Prof. Yen-Chieh Huang
Institute of Photonics Tech./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, 2023

Last update Feb. 17th, 2023

IPT5110 Nonlinear Optics
Spring, 2023
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: W4F3F4

Class location:　HOPE 406 (光電中心高能光電實驗室)

TA: Hossein Shirvani, x 62333, email: perturbative.qcd@gmail.com

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 during 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

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Doing homework is a teamwork in this course.

(1) 3 students, randomly drawn each week, will form a study group. There will be 2 groups for this class.

(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 3 questions relevant to the content of the slide. Answer up to 6 questions not designed by you on a separate page (QA sheet) and email it to the TA (email address: perturbative.qcd@gmail.com) and Prof. Huang by 5 pm a day before the class. Provide necessary information on the filename, such as QA_N_your_name.pdf, for the Nth submission.

(4) Before the class, all students have to email their slides + 3 designed questions in the pdf format to the TA and Prof. Huang. The file size can't exceed 1 Mb for the slide file (write your name on the slide pages). Provide necessary information on the filename, such as slide_N_your_name.pdf, for the Nth submission.

(5) To run the class smoothly, a student is strongly advised to email the slides and questions to his/her group members by 5 pm, Wednesday, to jointly discuss the slides for a day before emailing the files to the TA/professor by 5 pm, Thursday.

(6) Each student has to bring a memory stick to the class and get ready for a presentation.

(7) 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. In case your group member(s) can't provide you the slides or can't provide you the slides on time for your presentation, you can use my slides or the other group's slides for your presentation. You simply have to study the course materials well before the class.

Presentation

In each class, I **randomly** draw students, each giving half an hour presentation and hosting a Q&A session by using approximately10 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

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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 1 (Feb. 13th ~) Introduction

Week 2 (Feb. 20th ~) up to page 28 of the course reader

Week 3 (Feb. 27th ~): up to page 57 of the course reader

Week 4 (March 6th ~): up to page 84

Week 5 (March 13th ~): up to page 112

Week 6 (March 20th ~): up to page 140

Week 7 (March 27th ~): up to page 168

Week 8 (April 3rd ~): up to page 196 (no class on April 5th)

Week 9 (April 10th ~): up to page 224

Week 10 (April 17th ~): up to page 252, midterm exam

Week 11 (April 24th ~): up to page 280

Week 12 (May 1st ~): up to page 308

Week 13 (May 8th ~): up to page 336

Week 14 (May 15th ~): up to page 364

Week 15 (May 22th ~): up to 383

Week 16 (May 29th ~): Review

Week 17 (June 5th ~): Final exam

Week 18 (June 12th ~): the end

六、成績考核

Homework (slide+QA) & Quiz   40%

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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 bound copies available at the on-campus 利捷影印店 during the week of Feb 22nd.

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Presentation Grading Sheet

Grader's name: _____   Grader's ID #: _____

Date (mm/dd/yyyy): _____

1st 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+ (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)

3rd 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)

4th 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)

5th 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)

6th 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)