UNSW Course Outline

PHYS2114 Electromagnetism - 2024

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General Course Information

Course Code : PHYS2114
Year : 2024
Term : Term 2
Teaching Period : T2
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

Electromagnetism is important from both fundamental and applied viewpoints. This course builds on a conceptual understanding of electricity and magnetism, developed in first year Physics, to create a unified mathematical framework for solving problems involving

electromagnetic phenomena in terms of the Maxwell equations. The topics covered are framed to emphasize the intimate relation between electric and magnetic fields, the sources that generate them, and their fundamental connection with universal physical quantitates such as force, energy, and momentum. Appropriate microscopic theories are used to understand the modification of electromagnetic fields inside different types of matter. This course has a strong practical emphasis and is aimed at developing a range of analytical tools for solving realistic problems. These are explored in both lectures and tutorials as well as through a range of experiments, where students can gain hands-on experience with modern techniques for measuring electrical, magnetic and associated effects.

Course Aims

This course aims to provide students with an introduction to the principles and behaviours of electric and magnetic systems, and the unified subject of electromagnetism in terms of Maxwell's four equations. Building on electromagnetic theory, students will learn techniques to analyze static and dynamic electromagnetic fields in matter, and apply such techniques to relevant engineering problems.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Explain how electricity and magnetism are related.
CLO2 : Analyse static and simple time-dependent systems of charge and current distributions using Maxwell’s equations.
CLO3 : Apply Maxwell’s equations to describe the behavior of electromagnetic waves for a number of important geometric arrangements.
CLO4 : Perform experimental measurements and analysis to demonstrate electromagnetic phenomena.
CLO5 : Communicate experimental procedure and record keeping through lab books, written reports, and concise oral presentations.

Course Learning Outcomes	Assessment Item
CLO1 : Explain how electricity and magnetism are related.	• Assignment & Quizzes • Mid-term test • Final exam
CLO2 : Analyse static and simple time-dependent systems of charge and current distributions using Maxwell’s equations.	• Laboratory Work • Assignment & Quizzes • Mid-term test • Final exam
CLO3 : Apply Maxwell’s equations to describe the behavior of electromagnetic waves for a number of important geometric arrangements.	• Assignment & Quizzes • Mid-term test • Final exam
CLO4 : Perform experimental measurements and analysis to demonstrate electromagnetic phenomena.	• Laboratory Work
CLO5 : Communicate experimental procedure and record keeping through lab books, written reports, and concise oral presentations.	• Laboratory Work

Learning and Teaching Technologies

Moodle - Learning Management System

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Assignment & Quizzes Assessment Format: Individual	10%	
Mid-term test Assessment Format: Individual	20%	Start Date: 28/06/2024 04:00 PM
Final exam Assessment Format: Individual	50%	Start Date: In exam period
Laboratory Work Assessment Format: Individual	20%	

Assessment Details

Assignment & Quizzes

Assessment Overview

You will be given one assignment in the form of problem sets and/or quizzes. This will cover content from the second half of the term. Moodle quizzes will allow multiple attempts but with some penalty for each additional attempt. The assignment will be marked and returned to students within 10 days. Solutions will be discussed in class once all assignments have been turned in.

Course Learning Outcomes

- CLO1 : Explain how electricity and magnetism are related.
- CLO2 : Analyse static and simple time-dependent systems of charge and current distributions using Maxwell’s equations.
- CLO3 : Apply Maxwell’s equations to describe the behavior of electromagnetic waves for a number of important geometric arrangements.

Mid-term test

Assessment Overview

The mid-term test is designed to measure your learning and problem-solving skills on topics in the first half of the course, including material from lectures, and workshops. The test is 50 minutes and consists of analytic & numerical problems, and short answer responses - details will be confirmed during the course. The questions will be of a similar style to the exam, you should take your performance on this test as feedback on the effectiveness of your exam study techniques and consult with your lecturers for advice on how to improve.

Course Learning Outcomes

- CLO1 : Explain how electricity and magnetism are related.
- CLO2 : Analyse static and simple time-dependent systems of charge and current distributions using Maxwell's equations.
- CLO3 : Apply Maxwell's equations to describe the behavior of electromagnetic waves for a number of important geometric arrangements.

Assessment Length

50 minutes

Assessment information

This mid-term test will be held during the lecture time, 4-5 PM, on Friday of Week 5.

Final exam

Assessment Overview

The final exam is designed to summarise your learning and problem-solving skills on all topics delivered across the term, including material from lectures, tutorials and workshops. The exam is typically 2hrs and consists of analytic & numerical problems, and short answer responses - details will be confirmed during the course. The examination will occur during the official university examination period. Feedback is available through inquiry with the course convenor.

Course Learning Outcomes

- CLO1 : Explain how electricity and magnetism are related.
- CLO2 : Analyse static and simple time-dependent systems of charge and current distributions using Maxwell's equations.
- CLO3 : Apply Maxwell's equations to describe the behavior of electromagnetic waves for a number of important geometric arrangements.

Assessment Length

2 hours

Laboratory Work

Assessment Overview

You will complete 2 three-hour laboratory experiments over the term, the first one to be scheduled within the first three weeks of the term. You will be assessed based on the written account of each experiment and the accompanying interview with an academic marker in the week after the experiment. Marks will be allocated based on (i) an understanding of the underlying physical principles covered in the course, (ii) the quality of the experimental results and analysis, and (iii) the presentation of the lab book. Feedback will be provided on your lab

report and oral description during the interview.

Course Learning Outcomes

- CLO2 : Analyse static and simple time-dependent systems of charge and current distributions using Maxwell’s equations.
- CLO4 : Perform experimental measurements and analysis to demonstrate electromagnetic phenomena.
- CLO5 : Communicate experimental procedure and record keeping through lab books, written reports, and concise oral presentations.

General Assessment Information

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 27 May - 2 June	Topic	Electrostatics Chapter 2 Griffiths Electric field, principle of superposition, divergences & curl of electrostatic fields, electric potential, work and energy in electrostatics, conductors, capacitors.
Week 2 : 3 June - 9 June	Topic	Special Techniques Chapter 3 Griffiths: Laplace's equation, uniqueness theorems, method of images, separation of variable, numerical solutions of Laplace's equation, Multipole expansion
Week 3 : 10 June - 16 June	Topic	Electric Fields in Matter Chapter 4 Griffiths Electric polarisation, bound charges, electric displacement, linear dielectrics, boundary value problems with linear dielectrics, energy and forces in dielectrics
	Lecture	Monday this week is a public holiday. An asychronous online video lecture will be provided to cover this missed lecture.
Week 4 : 17 June - 23 June	Topic	Magnetostatics Chapter 5 Griffiths Lorentz force, steady currents, Biot-Savart law, divergence and curl of B, Ampère's law, magnetic vector potential, multipole expansion, boundary conditions
Week 5 : 24 June - 30 June	Topic	Magnetic Fields in Matter Griffiths chapter 6 Magnetisation, bound currents, Ampere's law in magnetised materials, magnetic susceptibility and permeability
	Assessment	The mid-term test will run from 4-5 PM (lecture time) this week.
Week 7 : 8 July - 14 July	Topic	The topics for the second half of the course are Electrodynamics, Electromagnetism and Light. These will be covered in weeks 6-10: Topic 6: Density of electric current. Ohm's law. Locality of Ohm's law. Drude formula. Electromotive force due to battery. Motional electromotive force. Topic 7: Faraday's law. The right hand rule. Lenz's law. Electric generator. Differential form of Faraday's law. Inductance (=selfinductance) of a coil. Mutual inductance of two coils. Energy density in magnetic field Topic 8: Kirchhoff 's laws for DC circuits. Kirchhoff 's laws for AC lumped circuits. Transient behaviours of simple circuits. AC circuits driven by sinusoidal voltage, complex impedance.6 Topic 9: Electric charge conservation. Maxwell's equations. Energy conservation and Poynting's vector. Maxwell's equations in dielectric matter: the linear approximation. Skin effect in a metal. Foucault's currents (= Eddy currents). Scalar and vector potentials, gauge transformation and gauge invariance, Maxwell's Eqs. written in terms of potentials. Topic 10: Electromagnetic waves. Plane wave. Partial and full polarization. Polarization density matrix and Stokes parameters. Fresnel Eqs. For reflection/transmission. Topic 11: Radiation of electromagnetic waves. Retarded potentials in Lorentz gauge. Spectral decomposition of retarded potentials. Fields in the wave zone (Far field). Radiated power. Electric dipole radiation (E1-radiation).

Attendance Requirements

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

General Schedule Information

For the first half of the course you should complete the pre-lecture quizzes on Moodle before

attending lectures. This course builds on what you have learnt about electromagnetism in Physics 1B and relies heavily on the vector calculus you have learnt in MATH2069 (or alternative). These quizzes will remind you of this content. The coure moves quickly and assumes that you are familiar with the content from the pre-requisite courses.

References are to Griffiths, Introduction to Electrodynamics. Any edition of this book is fine, the 5th edition was just released.

The week each topic is covered is approximate.

Course Resources

Prescribed Resources

Introduction to Electrodynamics 5e, Griffiths David J Reed

Print:

https://www.bookshop.unsw.edu.au/details.cgi?ITEMNO=9781009397759

Digital:

https://unswbookshop.vitalsource.com/products/-v9781009397728

Note: any edition of this textbook is fine!

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Elizabeth Angstmann		G61F in the old main building		Please email to make an appointment	Yes	Yes
Lecturer	Oleg Sushkov					No	No
Lab director	Tamara Rezstsova					No	No
Administrator	Zofia Krawczyk					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