City University of Hong Kong

Information on a Course offered by Department of Electronic Engineering with effect from Semester A 2012/13

Part I

Course Title:	Nonlinear Optical Devices
Course Code:	EE6609
Course Duration:	One Semester (13 weeks)
No. of credits:	3
Level:	P6
Medium of Instruction:	English
Prerequisites *:*	EE 4035 (Optical Communications), or EE 6428 (Optical Communications); or equivalent
Precursors *:*	Nil
Equivalent Course *:*	Nil
Equivalent to the Old Course *:*	Nil
Exclusive Courses:	Nil

Part II

Course Aims:

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

Course Intended Learning Outcomes (CILOs)

No.	CILOs
1.	Identify 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.	Calculate the parameters for frequency conversion
4.	Calculate the parameters for nonlinear optical switches
5.	Comprehend and present on special topics in nonlinear optics

Teaching and learning Activities (TLAs)

(Indicative of likely activities and tasks designed to facilitate students' achievement of the CILOs. Final details will be provided to students in their first week of attendance in this course)

CILO	Teaching and Learning Activities
1, 2, 3, 4, 5	Lecture, tutorial, in-class exercise, and presentation

The presentation is designed to encourage students to research into the latest topics in nonlinear optical devices, which are novel devices that use light to control light itself. The students are expected to learn through actively researching and integrating the knowledge about the latest scientific and technological developments.

Timetabling Information

Pattern	Hours
Lecture:	26
Tutorials:	13
Laboratory:	
Other activities:	

Assessment Tasks/Activities

(Indicative of likely activities and tasks designed to assess how well the students achieve the CILOs. Final details will be provided to students in their first week of attendance in this course)

	Type of assessment tasks	*Weighting (if applicable)*
Continuous Assessment	Tests, Assignments, Presentation	30%
Examination	Written exam	70% 2 hours

Remarks:. To pass the course, students are required to achieve at least 35% in course work and 35% in the examination.

Grading of Student Achievement:

Letter Grade	Grade Point	Grade definition
A+ A A-	4.3 4.0 3.7	Excellent
B+ B B-	3.3 3.0 2.7	Good
C+ C C-	2.3 2.0 1.7	Adequate
D	1.0	Marginal
F	0.0	Failure

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

Keyword Syllabus:

1. Introduction:
   - Maxwell's equations
   - Optical fields
   - Linear susceptibility
   - Dispersions
2. Foundations of Nonlinear Optics
   - Nonlinear optical susceptibility
   - Coupled-wave analysis
   - Phase matching
   - Nonlinear optical interaction
3. 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
4. Nonparametric Frequency Generators
   - Raman amplifiers and generators
   - Brillouin amplifiers and generators
   - Applications: Spectroscopy, sensing, lasing
5. 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

Recommended Reading:

Textbooks:

J. M. Liu, Photonic Devices, Cambridge University Press (2005)

R. W. Boyd, Nonlinear Optics, 2/e, Academic Press (2002)

References:

G. P. Agrawal, Nonlinear Fiber Optics, 3/e, Academic Press (2001)

N. Bloembergen, Nonlinear Optics, 4/e, World Scientific (1996)

P. N. Butcher and D. Cotter, The Elements of Nonlinear Optics, Cambridge University Press (1990)

H. A. Haus, Waves and Fields in Optoelectronics, Prentice-Hall (1984)

E. G. Sauter, Nonlinear Optics, Wiley (1996)

Y. R. Shen, The Principles of Nonlinear Optics, Wiley (1984)

R. L. Sutherland, Handbook of Nonlinear Optics, Marcel Dekker (2003)

Online Resources (if any)