ROCHESTER INSTITUTE OF TECHNOLOGY
COURSE OUTLINE FORM

# COLLEGE OF SCIENCE

Chester F. Carlson Center for Imaging Science

NEW COURSE: COS-IMGS-451-Imaging Detectors

**1.0 Course Designations and Approvals**

| **Required course approvals:** | **Approval request date:** | **Approval granted date:** |
|---|---|---|
| Academic Unit Curriculum Committee | 7/23/10 | 8/17/10 |
| College Curriculum Committee | 10/19/10 | 12/3/2010 |

| **Optional designations:** | **Is designation desired?** | | ***Approval request date:** | ****Approval granted date:** |
|---|---|---|---|---|
| General Education: | | No | | |
| Writing Intensive: | | No | | |
| Honors | | No | | |

**2.0 Course information:**

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|---|---|
| **Course title**: | Imaging Detectors |
| **Credit hours:** | 3 |
| **Prerequisite(s):** | COS-IMGS-251,COS-IMGS-341 or equivalent |
| **Co-requisite(s)**: | |
| **Course proposed by:** | Zoran Ninkov |
| **Effective date:** | Fall 2013 |

| | **Contact hours** | **Maximum students/section** |
|---|---|---|
| Classroom | 3 | 24 |
| Lab | | |
| Studio | | |
| Other (specify) | | |

**2.1 Course Conversion Designation (Please check which applies to this course)**

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|---|---|
| x | Semester Equivalent (SE) Please indicate which quarter course it is equivalent to:<br>1051-465 Imaging Detectors |
| | Semester Replacement (SR) Please indicate the quarter course(s) this course is replacing: |
| | New |

**2.2 Semester(s) offered** (check)

| | | | |
|---|---|---|---|
| Fall | Spring x | Summer | Other |

All courses must be offered at least once every 2 years. If course will be offered on a bi-annual basis, please indicate here:

**2.3 Student Requirements**

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| **Students required to take this course**: (by program and year, as appropriate)<br>Third or fourth-year majors in Imaging Science |
| **Students who might elect to take the course**:<br>Any student with appropriate prerequisites |

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

This course will enable students to understand the basic principles of thermal, photon, and detector operation, including the constituent materials from which detectors with different spectral response characteristics are made. The course also considers various detector figures of merit, the limitations of the different types of detectors, and methods for computing detector response characteristics. The use of radiation detectors in application areas of imaging science, such as astronomy, remote sensing and medical imaging, are also considered

**4.0 Course description** (as it will appear in the RIT Catalog, including pre- and co-requisites, and quarters offered). Please use the following format:

**COS-IMGS-451 Imaging Detectors**

This course provides an overview of the underlying physical concepts, designs, and characteristics of detectors used to sense electromagnetic radiation having wavelengths ranging from as short as X-rays to as long as millimeter radiation. The basic physical concepts common to many standard detector arrays will be reviewed. Some specific examples of detectors to be discussed include photomultipliers, micro channel plates, hybridized infrared arrays, positive-intrinsic-negative (PIN) detectors, and superconductor-insulator-superconductor (SIS) mixers. The use of detectors in fields such as astronomy, high energy physics, medical imaging and digital imaging will be discussed. (COS-IMGS-251,COS-IMGS-341 or equivalent) **Class 3, Credit 3 (S)**

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

5.1 George Rieke, *Detection of Light from the Ultraviolet to Submillimeter*, Cambridge University Press, Cambridge UK

5.2 MathCad, MatLab, and/or IDL or equivalent software package for computational exercises.

**6.0 Topics (outline):**

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| 6.1 | Review of principles of radiometry and solid state physics |
| 6.2 | Calorimeters |
| 6.3 | Field Effect Transistors: operation and use |
| 6.4 | Correlated double Sampling and its use in a readout circuit to minimize noise |
| 6.5 | Address encoders for imaging arrays |
| 6.6 | Complementary metal-oxide semiconductor (CMOS) arrays for imaging |
| 6.7 | Hybridized imaging arrays for the visible and infrared region |
| 6.8 | Charge-coupled device (CCD) arrays |
| 6.9 | Detector performance metrics including quantum efficiency, dark noise, read noise, linearity, detectivity and responsivity. |
| 6.10 | Other types of detectors including photon detectors, thermal detectors and heterodyne detectors |
| 6.11 | Other varieties of detectors including ; scintillators and microchannel plate detectors, transition edge sensors, superconducting tunnel junction devices, silicon (Si), silicon carbide (SiC) and gallium nitride (GaN) detectors, and avalanche photodiode (APD) arrays. |
| 6.12 | Use of detector arrays in scientific applications |

**7.0 Intended course learning outcomes and associated assessment methods of those outcomes**

| Course Learning Outcome | **Assessment 1** | **Assessment 2** | **Assessment 3** |
|---|---|---|---|
| 7.1 Compare the basic photon detection processes used in detectors across the spectrum. | Examinations | Homework | Project |
| 7.2 Classify the specific materials used for detection at different wavelengths. | Examinations | Homework | Project |
| 7.3 Explain reasons for detector performance at different wavelengths. | Examinations | Homework | Project |
| 7.4 Assess the limitations to practical operation of various detectors at different wavelengths. | Examinations | Homework | Project |
| 7.6 Identify common factors of the detection process at different wavelengths. | Examinations | Homework | Project |

**8.0 Program outcomes and/or goals supported by this course**

8.1 To provide understanding in the mechanisms of image formation using image detectors

8.2 To provide the education necessary to pursue careers in industry or to proceed to graduate studies in imaging-related disciplines.

8.3 To provide knowledge of imaging systems, physics, mathematics, and digital processing to formulate, analyze, and solve practical problems in imaging science.

**9.0**

| | General Education Learning Outcome Supported by the Course | Assessment Method |
|---|---|---|
| ***Communication*** | | |
| | Express themselves effectively in common college-level written forms using standard American English | |
| | Revise and improve written and visual content | |
| | Express themselves effectively in presentations, either in spoken standard American English or sign language (American Sign Language or English-based Signing) | |
| | Comprehend information accessed through reading and discussion | |
| ***Intellectual Inquiry*** | | |
| | Review, assess, and draw conclusions about hypotheses and theories | |
| | Analyze arguments, in relation to their premises, assumptions, contexts, and conclusions | |
| | Construct logical and reasonable arguments that include anticipation of counterarguments | |
| | Use relevant evidence gathered through accepted scholarly methods and properly acknowledge sources of information | |
| ***Ethical, Social and Global Awareness*** | | |
| | Analyze similarities and differences in human experiences and consequent perspectives | |
| | Examine connections among the world's populations | |
| | Identify contemporary ethical questions and relevant stakeholder positions | |
| ***Scientific, Mathematical and Technological Literacy*** | | |
| | Explain basic principles and concepts of one of the natural sciences | |
| | Apply methods of scientific inquiry and problem solving to contemporary issues | |
| | Comprehend and evaluate mathematical and statistical information | |
| | Perform college-level mathematical operations on quantitative data | |
| | Describe the potential and the limitations of technology | |
| | Use appropriate technology to achieve desired outcomes | |
| ***Creativity, Innovation and Artistic Literacy*** | | |
| | Demonstrate creative/innovative approaches to course-based assignments or projects | |
| | Interpret and evaluate artistic expression considering the cultural context in which it was created | |

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

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| 10.1 Smart classroom<br>10.2 Laboratory for demonstrations. |