CREOL OSE 6938E: Terahertz Technologies & Applications
College of Optics and Photonics, Summer 2014
University of Central Florida

COURSE SYLLABUS

Instructor:	Dr. Konstantin Vodopyanov	Term:	Summer 2017
Office:	CREOL Room A113	Class Meeting Days:	**Wed, Fri**
Phone:	407 823 6818	Meeting Hours:	**10:00-11:45am**
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Office Hours:	Fridays 5-6 pm	*TA: n/a*	

I. Welcome!

Welcome to CREOL OSE 6938E course: Terahertz Technologies & Applications.

II. University Course Catalog Description:

The goal of the course is to highlight the importance of the THz region of the electromagnetic spectrum and make the students familiar with numerous methods of terahertz wave generation and detection, as well as with different applications of THz technology, from biomedical to high-field physics.

III. Course Overview:

The topics to be covered: The concept of "terahertz gap". Vacuum electronics based THz sources. Semiconductor based sources. Sources based on quantum confined structures. Photonic-based THz sources driven by lasers (photomixers & photo-antennas, sources based on nonlinear optical frequency downconversion). Optically-pumped THz molecular lasers. Superconducting THz emitters. THz detectors including antennas, Schottky diodes, bolometers, thermopiles, pyroelectrics, Golay cells, heterodyne and up-conversion detectors, superconducting detectors, microbolometers, and focal-plane arrays. THz waveguides, photonic crystals & metamaterials. THz applications including: frequency-domain and time-domain THz spectroscopy and molecular sensing, THz imaging and tomography, near-field THz spectroscopy and diagnostics, THz in biology and medicine, security and defense. THz wireless communications. New science with high-field THz waves.

IV. Course Objectives:

- To understand why the THz range is so important for science and technology.
- To understand why this field was underdeveloped.
- To learn about different THz sources with their advantages, disadvantages and limitations.

- To learn about different THz detection methods.
- To understand the principle of broadband THz time-domain spectroscopy.
- To grasp the scope of numerous THz applications.

V. Course Prerequisites:

Graduate Standing or approval of the Instructor

VI. Course Credits:

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VII. Text Book:

There is no 'standard' textbook on THz

VIII. Reference Books:

1) E. Bruendermann, H-W. Huebers, M.F. Kimmitt, "Terahertz Techniques", Springer Series in Optical Sciences 151 (Springer, 2012); e-book, UCF library.
2) Xi-Cheng Zhang, Jingzhou Xu, Introduction to THz Wave Photonics" (Springer, 2009); e-book, UCF library.
3) Kiyomi Sakai, ed. "Terahertz Optoelectronics", (Springer, 2005); e-book, UCF library.
4) Yun-Shik Lee, "Principles of terahertz science and technology" (Springer, 2009) - e-book, UCF library.
5) Daniel Mittleman, ed. "Sensing with Terahertz Radiation", (Springer, 2004); book, UCF library.

Also: Selected key journal papers will be posted on the course web site:

IX. Basis for Final Grade:

Assessment	Percent of Final Grade
Homework	35 %
Midterm Exam	35 %
Final Exam (in the form of 10-min scientific presentation)	30 %
	100%

Grading scale:

Grading Scale (%)	
90-100	A
80 - 89	B
70 - 79	C
60 - 69	D
0 - 59	F

X. 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/.

XI. Course Policies: Grades

Late Work Policy: There are no make-ups for the homework, or the final exam. Homework will be assessed a penalty: 10 points will be deduced if it is one day late, and will not be accepted if overdue by more than seven days.

Extra Credit Policy: No extra credit will be offered.

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.

XII. 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 at:
http://www.creol.ucf.edu/Academics/Courses/CourseMaterial.aspx?Course=OSE6938E
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).

Classroom Devices: ***No recording of the lecture is permitted.***

XIII. 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:
• Regular class attendance is strongly advised and is necessary for students to understand many of the topics covered.
• 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, iPods, *etc*. **must be silenced** during all classroom lectures. Those not heeding this rule will be asked to leave the classroom immediately so as to not disrupt the learning environment. Please arrive on time for all class meetings. Students who habitually disturb the class by talking, arriving late, *etc*., and have been warned may suffer a reduction in their final class grade.

Academic Conduct Policy:
Academic dishonesty in any form will not be tolerated. As in all University courses, The Golden Rule Rules of Conduct will be applied. Violations of these rules will result in a record of the infraction being placed in your file and receiving a zero on the work in question AT A MINIMUM. At the instructor's discretion, you may also receive a failing grade for the course. Confirmation of such incidents can also result in expulsion from the University.

XIV. Important Dates to Remember

Withdrawal Deadline:	July 5, 2017
Final Exam:	Aug 2, 2017

XV. Schedule

1	17-May	Course logistics. Introduction to terahertz science. 'Terahertz gap'. Blackbody sources of THz radiation.
2	19-May	Sources-I: Semiconductor-based: Schottky diodes, RTD, IMPATT. Frequency multipliers.
3	24-May	Sources-II: Vacuum electronics-based: Backward-wave oscillators. Synchrotron radiation sources. Free electron lasers.
4	26-May	Sources-III: Optically pumped THz molecular lasers. THz quantum cascade lasers.
5	31-May	Sources-IV: Photomixers. Photo-antennas (Auston switches). Optical rectification.
6	02-Jun	Sources-V: Nonlinear optical frequency mixers. Periodically-inverted crystals. Frequency mixing in 1D and 2D periodically inverted nonlinear crystals.
7	07-Jun	Sources-VI: THz optical parametric oscillators. THz generation inside the optical cavity.
8	09-Jun	Detectors-I: Antennas, Schottky diodes, bolometers, thermopiles, pyroelectrics, Golay cells.
9	14-Jun	Detectors-II: Heterodyne and up-conversion detectors.
10	16-Jun	Detectors-III: Ultrasensitive and single-photon detectors. Microbolometers. Focal-plane arrays.
11	21-Jun	Time domain spectroscopy-I: Ultrafast time-domain systems and measurements. Fourier analysis.
12	23-Jun	Time Domain Spectroscopy-II: Electro-optic and photo-antenna generation and sampling.
	28-Jun	Mid-Term exam, open book.
13	30-Jun	Molecular sensing and chemical recognition with THz radiation
14	05-Jul	THz Imaging and tomography
15	07-Jul	THz waveguides. Photonic crystals. Metamaterials.
16	12-Jul	Near-field THz effects and measurements.
17	14-Jul	THz in biology and medicine.
18	19-Jul	THz in security and defense. THz communications.
19	21-Jul	Novel devices-I. Photo Dember effect. p-type Ge laser. Superconducting THz emitters.
20	26-Jul	Novel devices-II. Microcavity THz laser. THz produced by frequency mixing in QCL. Tilted-wave front optical rectification.
21	28-Jul	THz produced in air. Nonlinear interaction of THz waves with matter. Nonlinear THz spectroscopy.
	2-Aug	Final Exam in the form of students' 10-min presentations.