1051-712-01: Basic Principles of Imaging Science II
*The Image Chain*
Winter, 2004-2005. MW 10:00-11:50pm, Carlson 1155

**Course**
Four credit hours, Four lecture hours per week
Prerequisites: Basic Principles of Imaging Science I (1051-711)
Corequisites: Coregistration in Linear Math II
Instructor: Roger Easton, 76-2112, 475-5969, easton@cis.rit.edu
Office Hours: TBD, and by appointment

**Catalog Description**
This course provides the student with a basic understanding of the scientific principles associated with optics and optical image formation, image displays and their characterizations, digital image processing, color, and the human vision system. An end-to-end treatment of the imaging system shall be employed to illustrate the inter-relationship among the concepts introduced throughout the course. Systems analyses including the use of modeling concepts developed in Linear Image Mathematics can be used in concert with materials in this course to describe and assess a simple imaging system.

**Objectives**
1. Provide a common scientific foundation for all imaging science students that enables them to describe simple imaging systems.
2. Enable the student to break an imaging system into component elements and describe the physical and mathematical relationships between the components.
3. The student should be able to describe a simple imaging process from a systems perspective and be able to characterize relevant quality metrics and predict performance characteristics along the imaging chain.
Course Outline:
I. Imaging Optics
   A. Self review of oscillations and waves
II. Oscillations
   A. Superposition of oscillations
   B. Traveling waves
   C. Doppler effect for waves in a medium ("acoustic" waves)
      1. Nature of light, electromagnetic waves
III. Maxwell's Equations
   A. Vector calculus
   B. Plane-wave solution to Maxwell's equations
   C. Wave equation
   D. Polarization
IV. Optical imaging in ray model
   A. Fermat’s principle
   B. Snell’s law for reflection and refraction
   C. Refraction from a single spherical surface, paraxial approximation
   D. Thin lens equation
   E. Multiple thin lenses
   F. Thick lenses
   G. Pupils and stops
V. Optical Imaging in wave model
   A. Interference
   B. Diffraction
   C. Diffraction limit in imaging
   D. system examples
VI. Digital Image Processing
   A. Review of sampling and quantization
   B. Operations on digital images
   C. Point operations on single images
   D. Point operations on multiple images, vision and color
   E. Local operations; crosscorrelation and convolution
   F. Operations based on shapes and patterns
   G. Geometrical operations
   H. Global operations
   I. Image compression

Instructional Techniques
Lectures, demonstrations

Evaluations
Midterm examination (30%)
Cumulative final examination (40%)
Homework (30%)
Bibliography
Class Notes, available in pdf format


Optics
WebTOP "The Optics Project" of Mississippi State University)
http://webtop.msstate.edu/

Digital Image Processing
Center for Image Processing in Education, (lots of links to software and images)
(http://www.evisual.org/homepage.html)
ImageJ software for image processing and analysis in Java, evolution of NIHImage
http://rsb.info.nih.gov/ij/
Image 2000 from NASA http://www.ccpo.odu.edu/SEES/ozone/oz_i2k_soft.htm
Scion Image Processing Software for PC and MAC
Hypercube Image Analysis Software for PC and MAC
http://www.tec.army.mil/Hypercube/

**Image Compression**