

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

COLLEGE of SCIENCE
Center for Imaging Science

NEW COURSE: 1051-204

- 1.0 Title:** Introduction to Imaging Systems **Date:** May 7, 2003
Credit Hours: 4
Prerequisite(s): 1016-252 and 1017-311, or equivalent
Corequisite(s):
Course proposed by: Jon Arney, Joel Kastner

2.0 Course information:

	Contact hours	Maximum students/section
Classroom	3	36
Lab	2	12
Studio		
Other (specify _____)		

Quarter(s) offered

 X Fall Winter Spring Summer

Students required to take this course: (by program and year, as appropriate)
Majors in Imaging Science

Students who might elect to take the course:

Students in other, related science majors (Physics, Chemistry, Math). In particular, students looking to fulfill a “science with lab” requirement and/or students seeking a Minor in Imaging Science.

- 3.0 Goals of the course** (including rationale for the course, when appropriate):
To provide familiarity with the components, use, and analysis of common imaging systems, and to provide an understanding of how physical, chemical, and mathematical concepts are applied to imaging systems and their components.
- 4.0 Course description** (as it will appear in the RIT Catalog, including pre- and co-requisites, quarters offered)

1051-204

Introduction to Imaging Systems

This course provides a framework for the study of imaging science in the remainder of the imaging science curriculum. Elements of imaging science taxonomy,

including the imaging chain, image analysis, and imaging systems characterization, are introduced or reviewed. Practical examples are drawn from familiar imaging systems such as digital and film still cameras, LCD displays, NTSC video, etc., are introduced and selected systems are studied in-depth. Current events in the development or use of imaging science will be incorporated at the discretion of the instructor to reinforce understanding of the structure of the field of imaging science. The student will master basic laboratory skills in the use of still and video cameras, including effects of and control of illumination, exposure, focus & depth of field, focal length, dark and flat field calibration.

(Prerequisite 1016-252 and 1017-311, or equivalent) **Class 3, Lab 1, Credit 4 (F)**

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

Class notes compiled from various resources (e.g., *Seeing the Light* by Falk, Brill & Stork; *Digital Image Processing* by Gonzalez & Woods; *Charge-Coupled Devices* by Janesick). Labs make use of image processing tools like IDL and CISlab.

6.0 Topics (outline):

6.1 The Still Digital Camera (Example of an Imaging System)

- 6.1.1 Light Sources and their properties
- 6.1.2 Light as a carrier of information (object/light interaction)
- 6.1.3 The camera lens (Image Collection)
- 6.1.4 Image detection, and exposure control: light to pixels
- 6.1.5 Image Processing in a computer: pixels to pixels.
- 6.1.6 Image Display: pixels to light.

6.2 Digitizing an image: Analog-to-Digital Conversion

- 6.2.1 Sampling
- 6.2.2 Quantizing
- 6.2.3 File size and information capacity

6.3 The Light/Object Interaction

- 6.3.1 Beer-Lambert Law of transmittance
- 6.3.2 Reflectance Geometry: Diffuse and Specular
- 6.3.3 Reflectance and Beer-Lambert
- 6.3.4 Density

6.4 Image Collection

- 6.4.1 Thin Lens, graphical ray tracing
- 6.4.2 The thin lens equation

6.5 Image Processing and Analysis: Point Operators

- 6.5.1 4-quadrant tone reproduction cycle
- 6.5.2 The image histogram
- 6.5.3 Brightness and Contrast metrics
- 6.5.4 Sensitivity and Gamma metrics

- 6.6 Image Processing and Analysis: Spatial Operators
 - 6.6.1 Resolution: measurement and causes
 - 6.6.2 Noise: measurement and causes
- 6.7 Laboratory Topics
 - 6.7.1 Digital Still Camera:
 - 6.7.1.1 Control of illumination and exposure (F-stop & time)
 - 6.7.1.2 The histogram as an index of exposure
 - 6.7.1.3 Depth of field and the F-stop
 - 6.7.1.4 Motion and exposure time
 - 6.7.2 Video and Frame Grabbing
 - 6.7.2.1 Gamma and the histogram
 - 6.7.2.2 Dark field and flat field corrections
 - 6.7.3 Digital Image Analysis
 - 6.7.3.1 Histogram Segmentation as an analytical tool
 - 6.7.3.2 Multiple Image Processing as an analytical tool
 - 6.7.4 Image quality analysis: Scan lines and histograms
 - 6.7.4.1 Measuring the degree of out of focus
 - 6.7.4.2 Measuring sharpness and non-sharpness
 - 6.7.4.3 Measuring graininess
 - 6.7.4.3 The effect of file size on image quality

7.0 Intended learning outcomes and associated assessment methods of those outcomes

- 7.1 Knowledge of the taxonomy of imaging science and the imaging chain (EXAMS/QUIZES/LABS)
- 7.2 Understanding and practical skills in the use of a digital still camera (EXAMS/QUIZES/LABS)
- 7.3 Practical understanding of the interactions between objects and light (EXAMS/QUIZES/HOMEWORK/LABS)
- 7.4 Understanding of and practical skills in controlling focus, dept of field, illumination, and exposure (EXAMS/QUIZES/HOMEWORK/LABS)
- 7.5 Skills in the measurement and interpretation of tone transfer and histogram functions (EXAMS/QUIZES/HOMEWORK/LABS)
- 7.6 Basic understanding of experimental techniques for the evaluation of image quality (EXAMS/QUIZES/HOMEWORK/LABS)
- 7.7 Graphical understanding of the 4-quadrant tone reproduction cycle and of and of system and linearization and flat-fielding (EXAMS/QUIZES/HOMEWORK/LABS)
- 7.8 Basic understanding and skills in histogram segmentation analysis (EXAMS/QUIZES/HOMEWORK/LABS)

8.0 Program or general education goals supported by this course

Provides foundation in “systems” approach to imaging science. For non-majors, provides an option to fulfill a “science with lab” degree requirement.

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

Course requires at least six (6) two-student lab rooms, each equipped with (at minimum) optical bench with lens and camera mounts, digital camera, and PC for image acquisition and processing (i.e. PC running Photoshop and other special-purpose image processing and analysis software). Each student must have access to basic optics kits containing lenses, stand microscopes, and test/reference targets.

10.0 Supplemental information - NONE