OSE 6525 – Laser Engineering

Instructor:
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Class Hours:
Tuesday, Thursday 10:30 – 11:45 am in CREOL 102

Office Hours: Tuesday-Thursday 1:30-2:30pm
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.

Course description and learning outcomes:
This course could have been titled "Laser Principles." It is an introductory course in lasers, so in fact there is 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 and qualifying exam.
The primary ***learning outcomes*** are:

- To understand the difference between laser and thermal radiation.
- To become conversant with the Einstein treatment of absorption and emission and to be able to describe laser media with rate equations, and to solve these.
- To understand gain saturation and broadening and to calculate cw laser output powers.
- To determine stability of laser cavities and calculate Gaussian laser cavity modes, as well as how they propagate in free space and how they are focused.
- To understand and calculate pulsed laser outputs.
- To be knowledgeable about the principles of operation of the most common laser types.

Topics:
Introduction and history (1)

Ray tracing in an optical system (2)
Ray matrix
Ray tracing in optical cavities
Stability

Gaussian beam (3)
TEM waves (fundamental and higher orders)

ABCD laws for Gaussian beams

Gaussian beam- cavity modes (4,5)
Gaussian beams in stable resonators
Mode volume
Transverse and spatial modes of the cavity

Resonant optical cavities (6,7)
Resonance, Q, Finesse
Fabry-Perot cavity
Photon lifetime
Examples

Laser beam properties (8)
Coherence
Beam divergence
Applications

Atomic radiation (9-11)
Blackbody radiation
Einstein A and B coefficients
Rate equations
Lineshape and broadenings
Amplification by an atomic system
Broadening of spectral lines- Homogenous and Inhomogenous

First Midterm Exam (27th Sep. 2018)

Laser oscillation and amplification (13-15)
Threshold condition
Laser oscillation in homogenous medium
Laser oscillation in inhomogenous medium
Amplified spontaneous emission

General characteristics of lasers (16-18)
Efficiency
N-level lasers
Ring lasers
Optimum coupling
Laser pumping

Examples and preparation for the second midterm (19)

Second Midterm Oct. 25, 2018

Laser dynamics (21-25)
Transient behavior: relaxation oscillation
Q-switching
Mode locking
Measurement of laser dynamics

Semiconductor lasers (26,27)
band structure & density of states
Absorption and gain spectra, low-dimensional semiconductors
Semiconductor diodes, homojunction and heterojunction lasers
Quantum well lasers and VCSELs

Laser excitations (28,29)
Crystalline lasers
Glass and fiber lasers
Gas lasers: amplification in atoms, ions and molecules

Final Exam Tuesday, December 4, 2018 10:00 AM – 12:50 PM

Textbook:

"Laser Electronics", J. Verdeyen, (Prentice-Hall)- Third Edition
Reading assignments will be taken from this textbook.

Other useful reference books:

"Lasers" A.E. Siegman
"Optical Electronics in Modern Communications", 5th edition, A. Yariv, (Oxford)
"Laser Fundamentals" W. T. Silfvast, (Cambridge)
"Principles of Lasers", Orazio Svelto, 5th edition, (Springer)
Almost any other text titled "…Lasers…" will probably provide insight on the topic.

Class Website:

http://webcourses.ucf.edu
This site will provide latest changes and contain homework and reading assignments.

Teaching and Learning

Most people learn things for themselves. As a teacher, my job is to help you learn the material. In order 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 actually carry out reading assignments prior to class. Hence I will occasionally set quizzes to ensure that students come to class prepared.

Grading Policy:

Homework	15%
Quizzes	5%
Class participation	5%
Two mid-terms, each worth	20% for a total of 40%
Final exam	35%

Grading Scale:

90-100 A
80-89 B
70-79 C

60-69 D
0 - 59 F

Academic Activity:
As of Fall 2014, all faculty members are required to document students' academic activity at the beginning of each course. In order to document that you began this course, please complete the following academic activity by the end of the first week of classes, or as soon as possible after adding the course, but no later than August 28. Failure to do so will result in a delay in the disbursement of your financial aid.

Assignment: In a paragraph, explain why you are taking laser engineering course? Deadline for this assignment is August 28th 2017.

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 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.