Special Topic: Semiclassical Laser Theory

College of Optics and Photonics
College of Graduate Studies, University of Central Florida

COURSE SYLLABUS

Instructor:	Dr. Eric Van Stryland	Term:	Fall 2017
Office:	CREOL Room 271	Class Meeting Days:	T / Tr
Phone:	407-823-6835 cell: 407-222-1389	Class Meeting Hours:	10:30 AM
E-Mail:	ewvs@ucf.edu	Class Location:	CREOL 0266
Website:	CREOL.ucf.edu	Lab Location:	N/A
Office Hours:	TBD	Credit Hours:	3

I. Welcome!

II. University Course Catalog Description

This course follows "Laser Principles" or "Laser Engineering" where you learned the classical description of the interaction of light with matter and laser operation. We will use semiclassical laser theory, (i.e., we will quantize the matter but not the field, and use Maxwell's equations), introduce field quantization, which allows for a fully quantum mechanical treatment of quantum electrodynamics, and Q.E.D., where both the matter and field are quantized.

III. Course Prerequisites

Prerequisites for this course should be the first semester of a graduate level quantum mechanics course and electromagnetics course (not just statics). Also some course covering "Laser Engineering"/Physics" (eg. Silfvast, Yariv, Verdeyen or ?) and some course discussing the "Interaction of light with Matter" should have been taken. Exceptions are possible but should be discussed with me.

IV. Required Texts and Materials

"Elements of Quantum Optics", 4th, (3rd or 2nd) edition, P. Meystre and M. Sargent III, Springer Verlag, 1991

V. Supplementary (Optional) Texts and Materials

"Laser Fundamentals", William T. Silfvast, Cambridge University Press
"Intro. to Quantum Electronics", Amnon Yariv, Wiley
"Laser Physics", Sargent, Scully, Lamb; Addison Wesley
"Laser Electronics", Verdeyen, Prentice Hall
"Quantum Electronics", Amnon Yariv, Wiley
"Lasers", Anthony Seigman, University Science Books
"Optical Resonance and 2-Level Atoms", Allen and Eberly, Wiley
"Principles of Quantum Electronics", Dietrich Marcuse, Academic Press
"Laser and Coherence Spectroscopy, J.I. Steinfeld, (section by R.L. Shoemaker), Plenum Press

VI. Course Objectives

This course follows "Interaction of Light with Matter" or "Optical Properties of Materials" where you learned the classical description of the interaction of light with matter and laser operation (rate equations, Gaussian beam propagation, resonator theory, gain, loss, dispersion...). The text used there was e.g., Silfvast, Yariv, Verdeyen . .

We will "do" semiclassical laser theory, (i.e., we will quantize the matter but not the field, and use Maxwell's equations). While the title says “Laser”, it is much broader and of use for other problems in optics/photonics and nonlinear optics. If we have time, we will introduce field quantization. The extension of this course is the fully quantum mechanical treatment of quantum electrodynamics, Q.E.D., where both the matter and field are quantized.

Topics to be covered in this course are:	Tentative Schedule:
Atom field interaction	Chap. 1-3
2-level atoms	Basic E&M for Optics
Rabi flopping	Basic Quantum Mechanics for Optics
Fermi's Golden Rule	2-level atom
State vector	Fermi's Golden Rule
Density matrix	Test in class, closed book
pure case	
mixed case	Chap. 4-6
Coherent optical transients	Density matrices
optical nutation	Rate equations
optical free-induction decay	Laser physics
photon echo	Chap. 8,10,11 Coherent transients Pulses
Single-mode laser theory rate equations	Propagation
Multimode operation	Test, take home, comprehensive
Q-switching	Saturation spectroscopy
relaxation oscillations	Multimode lasers
mode locking	3-level atoms
Doppler broadening (gas laser)	Field quantization?
Pulse propagation	
+ other topics of interest	Test, in class final, open book, comprehensive

VII. Basis for Final Grade

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

Assessment	Points
Midterm exam 1	25%
Midterm exam 2	25%
Final exam	30%
Homework + quizzes	20%
Total points	100%

Homework is due 1 week after assigned.
I expect you to work independently on the homework and then discus the homework with your colleagues whether or not you were able to complete the assignment. If you did complete it you will learn better by showing others. If you couldn’t complete it you should learn from others.
Tests are to be done independently.

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.

VIII. 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.

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