ext. 62340 office: HOPE Lab 301/Delta 856 email: ychuang@ee.nthu.edu.tw IPT5110 Spring, 2017

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IPT5110 Nonlinear Optics

國立清華大學 光電光程研究所/電機工程學系

Prof. 黃衍介 class schedule: MNM5M6

Spring, 2017

Class location: 台達 Delta 202

Teaching Assistant: 吳明雄、林孟緯 x 62333

一、課程說明

The scope of this course covers most nonlinear optical phenomena associated with the 2^{nd} and 3^{rd} order optical nonlinearities. Near the end of the semester, high harmonic generation and plasma nonlinearity in the relativistic regime will also be introduced. To assist learning, this course begins with some review on the linear electromagnetic theory and then gradually moves into the nonlinear regime. This approach is to accommodate more and more undergraduate students taking this course.

Student's participation plays a key role in this course. All students are required to give a few presentations to earn their grades during the whole semester.

- 二 指定用書
- 1. Class handouts (available at 水木書苑 or http://www.hope.nthu.edu.tw)

三、參考書籍

- 0. David K. Cheng, <u>Field and Wave Electromagnetics</u> 2nd Ed., Addison Wesley, 1989.
- 1. 近代實驗光學,東華書局,黃衍介 著。
- 2. Nonlinear Optics by E.G. Sauter, John Wiley & Sons, 1996.
- 2. Fundamental of Photonics by Saleh & Teich, John Wiley & Sons, Inc.
- 3. Nonlinear Optics by R.W. Boyd, Academic Press.
- 4. Optical Waves in Crystals by Yariv and Yeh, John Wiley & Sons, Inc.
- 5. Quantum Electronics, by Yariv, John Wiley and Sons, Inc.

四、教學方式

Homework assignment

Doing homework is a team work in this course.

(1) Each 3 students form a study group.

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(2) Each week, members in a study group are required to work together on a set of 30

- slides, approximately 1 slide for 1 page of the course reader.
- (3) Mark your name on the slides prepared by you.
- (4) Before the class, all students have to email their slides in the pdf format to the teaching assistants and Prof. Huang. The file size can't exceed 1 Mb.
- (5) Each student has to bring a memory stick to the class and get ready for a presentation.
- (6) My slides are available on the course website for your reference only. Try to design your own slides. Don't copy my slides directly into your homework.

Presentation

In each class, I randomly draw 3-4 students, each giving half an hour presentation and host a Q&A session by using approximately 10 slides. Note that you could have to use the other member's slides in your group for your presentation. This means you do have to work together with your team members on ALL the slides. A presenter's performance will be graded by both the professor and the fellow students in the audience. Each student is expected to give 5-6 presentations in a semester.

Exams

There will be some quiz, a mid-term exam, and a final exam. All exams are open books/notes. Details of the exams will be announced later.

五、教學進度

- 1. Electromagnetic waves in the linear regime (D. K. Cheng, Huang)
- 2. Electromagnetic Wave in Anisotropic Media (Ch. 2 by Sauter, Ch. 6 by S&T, Ch. 4 by Y&Y)
- 3. Acousto-optics (Ch. 20 by S&T, Ch. 9 by Y&Y, Ch. 7 by Boyd)
- 4. Nonlinear Susceptibility (Ch. 1 by Boyd, Ch. 1 by Sauter)
- 5. Electro-optics (Ch. 3 by Sauter, Ch. 18 by S&T, Ch. 7 by Y&Y, Ch. 10 by Boyd)
- 6. Second harmonic generation (Ch. 2, 4 by Sauter, Ch. 19 by S&T)
- 7. Other Frequency Conversions using 2nd-order Nonlinearity (Ch. 4&5 by Sauter, Ch. 2 by Boyd, Ch. 19 by S&T, Ch. 12 by Y&Y)
- 8. Quasi-phase-matching nonlinear optics (handout)
- 9. Third-order Nonlinear Processes: third-harmonic generation, conjugate waves, Brillouin scattering, and Raman Scattering (Ch. 6 by Sauter, Ch. 18 by Yariv, Ch. 19 by S&T)
- 10. DC and AC Kerr Effect (Ch. 7 by Sauter, Ch. 19 by S&T)
- 11. High harmonic generation and plasma nonlinear optics

Prof. Yen-Chieh Huang Dept of Electrical Engineering National Tsing-Hua University Hsinchu, Taiwan 300 ext. 62340 office: HOPE Lab 301/Delta 856 email: ychuang@ee.nthu.edu.tw IPT5110 Spring, 2017

Week 0 (Feb. 13rd) first meeting

Week 1 (Feb 20th): up to page 30 of the course reader

Week 2 (Feb 27th): holiday for Feb. 27

Week 3 (March 6th): up to page 60

Week 4 (March 13th): up to page 90

Week 5 (March 20st): up to page 115

Week 6 (March 27th): up to page 140, laboratory: electro-optics

Week 7 (April 3rd): holiday for April 3

Week 8 (April 10th): up to page 165

Week 9 (April 17th): up to page 190 (Midterm exam)

Week 10 (April 24th): up to page 215

Week 11 (May 1st): up to page 240 (laboratory: Non-critically Phase-matched SHG)

Week 12 (May 8th): up to page 265

Week 13 (May 15th): up to page 290 (laboratory: Optical Parametric Generation)

Week 14 (May 22nd): up to page 318

Week 15 (May 29th): holiday for May 29, up to page 351

Week 16 (June 5th): up to page 382 (laboratory: Stimulated Raman Scattering)

Week 17 (June 12th) – exam week

六 、成績考核

Homework 20%
Ouiz 20%

presentation 20% (10% graded by peers)

midterm exam 20% Final exam 20%

Q&A – reference for score adjustment (Prof. Huang will keep a record of questions asked by you during and off the class)

七、講義位址 chapter files available at http://www.hope.nthu.edu.tw (passcode to access: 20155110) and bound copies available at 水木書苑 by March 2nd

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Presentation Grading Sheet

Grader's name:					rader's ID #:					
Date (mm/dd/yyyy):										
1 st presenter's name:										
A+ (90-100)	A (85-89)	A- (80-84)	B+ (77-79)	B (73-76)	B- (70-72)	C (60-69)	D (1-59)	X (0)		

2nd presenter's name:

	A+	A	A-	B+	В	B-	C	D	X
	(90-100)	(85-89)	(80-84)	(77-79)	(73-76)	(70-72)	(60-69)	(1-59)	(0)
ĺ									

3rd presenter's name:

A+	A	A-	B+	В	B-	C	D	X
(90-100)	(85-89)	(80-84)	(77-79)	(73-76)	(70-72)	(60-69)	(1-59)	(0)

4th presenter's name:

A+	A	A-	B+	В	B-	С	D	X
(90-100)	(85-89)	(80-84)	(77-79)	(73-76)	(70-72)	(60-69)	(1-59)	(0)

5th presenter's name:

A+	A	A-	B+	В	B-	C	D	X
(90-100)	(85-89)	(80-84)	(77-79)	(73-76)	(70-72)	(60-69)	(1-59)	(0)