



OSE 5525: Laser Engineering

CREOL, The College of Optics and Photonics

3 Credit Hours

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IMPORTANT: Regarding technical problems, please email Webcourses@ucf.edu.

Instructor Information

- Instructor: [Dr. Axel Schülzgen](#)
- Office Location: Room A115, CREOL Building
- Office Hours: Monday 1:00 - 3:00 p.m.

I will be in my office at these times, but of course I will be happy to discuss the material with you anytime. Often, I get questions via e-mail that can be quickly answered, typically within 24 hours.

- Phone: 407-920 8509
- Digital Contact: axel@creol.ucf.edu or [Webcourses@UCF](#) messaging

Teaching Assistants

- GTA(s): TBD
- Email: TBD

Course Information

- Term: Fall Semester 2022
- Course Number & Section: OSE 5525
- Course Name: Laser Engineering
- Credit Hours: 3 Credit Hours
- Class Meeting Days: Monday/Wednesday
- Class Meeting Time: 9:00-10:15 a.m.
- Class Location: CREOL 102 and Online
- Course Modality: P and V

Enrollment Requirements

Course Prerequisites (if applicable): Graduate standing or consent of instructor

Course Co-requisites (if applicable): None

Other Enrollment Requirements (if applicable): None

Course Description

This course is titled “Laser Engineering” but could as well have been titled “Laser Principles”. It is an introductory course in lasers, so in fact there is more “Laser Principles” and little “Engineering” in it. The chief purpose is for students to obtain a solid understanding of the basic principles of lasers and to be familiar with the operation of most common laser types. The course is taught in the classical approximation, so a knowledge of quantum mechanics is not required. This course is being taught to satisfy the requirements of the optics Ph.D. curriculum.

Course Materials and Resources

Required Materials/Resources

- “Principles of Lasers”, Orazio Svelto, 5th edition, (Springer)
Reading assignments will be taken from this textbook.
- Computer with microsoft office and internet access
- Calculator

Optional Materials/Resources

- Other useful reference books:
“Laser Electronics”, J. Verdeyen, (Prentice-Hall)

“Laser Fundamentals” W. T. Silfvast, (Cambridge)

“Lasers” A.E. Siegman

“Optical Electronics in Modern Communications”, 5th edition, A. Yariv, (Oxford)

Almost any other text titled “...Lasers...” will probably provide insight on the topic.

- Smartphone with internet access

Third-Party Accessibility and Privacy Statements

The content of the course is limited to the students participating in the course. Regarding privacy we will follow the American Physical Society (APS) policy. For the terms of use, please visit the [APS website](#).

Student Learning Outcomes

The primary learning outcomes are:

- To understand the laser idea and learn about the history of laser development and applications.
- To contrast properties of laser and thermal radiation.
- To become conversant with the Einstein treatment of absorption and emission.
- To describe absorption and emission line shapes and relate them to specific broadening mechanisms.
- To understand absorption saturation and explain resulting changes in the optical spectra.
- To demonstrate knowledge about the energy levels of atoms molecules and ions and to explain the resulting absorption and emission spectra.
- To describe laser media with rate equations, and to solve these.
- To calculate the lasing threshold and the continuous wave laser output powers for a set of given resonator parameters.
- To calculate how Gaussian beams propagate in free space and how they are focused.
- To determine stability of laser cavities and calculate Gaussian laser cavity modes.
- To distinguish between laser emission and amplified spontaneous emission.
- To understand possible laser pumping mechanisms and estimate their efficiencies
- To understand and calculate pulsed laser outputs.
- To calculate the minimum length of a laser pulse.
- To describe absorption and gain spectra of semiconductor structures.
- To be knowledgeable about the principles of operation of the most common laser types.

Course Activities

Most people learn things for themselves. As a teacher, it is my job to help you learn the material. To help you learn in depth, I plan to use some class time for detailed discussion of concepts and group project work. Credit will be given for these activities. These types of activities require that students carry out reading assignments prior to class. Hence, I will occasionally set quizzes to ensure that students come to class prepared. In addition, lectures will be posted here prior to the scheduled lecture time to allow students to create write their individual class notes during the lecture and/or prepare questions prior to the lecture.

In addition, homework will be assigned on a regular basis to help the students to accomplish the student learning outcomes. The homework will be graded to assess the students' progress in learning. Homework questions and solutions will be posted under Files/Homework. The major assessment of student learning outcomes will be two midterm exams and a final exam. In total, these exams will account for 75% of the grade. Solutions and grading criteria will be posted under Files/Exams. Grades of homework and exams will be available within one week from submission.

To be prepared for class, submit your homework assignments, and study for the exams, students should plan on at least five hours' worth of work outside of class each week.

Activity Submissions

Assignments will be submitted electronically via email or through Webcourses@UCF submission. The pdf-file format is preferred. Other file formats can be accepted if the files can be easily opened and are readable.

Attendance/Participation

This course will be taught both face-to-face and through Zoom for online students and the review of recorded lectures.

Please take the time to familiarize yourself with Zoom by visiting the [UCF Zoom Guides](https://cdl.ucf.edu/support/webcourses/zoom/) at [<https://cdl.ucf.edu/support/webcourses/zoom/>](https://cdl.ucf.edu/support/webcourses/zoom/). You may choose to use Zoom on your mobile device (phone or tablet).

Things to Know About Zoom:

- You must sign in to my Zoom session using your UCF NID and password.
- The Zoom sessions are recorded.
- Improper classroom behavior is not tolerated within Zoom sessions and may result in a referral to the Office of Student Conduct.
- You can contact Webcourses@UCF Support at [<https://cdl.ucf.edu/support/webcourses/>](https://cdl.ucf.edu/support/webcourses/) if you have any technical issues accessing Zoom.

It is strongly encouraged to attend lectures at the scheduled time. However, this is not a strict requirement. With prior approval, students will not be penalized for missing in-class activities such as group discussion or quizzes.

All students are expected to take the mid-term and final exams at the time that is provided in the schedule. Reasons for exceptions may include illness, serious family emergencies, military obligations, and severe weather conditions.

Make-up Exams and Assignments

Per university policy, you are allowed to submit make-up work (or an equivalent, alternate assignment) for authorized university-sponsored activities, religious observances, or legal obligations (such as jury duty). If this participation conflicts with your course assignments, I will offer a reasonable opportunity for you to complete missed assignments and/or exams. The make-up assignment and grading scale will be equivalent to the missed assignment and its grading scale. In the case of an authorized university activity, it is your responsibility to show me a signed copy of the Program Verification Form for which you will be absent, prior to the class in which the absence occurs. In any of these cases, please contact me ahead of time to notify me of upcoming needs.

Assessment and Grading Procedures

The table shows the weight distribution for each assignment.

Assignment	Percentage of Grade
In-class participation	5%
Homework	20%
1st midterm exam	20%
2nd midterm exam	20%
Final exam	35%
Total	100%

The table shows the range for each letter grade and uses a plus/minus system.

Letter Grade	Points
A	90 – 100 points
A-	85 – 89 points
B+	80 – 84 points
B	75 – 79 points
B-	70 – 74 points
C+	65 – 69 points
C	60 – 64 points
C-	55 – 59 points
D+	50 – 54 points
D	45 – 49 points
D-	40 – 44 points
F	39 and below

Consult the latest Graduate [catalog](#) for regulations and procedures regarding grading such as Incomplete grades, grade changes, and grade forgiveness.

Course Schedule

The detailed schedule of lectures and exams can be found [here](#).

DAY	DATE			
Mo	8/22/2022	Lecture 1	Introduction	Introduction, history, the laser idea
We	8/24/2022	Lecture 2	Int'n radiation/atoms & ions	Properties of laser light & laser applications
Mo	8/29/2022	Lecture 3	Int'n radiation/atoms & ions	Blackbody radiation, Planck's theorem
We	8/31/2022	Lecture 4	Int'n radiation/atoms & ions	Absorption & emission, relation between Einstein coefficients
	9/5/2022		Labor Day	
We	9/7/2022	Lecture 5	Int'n radiation/atoms & ions	Lineshapes, Lorentz model
Mo	9/12/2022	Lecture 6	The laser	Homogeneous and inhomogeneous broadening mechanisms
We	9/14/2022	Lecture 7	The laser	Saturation of inhom. broadened lines, spectral hole burning
Mo	9/19/2022	Lecture 8	The laser	ASE Energy levels: atoms, molecules, solid-state
We	9/21/2022	Lecture 9	The laser	2, 3, and 4-level lasers
Mo	9/26/2022	Lecture 10	The laser	Continuous wave operation, optimum output coupling
We	9/28/2022	Lecture 11	Recap	Space independent model, Recap
Mo	10/3/2022		Midterm 1	Light interaction with matter: The Laser
We	10/5/2022	Lecture 12	Modes in lasers	Paraxial beams, modes, ABCD matrices, resonator stability
Mo	10/10/2022	Lecture 13	Modes in lasers	Gaussian beams, higher order modes
We	10/12/2022	Lecture 14	Modes in lasers	Passive resonators, eigenmodes, stability
Mo	10/17/2022	Lecture 15	Modes in lasers	multiple modes, unstable resonators, Fabry-Perot interferometer
We	10/19/2022	Lecture 16	Modes in lasers	Longitudinal modes, cavity Q
Mo	10/24/2022	Lecture 17	Pumping	Electrical and optical pumping
We	10/26/2022	Lecture 18	Pulsed lasers	Transient behavior, relaxation oscillation
Mo	10/31/2022	Lecture 19	Pulsed lasers	Q-switching
We	11/3/2022	Lecture 20	Pulsed laser	Mode-locking
Mo	11/7/2022	Lecture 21	Recap	Measurement of laser dynamics, recap
We	11/9/2022		Midterm 2	Modes and laser dynamics
Mo	11/14/2022	Lecture 22	Semiconductor lasers	Electronic structure of semiconductors
We	11/16/2022	Lecture 23	Semiconductor lasers	Optical spectra of semiconductors
Mo	11/21/2022	Lecture 24	Semiconductor lasers	Semiconductor diodes, quantum well lasers and VCSELs
	11/23/2022		Thanksgiving Wednesday	
Mo	11/28/2022	Lecture 25	Selected laser types	Selected lasers: vibronic, excimer, fiber lasers, free electron lasers
We	11/30/2022	Lecture 26	Selected laser types	Selected lasers: vibronic, excimer, fiber lasers, free electron lasers
		Final Exam	12/5/2022 - 12/11/2022 TBD	

University Services and Resources

Academic Services and Resources

A list of available academic support and learning services is available at [UCF Student Services](#). Click on "Academic Support and Learning Services" on the right-hand side to filter.

Non-Academic Services and Resources

A list of non-academic support and services is also available at [UCF Student Services](#). Click on "Support" on the right-hand side to filter.

If you are a UCF Online student, please consult the [UCF Online Student Guidelines](#) for more information about your access to non-academic services.

Policy Statements

[Academic Integrity](#)

Students should familiarize themselves with [UCF's Rules of Conduct](#). According to Section 1, "Academic Misconduct," students are prohibited from engaging in:

- *Unauthorized assistance*: Using or attempting to use unauthorized materials, information or study aids in any academic exercise unless specifically authorized by the instructor of record. The unauthorized possession of examination or course-related material also constitutes cheating.
- *Communication to another through written, visual, electronic, or oral means*: The presentation of material which has not been studied or learned, but rather was obtained through someone else's efforts and used as part of an examination, course assignment, or project.
- *Commercial Use of Academic Material*: Selling of course material to another person, student, and/or uploading course material to a third-party vendor without authorization or without the express written permission of the university and the instructor. Course materials include but are not limited to class notes, Instructor's PowerPoints, course syllabi, tests, quizzes, labs, instruction sheets, homework, study guides, handouts, etc.
- *Falsifying or misrepresenting* the student's own academic work.
- *Plagiarism*: Using or appropriating another's work without any indication of the source, thereby attempting to convey the impression that such work is the student's own.
- *Multiple Submissions*: Submitting the same academic work for credit more than once without the express written permission of the instructor.
- *Helping another violate* academic behavior standards.

For more information about Academic Integrity, students may consult [The Center for Academic Integrity](#).

For more information about plagiarism and misuse of sources, see “[Defining and Avoiding Plagiarism: The WPA Statement on Best Practices](#)”.

Responses to Academic Dishonesty, Plagiarism, or Cheating

Students should also familiarize themselves with the procedures for academic misconduct in UCF’s student handbook, [The Golden Rule](#). UCF faculty members have a responsibility for students’ education and the value of a UCF degree, and so seek to prevent unethical behavior and when necessary respond to academic misconduct. Penalties can include a failing grade in an assignment or in the course, suspension or expulsion from the university, and/or a "Z Designation" on a student’s official transcript indicating academic dishonesty, where the final grade for this course will be preceded by the letter Z. For more information about the Z Designation, see <http://goldenrule.sdes.ucf.edu/zgrade>.

[Course Accessibility Statement](#)

The University of Central Florida is committed to providing access and inclusion for all persons with disabilities. This syllabus is available in alternate formats upon request. Students with disabilities who need specific access in this course, such as accommodations, should contact the professor as soon as possible to discuss various access options. Students should also connect with [Student Accessibility Services](#) (Ferrell Commons, 7F, Room 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.

[Campus Safety Statement](#)

Fully online course sections (W, V)

Though most emergency situations are primarily relevant to courses that meet in person, such incidents can also impact online students, either when they are on or near campus to participate in other courses or activities or when their course work is affected by off-campus emergencies. The following policies apply to courses in online modalities.

- To stay informed about emergency situations, students can sign up to receive UCF text alerts by going to <<https://my.ucf.edu>[Links to an external site.](#)> 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.

Sections with face-to-face components (M, RA, RV)

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.htmlLinks to an external site.>.
- 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>Links to an external site.> (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>Links to an external site.> 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 [You CAN Survive an Active Shooter](#)

Deployed Active Duty Military Students

Students who are deployed active duty military and/or National Guard personnel and require accommodation should contact their instructors as soon as possible after the semester begins and/or after they receive notification of deployment to make related arrangements.

Copyright

This course may contain copyright protected materials such as audio or video clips, images, text materials, etc. These items are being used with regard to 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.

Third-Party Software and FERPA

During this course you might have the opportunity to use public online services and/or software applications sometimes called third-party software such as a blog or wiki. While some of these could be required assignments, you need not make any personally identifying information on a

public site. Do not post or provide any private information about yourself or your classmates. Where appropriate you may use a pseudonym or nickname. Some written assignments posted publicly may require personal reflection/comments, but the assignments will not require you to disclose any personally identity-sensitive information. If you have any concerns about this, please contact your instructor.