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IPT5110 Nonlinear Optics Spring, 2019

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: M7M8M9

Class location: 台達 Delta 209

Teaching Assistants: 劉子齊 kingmax29@gmail.com, Tel: x 62333

一、課程說明

The scope of this course covers most nonlinear optical phenomena associated with the 2nd and 3rd 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 利捷影印店 on the NTHU campus or <http://www.hope.nthu.edu.tw> before the 1st week of the class)

三、參考書籍

0. David K. Cheng, Field and Wave Electromagnetics 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.
- (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) Each student is then responsible for working out ~10 slides. **For the ~10 slides, design 5 questions relevant to the content of the slide. Answer 10 questions not designed by you on a separate page (QA sheet) and email it to the TA and Prof. Huang before the class.** Mark your name on the slides prepared by you.
- (4) **Before the class, all students have to email their slides and QA sheet in the pdf format to the teaching assistants and Prof. Huang. The file size can't exceed 1 Mb. Provide necessary information on the filename, such as QA_1_your_name.pdf and slide_1_your_name.pdf for the first submission.**
- (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. 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 hosting 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 >10 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

- Week 0 (Feb. 18) first meeting
Week 1 (Feb. 25) up to page 28 of the course reader
Week 2 (March 4th): up to page 56 of the course reader
Week 3 (March 11th): up to page 84
Week 4 (March 18th): up to page 112
Week 5 (March 25th): up to page 140
Week 6 (April 1st): up to page 168
Week 7 (April 8th) : no class
Week 8 (April 15th): up to page 196,
Week 9 (April 22rd): up to page 224
Week 10 (April 29th): **midterm exam**
Week 11 (May 6th): up to page 252
Week 12 (May 13th): up to page 280
Week 12 (May 20st) : up to page 308
Week 13 (May 27th): up to page 336
Week 14 (June 3rd): up to page 364
Week 15 (June 10th): up to page 383 & review
Week 16 (June 17th): **Final exam week.**

六、成績考核

Homework (slide+QA) & Quiz	40%
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: **TBA**) and bound copies available at the on-campus 利捷影印店 by Feb. 25th.

Presentation Grading Sheet

Grader's name: _____

Grader's ID #: _____

Date (mm/dd/yyyy): _____

1st presenter's name:

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

2nd presenter's name:

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

3rd presenter's name:

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

IPT5110 Nonlinear Optics Group Signup Sheet
Spring, 2019
(tentatively 3 students from a group)

Group 1	Group 2	Group 3	Group 4	Group 5
Name, ID, phone #	Name, ID, phone #	Name, ID, phone #	Name, ID, phone #	Name, ID, phone #