OSE 6938/Quantum Cascade Lasers/Spring 2024
CREOL 102; MoWe 4:30PM to 5:45PM

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Course Description: 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.

Estimated effort (hours per week): reading – 2h, coding – 3h, classroom - 3h.

Textbooks: *Quantum Cascade Lasers, by Jerome Faist, (ISBN 978-0-19-852824-1);* Quantum Wells, Wired and Dots, third edition by Paul Harrison (ISBN 978-0-470-77097-9)

Lectures: Lectures will be a combination of computer slides and writing on the board. Notes and other material will be posted on Webcourses.

Homework: There will be no homework assigned in this course and the final grade will be entirely based on midterm and final exams.

Exams: Your grade will be determined on the basis of a mid-term exam 1 (30%), a mid-term exam 2 (30%), and a final exam (60%). For exceptional situations (such as Religious holiday, medical emergency, etc.) you may take an exam in a different day if you have a written request (not an e-mail) and submitted it personally to the instructor ahead of time with the appropriate documentation to justify the absence.

Grading:

A: 85-100 B: 70-85 C: 55-70 D: 45-55 F: 0-45

Comments on grading: Zero points will be given for missed assignments/exams. All assignment and exam grades are final 72h after they were published.

Missed work policy: Making up missed work will only be permitted for University-sanctioned activities and bona fide medical or family reasons. Authentic justifying documentation must be provided in every

case. At the discretion of the professor, the make-up may take any reasonable and appropriate form including (but not limited to) giving a replacement exam.

Golden rule: http://goldenrule.sdes.ucf.edu/

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

***This calendar will be adjusted to the needs of the course. Changes will be based on the course progress. The in-class exam dates will be announced on the web**.**

Course Accessibility: The University of Central Florida is committed to providing access and inclusion for all persons with disabilities. Students with disabilities who need disability-related access in this course should contact the professor as soon as possible. Students should also connect with Student Accessibility Services (SAS) (Ferrell Commons 185, sas@ucf.edu, phone 407-823-2371). Through Student Accessibility Services, a Course Accessibility Letter may be created and sent to professors, which informs faculty of potential access and accommodations that might be reasonable. Determining reasonable access and accommodations requires consideration of the course design, course learning objectives and the individual academic and course barriers experienced by the student.

Campus Safety Statement: Emergencies on campus are rare, but if one should arise during class, everyone needs to work together. Students should be aware of their surroundings and familiar with some basic safety and security concepts.

- In case of an emergency, dial 911 for assistance.
- Every UCF classroom contains an emergency procedure guide posted on a wall near the door. Students should make a note of the guide's physical location and review the online version at <http://emergency.ucf.edu/emergency_guide.html>.
- Students should know the evacuation routes from each of their classrooms and have a plan for finding safety in case of an emergency.

- If there is a medical emergency during class, students may need to access a first-aid kit or AED (Automated External Defibrillator). To learn where those are located, see <http://www.ehs.ucf.edu/AEDlocations-UCF> (click on link from menu on left).
- To stay informed about emergency situations, students can sign up to receive UCF text alerts by going to <https://my.ucf.edu> and logging in. Click on "Student Self Service" located on the left side of the screen in the toolbar, scroll down to the blue "Personal Information" heading on the Student Center screen, click on "UCF Alert", fill out the information, including e-mail address, cell phone number, and cell phone provider, click "Apply" to save the changes, and then click "OK."
- Students with special needs related to emergency situations should speak with their instructors outside of class.
- To learn about how to manage an active-shooter situation on campus or elsewhere, consider viewing this video (<https://youtu.be/NIKYajEx4pk>).

Copyright: This course may contain copyright protected materials such as audio or video clips, images, text materials, etc. These items are being used regarding the Fair Use doctrine in order to enhance the learning environment. Please do not copy, duplicate, download or distribute these items. The use of these materials is strictly reserved for this online classroom environment and your use only. All copyright materials are credited to the copyright holder.

Inclement Weather Policy: The National Hurricane Center provides information about hurricanes and other severe weather at http://www.nhc.noaa.gov/ During any threatening weather, UCF's Department of Security and Emergency Management monitors this site and sends official weather reports to campus leadership. If a serious storm or hurricane threatens our region, the Governor of Florida and President of UCF have the authority to cancel classes or close campuses. If they cancel classes or close the university, UCF Communications will disseminate details via UCF Alert, social media, local media, and radio outlets, including WUCF 89.9 FM. They also will post this information on the UCF home page at http://www.ucf.edu and I will send out an e-mail through Webcourses. Course deadlines and expectations will be modified depending on the severity of the storm and length of time that the university is closed. A list of other media outlets and hurricane resources is available at http://emergency.ucf.edu/hurricanes.html.