

ROCHESTER INSTITUTE OF TECHNOLOGY  
Rochester, New York

COLLEGE of SCIENCE  
Department of IMAGING SCIENCE

REVISED COURSE: 1051-401

1.0 TITLE: RADIOMETRY  
DATE: 27 June 2003  
CREDIT HOURS: 4  
PREREQUISITE(S): 1016-253, 1017-313  
COREQUISITE(S): none  
COURSE PROPOSED BY: John Schott

2.0 COURSE INFORMATION:

|           | Contact Hours | Maximum Students / Section |
|-----------|---------------|----------------------------|
| Classroom | 3             | 35                         |
| Lab       | 3             | 35                         |
| Studio    | n/a           | n/a                        |
| Other     | n/a           | n/a                        |

QUARTER(S) OFFERED:

Fall  Winter  Spring  Summer

STUDENTS REQUIRED TO TAKE THIS COURSE:

Imaging Science, 2nd year

STUDENTS WHO MIGHT ELECT TO TAKE THE COURSE:

Environmental Science, Physics

3.0 GOALS OF THE COURSE:

This course is intended to provide the student with the necessary skills to solve a broad range of source-propagation-sensor problems, use detector figures of merit to compute the feasibility of using these detectors to measure/record various signals, and to calculate the signal recorded by an imaging system given radiometric characterization of a scene.

4.0 COURSE DESCRIPTION:

**1051-401**

**Radiometry**

This course introduces the concepts of quantitative measurement of electromagnetic energy. The basic radiometry terms are introduced using calculus-based definitions. Governing equations for source-propagation and sensor output are derived. Simple source concepts are reviewed and detector figures of merit are introduced and used in problem solving. The radiometric concepts are then applied to simple imaging

systems so that a student could make quantitative measurements with imaging instruments. (1016-253, 1017-314) Class 3, Lab 3, Credit 4 (S)

## 5.0 POSSIBLE RESOURCES:

- 5.1 Lecture Notes – Radiometry, John Schott

## 6.0 TOPICS:

- 6.1 Review of electromagnetic energy
- 6.2 Basic electronics
  - 6.2.1 Energy
  - 6.2.2 Power
  - 6.2.3 Work
  - 6.2.4 Elementary Circuits
  - 6.2.5 Elementary control
  - 6.2.6 Output circuits for various detectors
- 6.3 Review of relevant modern physics
  - 6.3.1 Wave and particle theory
  - 6.3.2 Planck's equation
- 6.4 Sources
  - 6.4.1 Sun
  - 6.4.2 Tungsten
  - 6.4.3 Tungsten halogen
  - 6.4.4 Gas discharge
- 6.5 Radiometric terms and principles
  - 6.5.1 Cosine law
  - 6.5.2 Inverse square law
  - 6.5.3 Irradiance
  - 6.5.4 Radiant intensity
  - 6.5.5 Line source
  - 6.5.6 Broad source
- 6.6 Sensors
  - 6.6.1 Photo conductors
  - 6.6.2 Photo multipliers
  - 6.6.3 Photo voltaics
  - 6.6.4 Photo electric emission
- 6.7 Detector figures of merit
  - 6.7.1 Responsivity
  - 6.7.2 Signal-to-noise ratio
  - 6.7.3 Detectivity
  - 6.7.4 Noise equivalent power
  - 6.7.5 Thermal
  - 6.7.6 Photon
- 6.8 Measurement
  - 6.8.1 Irradiance
  - 6.8.2 Source
  - 6.8.3 Propagation

- 6.8.4 Detection
- 6.8.5 Output
- 6.8.6 Radiance
- 6.8.7 Lambertian surfaces
- 6.8.8 Lamp standards
- 6.9 Spectroradiometry
  - 6.9.1 Monochromators
  - 6.9.2 Reflection gratings
- 6.10 Reflection and transmission from/through diffuse surfaces
- 6.11 Radiometry in imaging systems
  - 6.11.1 Lens fall-off
  - 6.11.2 G-number – throughput
- 6.12 Quantum efficiency – Relationship to figures of merit
- 6.13 Integrating spheres
- 6.14 Energy exchange using non-point source calculations
- 6.15 Imaging examples

7.0 INTENDED LEARNING OUTCOMES AND ASSOCIATED ASSESSMENT METHODS OF THOSE OUTCOMES:

- 7.1 Ability to solve simple quantitative source, propagation-sensor radiation transfer problems. (HOMEWORK, EXAMS, QUIZES)
- 7.2 Ability to derive and use governing equations for using simple imaging devices as quantitative radiometers. Assessed by tests and lab reports. (HOMEWORK, EXAMS, QUIZES)

8.0 PROGRAM OR GENERAL EDUCATION GOALS SUPPORTED BY THIS COURSE:

- 8.1 This course supports the Imaging Science program goal of training students to be able to quantitatively describe the electromagnetic propagation of energy as recorded by imaging devices.

9.0 OTHER RELEVANT INFORMATION:

none

10.0 SUPPLEMENTAL INFORMATION:

none