

# OPTICAL DETECTION

ECEG287

Spring 2004

**INSTRUCTORS:**

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**OFFICE HOURS:**

DiMarzio Thursdays 10-12, 302 Stearns. Wednesdays 8-9PM electronically  
(See <http://www.ece.neu.edu/faculty/dimarzio> for details).

**TEXT:**

1. Dereniak, Eustace, and Devon G. Crowe, *Optical Radiation Detectors*,  
(Wiley series in Pure and Applied Optics), Wiley, New York, 1984.

2. Presentation Material on Course Website

**LOCATION:**

109 RB

**TIME:**

M, W, 11:40AM-1:20PM

**GRADING:**

Mid-Term	25%
Final	25%
Homework	25%
Project Final Report	25%

**EXAMS:**

Exams will be given at the middle and end of the course.

**PROJECTS:**

A list of suggested projects will be distributed. Each project must involve some research in the literature and some independent work. Reviews of the literature alone are not acceptable. If you have your own idea for a project, We would be happy to consider it. We will suggest other projects during class as they arise in the lectures.

**HOMEWORK:**

Homework Assignments will be available on the course website. Collaboration among students on homework is acceptable, but each student must submit his or her own work.

# SYLLABUS FOR OPTICAL DETECTION

ECEG287

Spring 2004

Northeastern University

Prof. DiMarzio and McKnight

This is the first time this course is offered jointly by Profs. DiMarzio and McKnight. Each of us has taught it separately before. This is a very tentative syllabus based on what I (CD) did the last time I taught the course. We expect to be making adjustments as we go along.

**1****5 Jan 2004**

**ADMINISTRIVIA. INTRODUCTION.** — History, Overview of detection techniques, devices, and performance criteria. Radiometric Quantities.

**Reading in Text:** 1,2.

**Related Sections in Notes:** 1.

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**Holiday:** 19 Jan 2004, King Holiday.

**2****7,12,14,21  
Jan 2004**

**RADIATION TRANSFER (CD).** Radiometry and photometry. Transport. Absorption, reflection, and transmission.

**Reading in Text:** 1.

**Related Sections in Notes:** 2.

**BLACK BODY RADIATION.** Principles. Typical sources and standards. Radiance of day and night sky, clouds, sun.

**Reading in Text:** 1.

**PHOTON DETECTORS.** General issues relating to photon detectors; quantum efficiency, gain and responsivity; photon-counting systems.

**Reading in Text:** 2.

**3****26, 28, Jan  
2004**

(*Photonics West: CD on travel.*) **NOISE** Quantum limits. Background limits. Electronic limits. Day and night operation of detectors outdoors. Spatial filters, spectral filters, electronic filters.

**Reading in Text:** 2.

**Related Sections in Notes:** 3.

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**Holiday:** 16 Feb 2004, Presidents' Day.

**4****2,4,9,11,18  
Feb 2004**

*2 CD travel day.* **SEMICONDUCTOR DETECTORS (SM)**

Photovoltaics. Photoconductors. Practical Considerations. Size and bandwidth issues. Circuit issues. Examples of Semiconductor detectors; Si, Ge, HgCdTe.

**Reading in Text:** 3,4.

**Related Sections in Notes:** 4.

<b>5</b> <b>23,25 Feb 2004</b>	<b>PHOTOELECTRIC DETECTORS.</b> Vacuum photodiode. Photomultipliers. <b>Related Sections in Notes:</b> 5. <b>Reading in Text:</b> 5. <b>THERMAL DETECTORS.</b> Principles of operation. Typical devices. Spectral response. Response to modulation. <b>Reading in Text:</b> 6,7. <b>PYROELECTRICS.</b> Principles of operation. Typical devices. Spectral response. Response to modulation. <b>Reading in Text:</b> 8.
<b>Holiday:</b> 1-5 March 2004, Spring Break.	
<b>6</b> <b>8,10 Mar 2004</b>	<b>THE DETECTOR AS A CIRCUIT ELEMENT.</b> Characteristic curves, typical receiver circuits, bias tee's, amplifiers. AC and DC performance. <b>Related Sections in Notes:</b> 6.
<b>7</b> <b>15,17 Mar 2004</b>	<b>COHERENT DETECTION (CD)</b> Basic concepts. Comparison to incoherent detection. Doppler LIDAR. Noise in Coherent Detection. <b>Related Sections in Notes:</b> 7.
<b>8</b> <b>22,24 Mar 2004</b>	<b>DATA PROCESSING OF OPTICAL SIGNALS</b> Signal Statistics for coherent and incoherent detection for coherent and incoherent sources. Applications of Detection and Estimation Theory. <b>Related Sections in Notes:</b> 8.
<b>9</b> <b>29,31 Mar, 5 Apr 2004</b>	<b>ARRAY DETECTORS (SM)</b> Thermal Imagers. One and two dimensional arrays. FLIR's. Charge Transfer Devices. <b>Reading in Text:</b> 9. <b>Related Sections in Notes:</b> 9.
<b>10</b> <b>7, 12, 14 Apr 2004</b>	<b>SPECIAL TOPICS.</b> Autocorrelation for measuring very short pulses (CD) <b>SPARE DAY. CONCLUSION.</b> <b>Related Sections in Notes:</b> 10.

## Selected References

Becklund and Williams, *Optics: A Short Course for Engineers and Scientists*, Wiley.

Boyd, Robert W., *Radiometry and the Detection of Optical Radiation* (Wiley series in Pure and Applied Optics), Wiley, New York, 1983. 254 pages.

Budde, Wolfgang, *Optical Radiation Measurements: Volume 4; Physical Detectors of Optical Radiation*, Academic Press, New York, 1983.

Dereniak, Eustace, and Devon G. Crowe, *Optical Radiation Detectors*, (Wiley series in Pure and Applied Optics), Wiley, New York, 1984.

Driscoll, Walter G., and Villiam Vaughan, *Handbook of Optics*, McGraw-Hill, New York.

Grum, Franc, and Richard J. Becherer, *Optical Radiation Measurements: Volume 1; Radiometry*, Academic Press, New York, 1979.

Kingston, Robert H., *Detection of Optical and Infrared Radiation*, (Springer Series in Optical Sciences, Vol. 10), Springer Verlag, New York, 1978.

Wolfe, William L., ed. *Handbook of Military Infrared Technology*, Office of Naval Research, Washington, DC. 1965. 906 pages.