Rochester Institute of Technology
Rochester, New York

College of Science
Chester F. Carlson Center for Imaging Science

ST: Remote Sensing Systems, 1051-553

1.0 Title: Remote Sensing Systems **Date:** May 12, 2009
Credit Hours: 4
Prerequisite(s): 1051-370, 1051-452, 1051-453, or permission of instructor.
Corequisite(s): none
Course described by: John Kerekes

2.0 Course information:

	Contact hours	Maximum students/section
Classroom	4	30
Lab		
Studio		
Other (specify _____)		

Quarter(s) offered (check)
_____**Fall** __X___**Winter** _____**Spring** _____**Summer**

Students required to take this course: (by program and year, as appropriate)
None.

Students who might elect to take this course:
Undergraduate students in Imaging Science.
Undergraduate students in Electrical Engineering.
Undergraduate students in the other College of Science or College of Engineering programs.

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

Provide students with tools and experience in the design and analysis of optical Earth remote sensing spectral imaging systems from scene phenomenology to digital image characteristics. Learn significant components and their effect on imaging system performance in tracing photons from the Sun, through the atmosphere, interacting with the surface, collection by the optics, conversion to electrons and the formation of the resulting digital image.

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

1051-553 Special Topics: Remote Sensing Systems
This course develops knowledge and understanding of the design and analysis of optical remote sensing systems for Earth remote sensing. Building on general imaging fundamentals learned earlier in their program, students will learn domain specific tools and techniques for analyzing airborne and satellite sensor systems for the optical spectral imaging of Earth. Through a combination of classroom and laboratory experiences, students will learn about the propagation of photons and signals from the Sun through the formation of a digital image. The course will emphasize a linear systems modeling perspective and provide the students the background to understand, model, and predict remote sensing imaging system performance. (1051-370, 1051-452, 1051-453, or permission of instructor) **Class 4, Credit 4 (F or W)**

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

5.1 John R. Schott, *Remote Sensing: The Image Chain Approach*, 2nd Edition Academic Press
5.2 Instructor's Course Notes.

6.0 Topics

6.1 Introduction to Remote Sensing Systems
- 6.1.1 Example Remote Sensing Systems
- 6.1.2 Examples of applications
- 6.1.3 Scene phenomenology overview
- 6.1.4 Sensor system components overview

6.2 Surface Reflectance Characteristics
- 6.2.1 Reflectance nomenclature
- 6.2.2 Spectral reflectance phenomenology
- 6.2.3 Lab 1: Field measurement of spectral reflectance

6.3 Solar Illumination and Atmospheric Effects
- 6.3.1 Sun as a source
- 6.3.2 Atmospheric transmission and scattering
- 6.3.3 Spectral effects
- 6.3.4 Spatial effects
- 6.3.5 Lab 2: MODTRAN atmospheric modeling

6.4 Optical System
- 6.4.1 Spatial scanning modes
- 6.4.2 Basic optical design
- 6.4.3 Resolution: PSF and MTF analysis
- 6.4.4 Lab 3: Optical system analysis

6.5 Spectral Selection
- 6.5.1 Interference filters
- 6.5.2 Tunable filters
- 6.5.3 Dispersive spectrometers

6.6 Detectors
- 6.6.1 Semiconductor detector basics
- 6.6.2 Detector material characteristics
- 6.6.3 Detector noise mechanisms

6.7 Readout and Signal Conditioning Electronics
- 6.7.1 Detector array geometries
- 6.7.2 Readout approaches
- 6.7.3 A/D conversion
- 6.7.4 Electronics noise mechanisms

6.8 Radiometric Noise Modeling
- 6.8.1 Probabilistic modeling
- 6.8.2 Additional noise sources

6.9 End-to-end Radiometric Modeling
- 6.9.1 Tracing photons to electrons
- 6.9.2 Spreadsheet analysis
- 6.9.3 Lab 4: Radiometric modeling and sensitivity analysis

6.10 Sensor Calibration
- 6.10.1 Geometric
- 6.10.2 Spectral Misregistration
- 6.10.3 Radiometric

6.11 Read World Sensor Study
- 6.11.1 Example system: WASP-Lite
- 6.11.2 Sensor artifacts
- 6.11.3 Lab 5: WASP-Lite data measurement and characterization

7.0 Intended learning outcomes and associated assessment methods of those outcomes

Learning Outcome	In class attendance and evaluation	Homework Assignments, Laboratory Experiments, and Exams
7.1 Knowledge of the significant components of optical remote sensing systems	X	X
7.2 Ability to use models for the propagation of photons through the components and predict performance of an image system	X	X
7.3 Demonstrated understanding of example system performance and real-world limitations	X	X

8.0 Program or general education goals supported by this course

8.1 Satisfies one elective course requirement for BS in Imaging Science, or BS in Electrical Engineering.

8.2 Prepares undergraduate students in science and engineering for careers in fields working with the design or use of optical remote sensing systems.

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
9.2 Field spectrometer, such as ASD FieldSpec Pro or Ocean Optics Spectrometer
9.3 MODTRAN atmospheric modeling software
9.4 WASP-Lite imaging sensor, or similar
9.5 Schedule as 2 two-hour classes to allow for in-class laboratories

10.0 Supplemental information - NONE