Spring Semester 2014: Physics 606: Nonlinear Optics

Instructor: Lloyd M. Davis
http://spie.org/profile/Lloyd.M.Davis

Format: Live classes at UTSI in the CLA conference room
Live interactive connection via Blackboard collaborate
(to any location with a fast internet connection)

Recordings will be made of Blackboard collaborate sessions for later viewing. Your live participation in Thursday classes is generally expected, unless you provide me with prior notification of a conflict. Extra credit of 5% will be given for live attendance in Thursday classes, with 1% deducted for any class missed without prior arrangement. You are encouraged to attend Monday classes live, but if you choose, you may watch the recording.

Proposed class times: Mondays and Thursdays
UTSI Campus: 8:15–9:30 a.m. Central time;
UTK Campus: 9:15–10:30 a.m. Eastern time;
(may be changed if there is a conflict)

Contact Information & Office Hours:

Students may contact me at any time by e-mail ldavis@utsi.edu, telephone 931-393-7335, or in person regarding questions about the coursework or homework. Formal office hours for the course are scheduled each Monday 11:10 a.m. –12:10 p.m. Central Time, immediately after class, but I am generally available at any time. My office is room 143 in the Center for Laser Applications lab building at UTSI.

Course Objectives:

Develop an in-depth understanding and knowledge of the fundamental principles and applications of nonlinear optics. Learn how to look up needed information and equations and understand how to extend and apply them to new experimental set-ups.

Course Content and Texts:

In this course, we will closely follow "Nonlinear Optics", Third Edition, 2008, by Robert Boyd. You will need to have access to the text and should read the indicated pages before and/or after class to more easily follow the lecture. http://www.amazon.com/Nonlinear-Optics-Third-Edition-Robert/dp/0123694701

Other recommended references:

(1) http://www.amazon.com/Modern-Optics-B-D-Guenther/dp/0471605387
(2) http://www.amazon.com/Nonlinear-Optics-Quantum-Electronics-Applied/dp/0471088072
(3) http://www.amazon.com/Fundamentals-Photonics-Bahaa-E-Saleh/dp/0471358320
(4) http://www.amazon.com/The-Principles-Nonlinear-Optics-Shen/dp/0471430803

Recommended prerequisite courses/background:

There are no required pre-requisite courses enforced by the course registration system, but it is recommended that you have taken previous courses covering the following subjects:
Quantum Mechanics, Maths Methods, Electrodynamics, Classical Optics

Required Instructional Technology:

Students will require access to a computer (laptop, tablet or smartphone may also work). If you are connecting by computer to Blackboard collaborate, your computer will need a microphone and speakers. A calculator is required for homework and exams. The midterm exam will be open-book and may require use of a calculator.

Grading:

Homework assignments:	35 %	(35 problems in total, each worth 1%)
Midterm exam:	40 %	(covers Chapters 1-9)
Final project:	25 %	(discussed below)
Participation:	5 %	(extra credit)

Grade allocation scale:

A	91–100
B+	81–90
B	71–80
C+	61–70
C	50–60
D	40–50
F	< 40

Each homework assignment (1-3 problems, mostly from Boyd) should be scanned and e-mailed to me by the due date posted in the schedule below, which is by 8 a.m. on the next Monday (except for the last homework). I will grade the assignments and post a model answer, which will be discussed during the beginning of the Thursday class. There is a 25% penalty for late assignments turned in after Monday morning but before the Thursday class. Late assignments will not be accepted after the model answer is posted and reviewed. Homework problems must be worked independently (never worked out together with another student) but the lecture notes and the principles needed for working problems may be discussed with other class members or me. Partial credit will be given for partial steps towards completion. The midterm exam must be worked independently, and without discussion with others.

(See pages 16-18 of http://dos.utk.edu/files/Hilltopics2012-2013.pdf for UT policies on plagiarism, receiving or giving assistance, collaborating, etc.)

Planned Course Schedule: (May be adjusted; Current as of December, 2014)

Lec.	Date	Topics	Boyd pages; Sections	Homework	HW Due
1*	Thursday Jan 8	Units, susceptibility, Non-linear processes	1-17; App. A, B, §1.1, 1.2	1.1,1.2,1.3	1/12
2	Monday Jan 12	Nonlinear Susceptibility (nls)	17-33; §1.3, 1.4	1.4	1/19
3*	Thursday Jan 15	Properties of nls	33-52; §1.5	#1	1/19
	Monday Jan 19	No class	MLK day		
4*	Thursday Jan 22	Time domain, Kramers-Kronig	52-63; §1.5, 1.6	1.11	1/26
5	Monday Jan 26	Wave equation, Phase matching	69-88; §2.1-2.4	2.1	2/2
6*	Thursday Jan 29	Manley-Rowe, Frequency mixing, OPOs	88-116; §2.5-2.9	2.5, 2.8, #2,	2/2
7	Monday Feb 2	NLO with Gaussian beams, interfaces	105-128; §2.10-2.11	2.10, 2.18	2/9
8*	Thursday Feb 5	Quantum mechanics theory of susceptibilities	135-169; §3.1-3.5	3.1	2/9
9	Monday Feb 9	QM theory of nonlinear susceptibilities	170-201; §3.6-3.9	3.4, 3.5 (part), #3	2/12
10*	Thursday Feb 12	Intensity dependent refractive index	207-228; §4.1-4.3	4.2	2/16
11	Monday Feb 16	Molecular reorientation, thermal & semiconductor	228-249; §4.4-4.7	4.11	2/23
12*	Thursday Feb 19	Molecular origin of nonlinear Response	253-273; §5.1-5.5	5.2	2/23
13	Monday Feb 23	Two-level approximation	277-327; §6.1-6.6	#4 (saturation), 6.3	3/2
14*	Thursday Feb 26	Self-focusing, Optical phase conjugation	329-359; §7.1, 7.2	7.3	3/2
15	Monday Mar 2	Optical bistability, two-beam coupling, temporal solitons	359-383; §7.3-7.5	7.13	3/9
16	Thursday Mar 5	Spontaneous light scattering, Acoustooptics	391-427; §8.1-8.4	8.1, 8.2, 8.7	3/9
17	Monday Mar 9	Stimulated Brillouin & Raman scattering	429-468; §9.1-9.6	9.1,9.6	3/16
18	Thursday Mar 12	Stimulated Raman scattering; Distribute midterm take-home exam (covers sections 1.1-10.3; due 3/22)	473-488; §10.1-10.3	10.1	3/16
	Monday Mar 16	No class	Spring Break		

	Thursday Mar 19	No class	Spring Break		
19	Monday Mar 23	CARS, Stimulated Rayleigh wing scat	488-508 §10.4-10.6	#5 (CARS microscopy)	3/30
20	Thursday Mar 26	Electro-optics, photorefractive	511-540; §11.1-11.6	#6, #7	3/30
21	Monday Mar 30	Optical breakdown	543-559; §12.1-12.5	#8	4/6
22	Thursday Apr 2	Ultrafast nonlinear optics	561-571; §13.1-13.3	#9	4/6
23	Monday Apr 6	Relativistic nonlinear optics	571-585; §13.4-13.8	#10	4/9*
24	Thursday Apr 9	Nonlinear optics in microscopy, Discuss projects; projects due 4/22	Literature	Set Final Project	
	Monday Apr 13	No class	Conference Travel		
	Thursday Apr 16	No class	Conference Travel		
	Monday Apr 20	No class	Conference Travel		
25	Thursday Apr 23	Final Project Presentations; 10 minutes each			
		No Final Exam			

Final Project:

Research a contemporary topic in non-linear optics of interest to you; make a tutorial report on your chosen topic to present to your classmates; and prepare a 10 minute PowerPoint presentation, which you will present at the last class meeting. Your written report should be ~ 3-4 pages long of text/ bullet notes/equations, and must be less than 10 pages long, for example in a double-spaced word document. You should include references (not included in the page limit). You may insert figures taken from the literature if you provide the references. Your written report is due 4/22, your presentation will be 4/23, unless of a need to reschedule due to a conflict.

Your 25% grade assessment for the project will be either (15% for the report + 10% for the presentation) or (20% for the report + 5% for the presentation), whichever is more favorable. You will be assessed largely on the basis of your conveyed understanding of the topic, although thoroughness of your references, and keeping within your allotted time limit will also be considered. You are encouraged to provide reference to the relevant section or equations from Boyd's text, wherever possible. Be prepared for questions following your presentation.

You are encouraged to discuss your proposed topic with me before April.