UNSW Course Outline

PHYS3114 Electrodynamics - 2024

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General Course Information

Course Code : PHYS3114
Year : 2024
Term : Term 3
Teaching Period : T3
Is a multi-term course? : No
Faculty : Faculty of Science
Academic Unit : School of Physics
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

Classical electrodynamics is important from both the fundamental and applied viewpoints. This course aims to provide students with an introduction to the principles of electrodynamic systems, and a theoretical foundation in classical field theory. The course begins with a detailed study of scalar diffraction and related topics in physical optics. This is followed by a discussion of radiating potentials and the use of Green’s functions for solving problems in electromagnetism involving moving sources. Finally, the topic of relativistic electrodynamics and its covariant formulation is introduced, paving the way for a quantum field theory of electrodynamics (QED). Topics to be covered include; scalar diffraction theory, image formation and Fourier optics, coherence, Green’s function solution of static problems, inhomogeneous wave equation and Green’s function solution, dipole radiation, emission of radiation from accelerating and decelerating charges, relativistic electrodynamics, the covariant formulation. The course is taught as four weekly lectures, a weekly tutorial and two four-hour laboratory sessions, scheduled throughout the term. Laboratory experiments are chosen to provide practical demonstrations of topics covered in lectures.

Course Aims

This course aims to provide students with an introduction to the principles and behaviours of electrodynamic systems, and a theoretical foundation in classical field theory. The course will begin with the application of electromagnetic theory to the study of optical phenomena, before moving on to radiating electromagnetic fields from moving charges. It will finish with an introduction to relativistic electrodynamics and its covariant formulation, paving the way for a quantum field theory of electrodynamics (QED)

Relationship to Other Courses

This course has a prerequisite of PHYS2114 (Electromagnetism) and PHYS2113 (Classical Mechanics).

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Explain phenomena such as the propagation of electromagnetic waves and the emission of radiation by accelerating charges in terms of solutions to Maxwell’s equations.
CLO2 : Apply electromagnetism as a mathematical framework to study optical phenomena.
CLO3 : Explain the relation between electrodynamics and special relativity.
CLO4 : Conduct laboratory-based experiments that demonstrate the practical implications of electromagnetic theory.

Course Learning Outcomes	Assessment Item
CLO1 : Explain phenomena such as the propagation of electromagnetic waves and the emission of radiation by accelerating charges in terms of solutions to Maxwell’s equations.	• Mid-term test • Assignment • Final exam
CLO2 : Apply electromagnetism as a mathematical framework to study optical phenomena.	• Laboratory • Mid-term test • Assignment • Final exam
CLO3 : Explain the relation between electrodynamics and special relativity.	• Assignment • Final exam
CLO4 : Conduct laboratory-based experiments that demonstrate the practical implications of electromagnetic theory.	• Laboratory

Learning and Teaching Technologies

Moodle - Learning Management System | Echo 360

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Mid-term test Assessment Format: Individual	15%	
Laboratory Assessment Format: Individual	10%	
Assignment Assessment Format: Individual	15%	
Final exam Assessment Format: Individual	60%	

Assessment Details

Mid-term test

Assessment Overview

You will complete a 50 minute in-class test during week 4 that will cover the content from the first part of the course. The test will typically consist of two multi-part questions that will include a combination of analytical problem solving, computation and interpretation. The style of questions will be similar to those used in the final examination. The test will be marked, and returned to students within 10 working days. The solutions to the test will be discussed in class.

Course Learning Outcomes

- CLO1 : Explain phenomena such as the propagation of electromagnetic waves and the emission of radiation by accelerating charges in terms of solutions to Maxwell's equations.
- CLO2 : Apply electromagnetism as a mathematical framework to study optical phenomena.

Detailed Assessment Description

Please see Moodle for further details.

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.

For more information on Generative AI and permitted use please see here.

Laboratory

Assessment Overview

You will complete two, four-hour laboratory experiments over the term. The first lab will be scheduled between Weeks 2-4, and the second between Weeks 7-9. You will be assessed on your written account of the experiments and an accompanying interview with an academic marker in the week following the final laboratory session. Marks will be allocated based on (i) an understanding of the underlying physical principles, (ii) the quality of the experimental results and analysis, and (iii) the presentation of the lab book. Feedback is provided on the same day as the interview.

Course Learning Outcomes

- CLO2 : Apply electromagnetism as a mathematical framework to study optical phenomena.
- CLO4 : Conduct laboratory-based experiments that demonstrate the practical implications of

electromagnetic theory.

Detailed Assessment Description

Please see Moodle for further details.

Generative AI Permission Level

Simple Editing Assistance

In completing this assessment, you are permitted to use standard editing and referencing functions in the software you use to complete your assessment. These functions are described below. You must not use any functions that generate or paraphrase passages of text or other media, whether based on your own work or not.
If your Convenor has concerns that your submission contains passages of AI-generated text or media, you may be asked to account for your work. If you are unable to satisfactorily demonstrate your understanding of your submission you may be referred to UNSW Conduct & Integrity Office for investigation for academic misconduct and possible penalties.
For more information on Generative AI and permitted use please see here.

This is a laboratory excercise where the assessment is based on an in-person interview and accompanying written lab report. AI assisted editing of the report is permitted to help with clarity of expression. Any information presented in the report can be the subject of further discussion during the interview.

Assignment

Assessment Overview

You will be required to complete an assignment that will cover material from the second half of the course. The assignment will consist of several multi-part questions that will include a combination of analytical problem solving, numerical computation, and reflection. The aim of the assignment is to apply the analytical approaches discussed in class to practical problems. The assignment will be posted in Week 8 and you will be given approximately 1 week to complete. The assignment will be marked and feedback will be provided to you within 10 working days.

Course Learning Outcomes

- CLO1 : Explain phenomena such as the propagation of electromagnetic waves and the emission of radiation by accelerating charges in terms of solutions to Maxwell's equations.
- CLO2 : Apply electromagnetism as a mathematical framework to study optical phenomena.
- CLO3 : Explain the relation between electrodynamics and special relativity.

Detailed Assessment Description

Please see Moodle for further details.

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
For more information on Generative AI and permitted use please see here.

This is a computational essay with no marks assigned for writing style beyond providing clarity in communicating answers. You may be asked to attend an interview with the lecturer to present your finding if there is any suspicion of AI assistance.

Final exam

Assessment Overview

You will complete a 2-hour exam typically consisting of four multi-part questions that will include a combination of analytical problem solving, computation, interpretation, and reflection. The exam will be held during the formal examination period and covers material from all parts of the course. Feedback is provided from the lecturers upon request.

Course Learning Outcomes

- CLO1 : Explain phenomena such as the propagation of electromagnetic waves and the emission of radiation by accelerating charges in terms of solutions to Maxwell's equations.
- CLO2 : Apply electromagnetism as a mathematical framework to study optical phenomena.
- CLO3 : Explain the relation between electrodynamics and special relativity.

Detailed Assessment Description

Please see Moodle for further details.

Generative AI Permission Level

Not Applicable

Generative AI is not considered to be of assistance to you in completing this assessment. If you do use generative AI in completing this assessment, you should attribute its use.
For more information on Generative AI and permitted use please see here.

General Assessment Information

<u>Grading Basis</u>

Standard

Course Schedule

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

General Schedule Information

This course is run in two parts: one devoted to the application of electromagnetic theory to optical phenomena, and a second looking at problems involving radiating potentials and advanced methods in electrodynamics. This year we will run the two parts in parallel where each week we will devote some lectures to each topic. A list of topics to be covered in each part is listed below:

PART A - Physical Optics

Topic A1: Review of Optics and Scalar Diffraction: Fraunhofer Diffraction, Huygens-Fresnel theory; Introduction to 1D Fourier Transforms and the Convolution Theorem. Far-field diffraction problems involving slits and gratings.

Topic A2: Introduction to Geometric Optics; Phase response of a lens; 2D Fourier Transforms, Hankel Transforms; Abbe’s Theory of Image Formation; Imaging systems and limits of resolution. Spatial Filtering, Image Processing and Enhancement as applied to Fourier theory and Abbe’s theory.

Topic A3: Introduction to Coherence covers basic concepts in optical coherence. Classical Coherence Theory and the van Cittert-Zernike Theorem. Coherence from extended sources.

Topic A4: Wave propagation in vacuum and in simple media; Wave packet in a dispersive medium; Causality and analyticity of $\chi(\omega)$, dispersion relations.

PART B - Radiating Potentials

Topic B1: Green's function solution to static problems, Inhomogeneous wave equations, Green's function solution, Retarded waves, potentials and fields.

Topic B2: Fields of a time-dependent electric dipole: exact solution; Radiation, detachment, Larmor's formula, Dipole antenna, Cartesian multipole radiation (electric and magnetic dipole), Fields from moving charges.

Topic B3: Liénard-Wiechert potentials, Synchrotron radiation, Radiation reaction, Cherenkov radiation, Bremsstrahlung, Thomas precession,

Topic B4: Covariant formulation of electrodynamics: Lorentz force, field tensor; Covariant Maxwell's equations, gauge transformations, Covariant conservation laws, Lagrangian description for a closed system of non-relativistic point particles.

Topic B5: Action principle, Euler-Lagrange equation, Covariant formulation, invariance and conservation laws, Noether's theorem.

Course Resources

Prescribed Resources

A. Zangwill, *Modern Electrodynamics*

Lecture notes will be posted on Moodle

Recommended Resources

D. J .Griffiths, *Introduction to Electrodynamics*

J. D. Jackson, *Classical Electrodynamics*

W. Greiner, *Classical Electrodynamics*

E. Hecht, *Optics*

J. Goodman, *Fourier Optics*

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Peter Reece		Old Main Building (K15), Ground Floor, Room G57B	(02) 9385 4998	consultation by appointment	No	Yes
Lecturer	Oleg Tretiako v		Old Main Building (K15), Ground Floor, Room G57E		consultation by appointment	No	No
Administrat or	Zofia Krawcz yk-Bernotas		G06 OMB			No	No
Lab staff	Tamara Rezt sova		142D, OMB K15	(02) 9385 4577	consultation by appoinment	No	No
Year coordinator	Elizabeth An gstmann					No	No

Other Useful Information

Academic Information

Upon your enrolment at UNSW, you share responsibility with us for maintaining a safe, harmonious and tolerant University environment.

You are required to:

- Comply with the University's conditions of enrolment.
- Act responsibly, ethically, safely and with integrity.
- Observe standards of equity and respect in dealing with every member of the UNSW community.
- Engage in lawful behaviour.
- Use and care for University resources in a responsible and appropriate manner.
- Maintain the University's reputation and good standing.

For more information, visit the UNSW Student Code of Conduct Website.

Academic Honesty and Plagarism

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.
Further information about referencing styles can be located at https://student.unsw.edu.au/referencing

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits: honesty, trust, fairness, respect, responsibility and courage. At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.

Further information about academic integrity, plagiarism and the use of AI in assessments can be located at:

- The Current Students site,
- The ELISE training site, and
- The Use of AI for assessments site.

The Student Conduct and Integrity Unit provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct

Submission of Assessment Tasks

Penalty for Late Submissions

UNSW has a standard late submission penalty of:

- 5% per day,
- for all assessments where a penalty applies,
- capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and
- no permitted variation.

Any variations to the above will be explicitly stated in the Course Outline for a given course or assessment task.

Students are expected to manage their time to meet deadlines and to request extensions as early as possible before the deadline.

Special Consideration

If circumstances prevent you from attending/completing an assessment task, you must officially apply for special consideration, usually within 3 days of the sitting date/due date. You can apply by logging onto myUNSW and following the link in the My Student Profile Tab. Medical documentation or other documentation explaining your absence must be submitted with your application. Once your application has been assessed, you will be contacted via your student email address to be advised of the official outcome and any actions that need to be taken from there. For more information about special consideration, please visit: https://student.unsw.edu.au/special-consideration

Important note: UNSW has a "fit to sit/submit" rule, which means that if you sit an exam or submit a piece of assessment, you are declaring yourself fit to do so and cannot later apply for Special Consideration. This is to ensure that if you feel unwell or are faced with significant circumstances beyond your control that affect your ability to study, you do not sit an examination or submit an assessment that does not reflect your best performance. Instead, you should apply for Special Consideration as soon as you realise you are not well enough or are otherwise unable to sit or submit an assessment.

Faculty-specific Information

Additional support for students

- The Current Students Gateway
- Student Support
- Academic Skills and Support
- Student Wellbeing, Health and Safety
- Equitable Learning Services
- UNSW IT Service Centre
- Science EDI Student Initiatives, Offerings and Guidelines