Quantum Cascade Lasers

NanoScience Technology Center
College of Graduate Studies, University of Central Florida

COURSE SYLLABUS

Instructor:	Dr. Arkadiy Lyakh	Term:	Spring 2017
Office:	NanoScience Technology Center Suite 478	Class Meeting Days:	Tues
Phone:	407-823-0699	Class Meeting Hours:	12:30-2:50
E-Mail:	arkadiy.lyakh@ucf.edu	Class Location:	Rm 475
Website:	Nano.ucf.edu	Lab Location:	N/A
Office Hours:	TBD		

I. Welcome!

II. University Course Catalog Description

Introduction to Quantum Cascade Lasers (QCLs): active region, waveguide and thermal design; simulation of laser characteristics; commercial and defense QCL applications

III. Course Overview

QCLs are a novel class of infrared semiconductor lasers covering 3μm to 12μm spectral region that is critical for infrared spectroscopy, imaging and various defense applications. In contrast to the traditional diode lasers, light in these devices is generated via electron transitions between quantized energy levels in the conduction band only (intersubband transitions) rather than between the conduction and valence bands (interband transitions). As a consequence, QCLs have different selection rules and dynamical properties than the diode lasers. QCL design relies on the unique bandgap engineering technique: a precise control of thicknesses, material composition, and doping for over 1,000 nanometer-thick active region layers. A number of quantum mechanical processes, such as electron-phonon interaction, interface scattering, and carrier leakage through indirect states, has to be taken into account to accurately predict their performance. Despite the device design and fabrication complexity, QCL performance has dramatically improved to the point where they offer unrivaled combination of size, weight and power for various infrared applications. QCL design, modelling, and applications will be covered in this course.

IV. Course Objectives

From this course, students will learn the fundamental principles, modeling techniques and applications for Quantum Cascade Lasers. At the end of the course, they will be able to design state-of-the-art QCLs and tailor their characteristics to specific applications.

Tentative Course Schedule (total 15 weeks)

1. Intersubband transitions
2. Epi-growth and fabrication
3. Electronic states in semiconductor quantum wells
4. Optical transitions
5. Intersubband scattering processes
6. Midterm 1
7. Midinfrared waveguides
8. Active region design: 3 to 5μm
9. Active region design: 8 to 12μm
10. Mode control: distributed feedback

11. Mode control: external cavity
12. Midterm 2
13. Transport models
14. Dynamical properties
15. Device characterization
16. Final exam (take-home)

V. Course Prerequisites

Upon approval by the instructor

VI. Course Credits

3 credit hours

VII. Required Texts and Materials

Quantum Cascade Lasers, by Jerome Faist, (ISBN 978-0-19-852824-1)

VIII. Supplementary (Optional) Texts and Materials

Quantum Wells, Wired and Dots, third edition by Paul Harrison (ISBN 978-0-470-77097-9)

IX. Basis for Final Grade

The listing of assessments and their weighting in the semester will be as follows.

Assessment	Points
Midterm exam 1	75
Midterm exam 2	75
Final exam (take-home)	100
Homework	50
Total points	300

The following grading scale will apply:

Grading Scale (%)	
250-300	A
200-250	B
170-200	C
150-170	D
Below 150	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 in-class presentations, quizzes, the midterm, or the final exam.

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. Your 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: For all inquiries, students should contact Dr. Lyakh by email (arkadiy.lyakh@ucf.edu) or during office hours. Students should expect a response within 24hours throughout the week.

XIII. Course Policies: Student Expectations

Disability Access: The University of Central Florida is committed to providing reasonable accommodations for all persons with disabilities. This syllabus is available in alternate formats upon request. 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: Class attendance is required in this course.

Professionalism Policy: Per university policy and classroom etiquette; mobile phones, iPods, *etc*. **must be silenced** during all classroom and lab lectures. Those not heeding this rule will be asked to leave the classroom/lab 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. If you are uncertain as to what constitutes academic dishonesty, please consult The Golden Rule, the University of Central Florida's Student Handbook (http://www.goldenrule.sdes.ucf.edu/) for further details. 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.

Turinitin.com In this course we will utilize turnitin.com, an automated system which instructors can use to quickly and easily compare each student's assignment with billions of web sites, as well as an enormous database of student papers that grows with each submission. Accordingly, you will be expected to submit all assignments in both hard copy and electronic format. After the assignment is processed, as instructor I receive a report from turnitin.com that states if and how another author's work was used in the assignment. For a more detailed look at this process visit http://www.turnitin.com.

University Writing Center: The University Writing Center (UWC) is a free resource for UCF undergraduates and graduates. At the UWC, a trained writing consultant will work individually with you on anything you're writing (in or out of class), at any point in the writing process from brainstorming to editing. Appointments are recommended, but not required. For more information or to make an appointment, visit the UWC website at http://www.uwc.ucf.edu, stop by MOD 608, or call 407.823.2197.