City University of Hong Kong
Course Syllabus

offered by Department of Physics
with effect from Semester A 2020/21

Part I Course Overview

Course Title:	**Advanced Electrodynamics**
Course Code:	**PHY6506**
Course Duration:	**One semester**
Credit Units:	**3**
Level:	**P6**
Medium of Instruction:	**English**
Medium of Assessment:	**English**
Prerequisites: *(Course Code and Title)*	**Nil**
Precursors: *(Course Code and Title)*	**PHY2191 Electricity and Magnetism** **PHY3205 Electromagnetism**
Equivalent Courses: *(Course Code and Title)*	**Nil**
Exclusive Courses: *(Course Code and Title)*	**PHY8506 Advanced Electrodynamics**

Part II Course Details

1. Abstract

This course aims to equip graduate students with advanced concepts and mathematical methods of electrodynamics that are necessary to conduct research in related fields such as photonics and metamaterials. The course will cover the fundamentals of electrodynamics including electromagnetic wave propagations in homogeneous materials, wave behaviors at a surface, plasmon, waveguides, cavities, scattering and radiation phenomena. In addition, the course will introduce applications related to electrodynamics, such as photonic crystals and metamaterials.

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.	Recognize the importance of electrodynamics	10%	√		
2.	Understand the key concepts of electrodynamics	20%	√		
3.	Understand the physics mechanisms underlying electrodynamic phenomena	20%		√	
4.	Apply analytical methods to solve practical problems	40%		√	
5.	Develop electrodynamic systems with specific wave properties	10%		√	√
		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 self-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. Teaching and Learning Activities (TLAs)

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

TLA	Brief Description	CILO No.					Hours/week (if applicable)
		1	2	3	4	5	
Lectures	Explain concepts and introduce mathematical methods	√	√	√	√	√	2
Tutorials	Explain the mechanisms of some electrodynamic systems and how to solve electrodynamic problems	√	√	√	√	√	1

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: 50%							
Assignments	√	√	√	√	√	50%	
Examination: 50% (duration: 2 hours)							
	√	√	√	√	√	50%	
						100%	

5. Assessment Rubrics

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

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Assignments	Understanding the key concepts and principles; Ability to explain the physical mechanisms of electrodynamic phenomena; Ability of applying mathematical methods to solve problems.	High	Significant	Moderate	Basic	Not reaching marginal level
2. Examination	Having an in-depth understanding of electrodynamic concepts and principles; Ability of applying analytical methods to solve practical problems independently.	High	Significant	Moderate	Basic	Not reaching marginal level

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

1. Keyword Syllabus

(An indication of the key topics of the course.)

- Maxwell's Equations
  - Displacement current, vector and scalar potentials, gauge transformation, Green's functions
- Conservation Laws
  - Poynting's theorem, conservation of energy and momentum, Maxwell's stress tensor
- Plane waves and wave propagation
  - Impedance and admittance, polarizations, Stokes parameters, spin and orbital angular momentums, dispersion, Causality, Kramers-Kronig relations, plasmon
- Waveguides, transmission line, and resonant cavities
  - Fields at surface and within a conductor, modes in cylindrical and rectangular waveguides, transmission lines, resonant cavities, quality factor
- Radiation
  - Multipole expansions, electric dipole, magnetic dipole and electric quadrupole
- Scattering and diffraction
  - Rayleigh scattering, Mie scattering, optical theorem, scalar and vectorial diffraction theory
- Electromagnetic waves in artificial structures and materials
  - photonic crystals, photonic band theory, metamaterials, effective medium theory

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. D. Jackson, *Classical Electrodynamics*, 3rd edition, Wiley & Sons, 1999.
2.	
3.	
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2.2 Additional Readings

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

1.	L. D. Landau and E. M. Lifshitz, *Electrodynamics of Continuous Media*, 2nd edition, Butterworth-Heinemann, 1984.
2.	C. F. Bohren and D. R. Huffman, *Absorption and Scattering of Light by Small Particles*, Wiley & Sons, 1983.
3.	J. D. Joannopoulos, S. G. Johnson, J. N. Winn, and R. D. Meade, *Photonic Crystals: Molding the Flow of Light*, 2nd edition, Princeton University Press, 2008.
4.	L. Solymar and E. Shamonina, *Waves in Metamaterials*, Oxford University Press, 2009.