PEP 577 Laser Theory and Design

Department of Physics and Engineering Physics
Stevens Institute of Technology
Semester: Fall 2017

Schedule: Mondays 6:15-8:45pm,

Room: North Building 101

Instructor: Prof. Christopher Search

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Office: Buchard 609
Office Hours: Monday 3:00-5:00pm or by appointment
Phone: (201) 216-5626.

Required Textbook

Laser Physics 1st Ed. by Peter W. Milonni and Joseph H. Eberly, Wiley, 2010. (ISBN-13: 978-0470387719)

Recommended Supplementary Textbooks

(These are not required but may be helpful if you want to pursue a topic in more depth.)

1. *Laser Physics* by Murray Sargent III, Marlan O. Scully, and Willis E. Lamb Jr. (Westview Press, 1978). This is a classic text. Requires a more advanced knowledge of quantum mechanics.
2. *Lasers* by Anthony E. Siegman (University Science Books, 1986). An exhaustive encyclopedic work on lasers.
3. *Fundamentals of Photonics 2nd ed.*, B. E. A. Saleh and M. C. Teich (Wiley, 2007). An excellent reference for all areas of modern optics (This text is also used for PEP 578.)

Grading Procedure

Grades are calculated from a weighted average of homework and exams. The various components of your grades have the following weights:

Take Home Final Exam…………………..22%
Take Home Midterm Exam…………..…...22%
Homework (11 of them)…………………..44%
Final Paper………………………………...10%
Lecture Participation………………………2%

Homework will be assigned weekly and will consist of 3-4 problems. Each HW problem will be graded on a scale of 0-10 (0=no attempt made; 10=100% correct). I will drop the lowest HW score and only use the best 10 of 11 for the final grade.

The final paper should describe in detail the physics and design considerations of a particular type of laser system. The paper should go beyond the level of what is covered in class and include at least six references. The minimum length of the paper is 4 pages at double spacing and 12 point font. Figures, while desirable, do not count towards the 4 page minimum.

The take home exams will be posted on the course Canvas page on Saturday afternoon and are to be turned in at the beginning of class the following Monday.

Final letter grades will be calculated based on the following distribution:

Letter Grade:	% Grade:
A	90-100%
A-	85-89.9%
B+/B/B-	70-84.9%
C+/C/C-	50-69.9%
D+/D/D-	30-49.9%
F	<30%

Canvas

All lecture slides and homework solutions will be posted on Canvas. Take home exams will also be posted here. Canvas will also be used for all announcements. Please check the course's Canvas page regularly.

Lecture Schedule

Week	Textbook Chapter	Topics
1	1	An overview of laser physics and operation
2	2	A brief introduction to quantum theory, atoms, and molecules.
3	3	Classical oscillator model of atoms, absorption and emission of light, Einstein rate equations, thermal radiation
4	3	Homogenous and inhomogeneous broadening; Voigt profile; absorption and gain coefficients; index of refraction
5	4	Gain, feedback, and lasing threshold condition; photon and population rate equations; 3-level laser.
6	4	4-level laser, pumping, saturation, hole burning
7	5	Output coupling, effect of spatial hole burning, inhomogenously broadened gain media.
8	5	Spectral hole burning, frequency pulling, laser linewidth, single mode operation, laser threshold phase transition.
9	6	Relaxation oscillations; Q-switching; Mode locking
10	7	Ray matrices; resonator stability; Gaussian beams
11	7	ABCD law of Gaussian beams; Hermite-Gaussian and Laguerre-Gaussian beams; apertures; beam quality
12	11	Electron impact excitation, HeNe laser, Argon ion laser, CO_2 laser, dye lasers, and chemical lasers
13	11	Optically pumped solid state lasers; Ultrafast lasers
14	15	Semiconductor lasers