OSE 6525 – Laser Engineering

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

Office Hours:  
Monday, Wednesday 11-12  
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:  
Review of electromagnetic theory  
Maxwell Equations  
Wave equations: in free space, in dielectrics, and in anisotropic media  
Coherent EM waves  
Ray tracing in an optical system  
Ray matrix  
Ray tracing in optical cavities  
Stability
**Gaussian beam**
- TEM waves (fundamental and higher orders)
- ABCD laws for Gaussian beams
- Gaussian beams in stable resonators
- Mode volume

**Resonant optical cavities**
- Resonance, Q, Finesse
- Fabry-Perot cavity
- Photon lifetime

**First Midterm Exam**

**Atomic radiation**
- Blackbody radiation
- Einstein A and B coefficients
- Rate equations
- Lineshape
- Amplification by an atomic system
- Broadening of spectral lines- Homogenous and Inhomogenous

**Laser oscillation and amplification**
- Threshold condition
- Laser oscillation in homogenous medium
- Laser oscillation in inhomogenous medium
- Amplified spontaneous emission

**General characteristics of lasers**
- Efficiency
- N-level lasers
- Ring lasers
- Optimum coupling

**Second midterm exam**

**Laser dynamics**
- Transient behavior: relaxation oscillation
- Q-switching
- Mode locking

**Laser excitations**
- Crystalline lasers
- Glass and fiber lasers
- Gas lasers: amplification in atoms, ions and molecules

**Semiconductor lasers:**
- Band structure & density of states
- Absorption and gain spectra, low-dimensional semiconductors
- Semiconductor diodes, homojunction and heterojunction lasers
- Quantum well lasers and VCSELs

**Final Exam**

**Textbook:**
- Reading assignments will be taken from this textbook.

**Other useful reference books:**
“Lasers” A.E. Siegman
“Laser Fundamentals” W. T. Silfvast, (Cambridge)
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 and class participation 5%
Two mid-terms, each worth 25% for a total of 50%
Final exam 30%

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.