaging applications. The concepts of linearity, shift invariance,

convolution, Fourier transforms, the impulse response, and the transfer function are considered.

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

1051-5xx

Imaging Systems I: Tone Transfer Function

This course applies the mathematical and computational skills acquired in previous courses to the analysis and modeling of mean-value, tone propagation through both linear and non-linear imaging systems of both discrete and continuous processes. System modeling techniques will be described based on (a) empirical metrics of system components, (b) underlying physical mechanisms of imaging processes. Modeling of multi-channel systems will emphasize the analysis of inter-image characteristics and the impact of spectral sensitivity on information content in the output image. (1051-211, 1051-320) **Class 3, Lab 1, Credit 4 (F)**

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 "Introduction to Image Microstructure," Engeldrum

5.2.2 *An Introduction to Microdensitometry*, by Richard E. Swing, SPIE, 1998.

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

6.0 Topics (outline):

6.1 Experimental Metrics of the Tone Transfer Function (TTF)

6.1.1 Sensitivity, gamma, speed, and contrast

6.1.2 TTF metrics and visual perception of image quality (Engeldrum, etc.)

6.2 Tone Propagation Through Multiple Systems

6.2.1 The forward model by regression analysis

6.2.2 The forward model by mechanistic analysis

6.2.3 The inverse problem and system linearization

6.3 Parallel Processes

6.3.1 Tri-chromatic, multi-, and hyper-spectral examples

6.3.2 Spectral Sensitivity and output information content

6.3.3 Inter-system cross-talk for signal compression (eg. NTSC)

- 6.2.4 Inter-image analysis (eg. analytical densitometry)
- 6.2.5 Mechanistic causes of inter-image effects.

6.4 Practical Design Techniques: The Maxwell Color Copying System

- 6.4.1 Practical system design strategies (eg. Hunt's strategies)
- 6.4.2 Output spectrum vs input spectral sensitivity
- 6.4.3 Design of an efficient tri-chromatic system.

6.5 Halftoning: Controlling the TTF by Spatial Modulation

- 6.5.1 Video Monitors, and visual acuity
- 6.5.2 Tone Reproduction and Dot Gain effects
- 6.5.3 Color printing, moment theory, and Neugebauer
- 6.5.4 Spectral characteristics of continuous vs halftone images

6.6 Modes of Failure in System Transfer Functions

- 6.6.1 Reciprocity failure and hysteresis effects
- 6.6.2 Spatial problems
 - 6.6.2.1 Moiré, aliasing, and other spatial artifacts
 - 6.6.2.2 Noise characteristics

6.7 Laboratory Exercises (some laboratory experiments require two lab sessions)

- 6.7.1 Radiometric calibration of a video monitor and a video camera
- 6.7.2 Psychophysical measurement of image quality vs gamma
- 6.7.3 Analytical densitometry I: Calibrating the Densitometer
- 6.7.4 Analytical Densitometry II: Measuring an inter-image effect
- 6.7.5 Colorimetric estimates with a tri-chromatic camera.
- 6.7.6 Spectral estimates from hex-chromatic camera measurements.

7.0 Intended learning outcomes and associated assessment methods of those outcomes

The successful student will be able to:

- 7.1 Make quantitative measurements of mean level characteristics of imaging systems and extract key metrics such as gamma, tone range, color gamut, and sensitivity. (labs)
- 7.2 Apply regression techniques to model a sequence of imaging processes. (labs)
- 7.3 Calibrate an imaging system. (labs)
- 7.4 Measure and model spectral sensitivity and inter-image characteristics of multi-channel systems. (labs)

7.5 Design an efficient tri-chromatic imaging process based on known, limiting characteristics of the system.(homework, labs)

7.6 Describe mathematically the tone and color characteristics of halftone images and of video monitors. (homework, labs, exams)

7.2 Describe qualitatively common failure modes such as RLF, hysteresis, moiré and aliasing, and granularity. (homework, labs, exams)

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 tone transfer functions of complex 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