CREOL, The College of Optics and Photonics

OSE6242: Infrared Systems

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Credit Hours: 3.0
Term: Spring 2024

Time:	Tue, Thu 3:00–4:15 PM
Location:	Room 102 CREOL
Prerequisites:	Graduate standing and consent of instructor
Course Web Description:	https://creol.ucf.edu/academics/courses/course-schedule/details/?courseid=0
Instructor:	Dr. Konstantin Vodopyanov
Email/Contact Info:	vodopyanov@creol.ucf.edu
Office Hours and Location:	by email appointment
Class Website	on Webcourses

Syllabus

I. Course Description:

The course focuses on the measurement of infrared light and its spatial, temporal and spectral characteristics, as well as sensitive detection of infrared radiation. First, the course introduces radiometry—a set of methods for measuring electromagnetic radiation—and defines radiometric quantities and units of measurement. Next, we'll review the theory of black body radiation and concepts such as shot noise, Johnson noise, and background thermal noise that limit the signal-to-noise ratio of infrared detection. We will then look at various infrared detectors, from photon detectors to thermal detectors, and their characteristics such as sensitivity, detectability and speed. Finally, we will review the most advanced detector systems, such as superconducting single photon detectors, optically coupled cantilevers, and focal plane detector arrays.

II. Learning Outcomes:

Students will gain a strong theoretical foundation of infrared detection principles as well as practical knowledge of different types of infrared detectors. This course will allow you to (i) understand the fundamental laws that limit the sensitivity of infrared detection, (ii) understand the advantages and disadvantages of different types of detectors, and (iii) gain a clear understanding of how to select an infrared detector for a specific application.

III. Textbooks (recommended but not required):

E. L. Dereniak, G. D. Boreman, *Infrared Detectors and Systems* (Wiley, 1996)

IV. Basis for Final Grade:

Assessment	Percent of Final Grade
Homework (once a week)	25 %
Exam 1 (open book)	25 %
Exam 2 (open book)	25%
Final Exam (open book)	25 %
	100%

Grading scale:

Grading Scale (%)	
94-100	A
90-93	A-
87-89	B+
84-86	B
80-83	B-
77-79	C+
74-76	C
70-73	C-
67-69	D+
64-66	D
60-63	D-
0 - 59	F

V. Grade Dissemination

Graded tests and materials in this course will be returned individually only by request. You can access your scores at any time using "myUCF Grades" in the portal. Please note that scores returned mid-semester are unofficial grades. If you need help accessing myUCF Grades, see the online tutorial: https://myucfgrades.ucf.edu/help/.

VI. Course Policies: Grades

Late Work Policy: There are no make-ups for the homework, or the intermediate and final exams. Late homework submission penalty: *10% will be deduced for each day of the delay.*

Grades of "Incomplete":
The current university policy concerning incomplete grades will be followed in this course. Incomplete grades are given only in situations where *unexpected emergencies prevent a student from completing the course and the remaining work can be completed the next semester*. Instructor is the final authority on whether you qualify for an incomplete. Incomplete work must be finished by the end of the subsequent semester or the "I" will automatically be recorded as an "F" on your transcript.

VII. Course Policies: Technology and Media

Email: Please use email vodopyanov@creol.ucf.edu for all correspondence.

Website: All information concerning the course will be posted on WebCourses. This site will reflect latest changes, contain some key scientific papers, as well as lecture handouts that will be posted for each lecture the day before the lecture (may be very late evening).

VIII. Course Policies: Student Expectations

Disability Access: The University of Central Florida is committed to providing reasonable accommodations for all persons with disabilities. Students with disabilities who need accommodations in this course must contact the professor at the beginning of the semester to discuss needed accommodations. No accommodations will be provided until the student has met with the professor to request accommodations. Students who need accommodations must be registered with Student Disability Services, Student Resource Center Room 132, phone (407) 823-2371, TTY/TDD only phone (407) 823-2116, before requesting accommodations from the professor.

Attendance Policy:
- This is a face-to-face class. Student's attendance is required.
- Students must be on time to class.
- If missed a class, it is the responsibility of the student to find out the materials covered.

Professionalism Policy:
Per university policy and classroom etiquette; mobile phones must be silenced during all classroom lectures. Those not following this rule will be asked to leave the classroom immediately so as to not disrupt the learning environment.

IX. Weekly Schedule, Spring 2023

week	date	Concepts presented
1	9-Jan	Lecture 1. Radiometry, and its quantities and units.
2	11-Jan	Lecture 2. Theory of blackbody radiation.
3	16-Jan	Lecture 3. Different optical detection processes.
4	18-Jan	Lecture 4. Noise in optical detection-I.
5	23-Jan	Lecture 5. Noise in optical detection-II.
6	25-Jan	Lecture 6. Figures of merit for optical detectors. Responsivity. Noise equivalent power. Detectivity D*.
7	30-Jan	No classes, the instructor is out at Photonics West Conference in San Francisco
8	1-Feb	Lecture 7. Intro to semiconductor physics. p-n and p-i-n junctions.
9	6-Feb	Lecture 8. Photovoltaic detectors.
10	8-Feb	Lecture 9. Photoconductive detectors
11	13-Feb	**Exam 1**
12	15-Feb	Lecture 10. Photoemissive detectors. Photomultipliers.
13	20-Feb	Lecture 11. Thermal detectors-I. Thermopiles. Bolometers.
14	22-Feb	Lecture 12. Thermal detectors -II. Pyroelectric detectors. Golay cells.
15	27-Feb	Lecture 13. Schottky-barrier photodiodes.
16	29-Feb	Lecture 14. Intrinsic and extrinsic silicon and germanium detectors.

17	5-Mar	Lecture 15. Detector bandwidth and speed, and their relation to noise.
18	7-Mar	Lecture 16. III-V detectors. InAs, InSb
19	12-Mar	Lecture 17. II-VI detectors. PbS, PbSe.
20	14-Mar	**Exam 2**
21	19-Mar	**Spring Break**
22	21-Mar	**Spring Break**
23	26-Mar	Lecture 18. HgCdTe detectors.
24	28-Mar	Lecture 19. Detection with optically coupled cantilevers
25	2-Apr	Lecture 20. Superconductive detectors and quantum techniques.
26	4-Apr	Lecture 21. Coherent detection. Heterodyning
27	9-Apr	Lecture 22. Detection via frequency upconversion. Electro-optic sampling.
27	11-Apr	Lecture 23. Detector focal plane arrays.
29	16-Apr	Lecture 24. Thermal-imager systems. VO2
30	18-Apr	Lecture 25. Hyper-spectral imaging
31	23-Apr	Prepare for the Final Exam
32	25-Apr	**Final Exam**
33	1-May	Final Grades (officially due 3-May before 12pm)