UWM, Dept. of EECS

EE 490, Section 002
EE 890, Section 002
Introduction to Lasers

Fall 2017

Prerequisites: EE361 or instructor's consent

Course description:

Principles of laser amplification and oscillation; properties of laser beam; applications and characteristics of certain systems in particular gaseous lasers and solid-state lasers.

Course goal: Understand the factors affect laser beam properties and various schemes in laser design. Acquire skill to analyze performance of laser systems from typical data and operation parameters.

Time and place: MW 3:30-4:15PM, EMS E206

Instructor: Dr. Chiu-Tai Law
Office: EMS 1039
Phone: 229-6203
Email:lawc@uwm.edu
Office Hours: MW 11:00AM-3:00PM, TR 3:00-4:30PM

Homepage for the course: http://scylla.ceas.uwm.edu/890

Required Textbook:
B. E. A. Saleh and M. C. Teich, *Fundamentals of Photonics*, 2nd Ed., Wiley-interscience, New York, 2007.

Recommended books:
Kelin Kuhn, *Laser Engineering,* Prentice Hall, Upper Saddle River, New Jersey, 1998.
J. T. Verdeyen, *Laser Electronics,* 3rd Ed., Prentice Hall, Englewood Cliffs, New Jersey, 1995.
Jeff Hecht, *Laser Guidebook*, 2nd Ed., McGraw Hill, New York, 1992.

Homework:

Problem sets are assigned every week and due on the Thursday at 5PM in the following week. Students can submit their homework via email (make sure that your homework is eligible and is in one pdf or word file). Homework submitted 24 hours late will not be accepted. 10% of points will be deducted for late homework. No late homework will be accepted when the mid-term test is coming. Graduate students will be assigned additional problems.

Tests and exam:

One mid-term and one final will be given during the semester for all students. Graduate students are required to do different and/or additional problems for examinations. No makeup exam if the instructor is not notified before the scheduled exam. Each student will choose a project. Detailed requirements and possible topics will be described later in a handout. In summary, a proposal and progress report will be due in the middle of the semester. At the end of semester, each student is required to give 15 minutes

presentation and submit a final report.

Grading:

Assignments (homework and class work)	15%
In class assignments and attendance	5%
Mid-term (Oct. 18)	25%
Final (Dec. 19)	25%
Project [proposal (Oct. 11), progress (Nov. 15), draft of final report (Dec. 4) & final report (Dec. 122) and presentation (WEEK 15)]	30%
	100%

Student conduct and rights:

According to academic misconduct regulations, Chapter UWS 14, cheating in examinations and copying assignments are prohibited. Serious misconduct can result in probation, suspension or expulsion. Details for this and other policies as well as rights can be found in the following document on the web:
http://uwm.edu/secu/wp-content/uploads/sites/122/2016/12/Syllabus-Links.pdf.

Extra-credit exercise:

Extra-homework problems will be given from time to time.

Course Outline

(Note: this schedule may subject to changes according to the real needs of students.)

WEEK 1: Sept. 6
Introduction. Brief overview of the lasers and related concepts.
Chapter 15 introduction, sec 15.1 and Chapter 1 of ‘‘Laser Engineering’’.

WEEK 2: Sept. 11 and 13
Review of the electromagnetic theory; wave propagation in isotropic and laser media.
Chapter 5.

WEEK 3: Sept. 18 and 20
Review of the electromagnetic theory; wave propagation in isotropic and laser media.
Review of ray optics (lens) and ray matrices; Fresnel equations for transmission and reflection.
Chapter 1.

WEEK 4: Sept. 25 and 27
Review of ray optics (lens) and ray matrices; Fresnel equations for transmission and reflection.
Paraxial wave and interference; Longitudinal modes in resonant cavity and Fabry-Perot etalon.
Chapter 2 and 10.1.

WEEK 5: Oct. 2 and 4
Resonance of reflection and transmission in Fabry-Perot etalon.
Paraxial wave equation and Gaussian beam (or TEM) propagation; high order modes.
Chapter 3.

WEEK 6: Oct. 9 and 11
Proposal due on Oct. 11.
Spherical-mirror resonators and Gaussian beam.
Gain and blackbody radiation.
Chapters 10.2, 13

WEEK 7: Oct. 16 and 18
Gain and blackbody radiation, review for mid-term test.
Mid-term test, Oct. 18.
Chapter 13.

WEEK 8: Oct. 23 and 25
Laser systems and linewidth.
Gain coefficient and population difference,
Chapter 14.

WEEK 9: Oct. 30 and Nov. 1
Gain saturation and rate equations.
Laser oscillation and Laser output power.
Chapter 14 and 15.1, 15.2.

WEEK 10: Nov. 6 and 8
Modeling of relaxation oscillations; Q-switching; Mode locking.
Chapter 15.4 and notes.

WEEK 11: Nov. 13 and 15
Progress report due Nov. 15.
Semiconductor lasers.
Portions of chapters 16 and 17.

WEEK 12: Nov. 20
Gaseous Lasers: He-Ne, Argon Ion lasers.
Optically-pumped solid state lasers: Ruby, Nd-YAG.
Sec. 15.3 and notes.

WEEK 13: Nov. 27 and 29
Applications of nonlinear optics in lasers.
Notes and portions of Chapter 21.

WEEK 14: Dec. 4 and 6
Draft of final report due Dec. 4.
Femtosecond lasers.
Portions of Chapter 22.

WEEK 15: Dec. 11 and 13
Review.
Student presentations (may need to schedule on other days outside the lecture period, such as on Dec. 15 (study day), to accommodate the number of student presentations).

WEEK 16: Dec. 19
Final exam. (Dec. 19, 12:30 - 2:30 PM)
Final report will be due on Dec. 22 at noon.