EE 540 SYLLABUS – Spring 2009

Course Title:	Introduction to Quantum Electronics
University:	University of Southern California
Credit Given at University:	3 Semester Units
Number of Lectures Hours:	36 Hours Lecture
Days Class Meets on Campus:	Mon./Wed. 2:00-3:20 PM
Term Normally Offered on Campus:	Spring
Instructor:	Robert W. Hellwarth Professor of Electrical Engineering & Professor of Physics
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Prerequisite:	An Undergraduate Course in Electromagnetics
Textbook:	J.T. Verdeyen, Laser Electronics, (third edition) Prentice Hall, Englewood Cliffs, New Jersey. The course will concentrate on chapters 7 through 11.

Course Level at Your University: Please Check One

300 Level – A Bridging course, not available for credit at your institution.
X 500 Level – A Mezzanine course, available for graduate credit outside the home dept.
600 Level – A Mezzanine course, available for graduate credit within the home dept.
700 Level – A graduate course primarily available to graduate students in the home dept.

Course Description:

Many of the properties and interactions of light can be understood by considering that light is composed of photons which are particles that have energy hf (h=Planck's constant and f is the frequency of the light in Hz), Much of the coherence properties of laser light can be understood from thinking of a photon as a quantum of excitation of a particular mode of the electromagnetic field. The atoms (ions, molecules, etc.) which emit or absorb these photons can be thought of as existing only in "quantized" states, each of which has a particular energy E_i (i=1,2,…). In this course we derive all the most important quantitative features of laser oscillators and amplifiers by compounding many events in which an atom makes a transition from state i to state j while absorbing (or emitting) a photon of frequency f according to Planck's law: $E_j - E_i = hf$. These absorption and emission processes are described by simple rate equations for three radiative processes: 1) absorption of a photon, 2) spontaneous emission of a photon and 3) stimulated emission (the SE of LASER) of a photon. Nonradiative relaxation and "pumping" rates are added from physical reasoning to complete a general theory of lasers. We then apply these concepts to understand the pump requirements, average output powers, peak powers and pulse widths under Q-switching and mode locking, for a variety of commonly used lasers. The last five weeks, and five homework assignments, will be devoted to semiconductor lasers. Only elementary differential equations need to be solved to obtain the wide range of important practical formulae which we will develop.

Course Requirements: None

Homework:

Papers are due each Monday in the class except as noted on p. 3. Each assignment will be graded and returned with written solutions. The lowest grade will be omitted from calculating the overall homework grade, which will be assigned on the basis of the class curve (from F to A+, i.e., 0 to 4.3).

Examinations:

One midterm and one final examination. Grades from 0 – 4.3 will be assigned using the class curve. The final course grade G will be computed using the formula:

$$G = [\text{homework}]/4 + [\text{midterm}]/4 + [\text{final}]/2$$

Computer Language(s): N/A

Computer Facilities: N/A

Laboratory: N/A

Projects: None

Calendar: Spring 2009

University Holidays: January 19
February 18
March 16-21

First Class: January12

Last Class: May 4

Midterm Exam: March 2, during class period.

Final Exam: May 11, 2:00 – 4:00 PM

Homework

First Week: Read Sections P,C,L & O, plus pp.172-187 (Sections 7.1 to 7.4) and Class Notes I. Do problem 7.1, plotting the number of modes whose frequency is below ν (Hz) for ν between 0 and 10 GHz, by the two methods specified*.
Because Monday, January 19 is a holiday, the first homework is due Wednesday, January 21.

Second Week: Read pp. 187-200
Do problem 7.5, 7.6, and 7.7 (HW#2).
This homework will be due Wednesday, January 28.

Third Week: Read pp. 207-209
Do problem 7.12 and 7.13 (HW#3)
This assignment is due Monday, February 2.

*Replace the cavity dimensions specified in the text by $a = 1cm$, $b = 8\,cm$, and $c = 12cm$.