City University of Hong Kong
Course Syllabus

offered by Department of Electrical Engineering
with effect from Semester A in 2024/2025

Part I Course Overview

Course Title:	Nonlinear Optical Devices
Course Code:	EE6609
Course Duration:	One Semester (13 weeks)
Credit Units:	3
Level:	P6
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	EE 4035 Optical Communications, or EE 6428 Optical Communications; or equivalent
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

This course aims to provide students with an understanding of the fundamental physics, photonics devices, and unique applications using nonlinear optics in engineering, which encourages students to discover the latest technological developments towards all-optical systems.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Describe the origin of optical nonlinearities and analyze their effects in photonic devices.				
2.	Apply the concept of phase matching and estimate the efficiencies in optical signal conversions.				
3.	Discuss the parameters for frequency conversion.				
4.	Calculate the parameters for nonlinear optical switches.				
5.	Comprehend and present on special topics in nonlinear optics.		✓	✓	
		100%			

A1: *Attitude*
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: *Ability*
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: *Accomplishments*
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3. Learning and Teaching Activities (LTAs)

(LTAs designed to facilitate students' achievement of the CILOs.)

LTA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4	5		
Lecture	Students will engage in lectures on the subject matter for the whole class.	✓	✓	✓	✓	✓		2 hrs/wk
Tutorial and in-class exercise (including a presentation)	Students will engage in working out solutions to examples on selected topics. The presentation is designed to encourage students to research into the latest topics in nonlinear optical devices	✓	✓	✓	✓	✓		1 hr/wk

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting	Remarks
	1	2	3	4	5			
Continuous Assessment: 30%								
Assignments including laboratories (min. 3)	✓	✓	✓	✓	✓		15%	
Test(s)	✓	✓	✓	✓	✓		15%	
Examination: 70% (duration: 2hrs , if applicable)								
Examination	✓	✓	✓	✓	✓		70%	
							100%	

Remark:

To pass the course, students are required to achieve at least 30% in course work and 30% in the examination.

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Examination	Achievements in CILOs	High	Significant	Moderate	Basic	Not even reaching marginal level
2. Coursework	Achievements in CILOs	High	Significant	Moderate	Basic	Not even reaching marginal level

Applicable to students admitted in Semester A 2022/23 to Summer Term 2024

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B,)	Marginal (B-, C+, C)	Failure (F)
1. Examination	Achievements in CILOs	High	Medium	Low	Not even reaching marginal level
2. Coursework	Achievements in CILOs	High	Medium	Low	Not even reaching marginal level

6. Constructive Alignment with Programme Outcomes

PILO	How the course contribute to the specific PILO(s)
1, 2, 3, 4	The application of current knowledge in photonics technology, specialized knowledge in nonlinear optics, and formulation of solutions is central to the aim of this course.

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

Introduction:
- Maxwell's equations
- Optical fields
- Linear susceptibility
- Dispersions

Foundations of Nonlinear Optics
- Nonlinear optical susceptibility
- Coupled-wave analysis
- Phase matching
- Nonlinear optical interaction

Parametric Frequency Converters
- Parametric frequency conversion
- Sum- and difference- frequency generation (SFG/DFG)
- Second-harmonic generation (SHG)
- Optical parametric amplification (OPA)
- Applications: Imaging, pulse measurements, signal amplification

Nonparametric Frequency Generators
- Raman amplifiers and generators
- Brillouin amplifiers and generators
- Applications: Spectroscopy, sensing, lasing

All-Optical Modulators
- Kerr lenses
- Saturable absorbers
- All-optical interferometers
- Applications: All-optical switch, all-optical storage

Special topics may be included:
- Super-continuum generation
- Nonlinear optical imaging
- Raman lasers

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

1.	J. M. Liu, Photonic Devices, Cambridge University Press (2005)
2.	R. W. Boyd, Nonlinear Optics, 2/e, Academic Press (2002)

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	G. P. Agrawal, Nonlinear Fiber Optics, 3/e, Academic Press (2001)
2.	N. Bloembergen, Nonlinear Optics, 4/e, World Scientific (1996)
3.	P. N. Butcher and D. Cotter, The Elements of Nonlinear Optics, Cambridge University Press (1990)
4.	H. A. Haus, Waves and Fields in Optoelectronics, Prentice-Hall (1984)
5.	E. G. Sauter, Nonlinear Optics, Wiley (1996)
6.	Y. R. Shen, The Principles of Nonlinear Optics, Wiley (1984)
7.	R. L. Sutherland, Handbook of Nonlinear Optics, Marcel Dekker (2003)