UWM, Dept. of EECS

EE 318-766, Lec 001
Introduction to Nonlinear Optics

Spring 2014

Prerequisites: Undergraduate electromagnetics and graduate status

Course description:

Introduce various nonlinear optical processes that find applications in optical communications, signal processing and computing; in particular, optical switching devices, optical mixers, and solitons.

Course goal: 1) Understand the conventions and technical terms in the nonlinear optics literature. 2) acquire analytical and numerical technique for analysis of nonlinear systems that occur in the field and be able to judge the technical merits of various schemes for making a device.

Time and place: M 4:30-7:10pm, EMS E170

Instructor: Dr. Chiu-Tai Law
Office: EMS 1039
Phone: 229-6203
Email:lawc@uwm.edu
Office Hours: MW 1:00-3:00PM. TR 3:30PM-6:00PM
Homepage of the course: http://scylla.ceas.uwm.edu/766

Required Textbook:
B. E. A. Saleh and M. C. Teich, *Fundamentals of Photonics,* Wiley-interscience, New York, 1991.
or
B. E. A. Saleh and M. C. Teich, *Fundamentals of Photonics,* 2nd Ed. Wiley-interscience, New York, 2007.

References:

1. Robert W. Boyd, *Nonlinear Optics,* Academic Press, New York, 1992. (on reserve in library QC446.2.B69 1992)
2. N. Bloembergen, *Nonlinear optics; a lecture note and reprint volume,* New York, W. A. Benjamin, 1965. (on reserve in library QC355.B62)
3. Y. R. Shen, *The principles of nonlinear optics,* New York, J. Wiley, 1984.

Homework:

Problem sets are assigned weekly and usually due on Tuesday at 5PM in the following week. However, students are encouraged to submit homework at class time. Students can submit their homework by fax (229-6958) or email. For fax submission, student needs to after notify instructor by email or call. Email submission must be in one MSword or pdf file. Homework

submitted two days late will not be accepted. 20% of points will be deducted for late homework.

Tests and project:

One mid-term test and one final will be given during the semester. No makeup tests will be given without prior agreement with the instructor before the date of examinations. Each student will choose a research project. Detailed requirements and possible topics will be described later in a handout. In summary, each student needs to write a proposal (due Mar. 3), a progress report (due Apr. 7) and a draft of the final report (due Apr. 28). At the end of semester, each student is required to give 15-20 minutes presentation (on May 5) and submit the final report (by May 14).

Grading:

Homework	20%
In class assignments	5%
Mid term test and final (Mar. 10 and May 12)	50%
Project (17% report; 8% presentation)	25%
	100%

Student misconduct: 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://www.uwm.edu/Dept/SecU/SyllabusLinks.pdf.

Extra-credit:

Extra-homework problems will be given from time to time. Notice that each item for determining grade cannot go over the prescribed percentage even if students score more points owing to extra-work. However, the excessive points will be considered for students who are on the borderline between grade letters.

Course Outline

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

WEEK 1: Jan. 27
Introduction: electronics counterparts of nonlinear optical devices.
Review: electromagnetic waves -- 5.1-5.4, 2.2

WEEK 2: Feb. 3
Gaussian beam -- 3.1; absorption and dispersion -- 5.5
Pulse propagation in dispersive media -- 5.6

WEEK 3: Feb. 10
Polarization and crystal optics -- Chapter 6

WEEK 4: Feb. 17
Polarization and crystal optics -- Chapter 6
Interference and simple linear optical components -- 2.4-2.5

WEEK 5: Feb. 24

Planar-mirror resonators -- 9.1 (10.1 in 2nd Ed)
Electro-optics -- Chapter 18 (Chapter 20 in 2nd Ed)

WEEK 6: Mar. 3
Electro-optics -- Chapter 18 (Chapter 20 in 2nd Ed)
(no late homework submission)
Proposal due Mar. 3

WEEK 7: Mar. 10
Nonlinear polarization (second order nonlinearity) -- Chapter 19 (Chapter 21 in 2nd Ed) and notes
Mar. 10 mid-term test.

WEEK 8: Mar. 24
Nonlinear polarization (second order nonlinearity) -- Chapter 19 (Chapter 21 in 2nd Ed) and notes

WEEK 9: Mar. 31
Nonlinear wave equation (second order processes) -- Chapter 19 (Chapter 21 in 2nd Ed) and notes
Nonlinear polarization (third order nonlinearity) -- Chapter 19 (Chapter 21 in 2nd Ed) and notes

WEEK 10: Apr. 7
Nonlinear polarization (third order nonlinearity) -- Chapter 19 (Chapter 21 in 2nd Ed) and notes
Processes result from third order nonlinearity -- Chapter 19 (Chapter 21 in 2nd Ed) and notes
Progress report due Apr. 7

WEEK 11: Apr. 14
Processes result from third order nonlinearity -- Chapter 19 (Chapter 21 in 2nd Ed) and notes
Application: photonics switching -- Chapter 21 (Chapter 23 in 2nd Ed)

WEEK 12: Apr. 21
Application: photonics switching -- Chapter 21 (Chapter 23 in 2nd Ed)

WEEK 13: Apr. 28
Application: nonlinear scattering and amplifier in optical fibers.
Ultrafast optics -- Chapter 22 in 2nd Ed
Draft of final report due on Apr. 28

WEEK 14: May 5
Review
Project presentations

WEEK 15: May 12
Final exam on May 12 4:30-6:30pm
Project report due on May 14 noon.