MACQUARIE University SYDNEY·AUSTRALIA

PHYS301

Classical Electrodynamics

S1 Day 2019

Dept of Physics and Astronomy

Contents

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General Information

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Credit points 3
Prerequisites MATH235 and PHYS201 and PHYS202
Corequisites
Co-badged status

Unit description

This course extends our development of the classical theory of electromagnetism, the first example of a unified theory in physics and the origin of the concept of fields. We build on the differential Maxwell equations introduced in PHYS202 and its focus on statics to formulate the full dynamical description of electromagnetism in free space and in materials. The techniques developed in this unit provide tools for solving practical problems in power generation and transmission, circuits, radiation and optics, and is essential training for more advanced courses in physics. Topics include electromagnetic waves in vacuum and lossy dielectrics; energy and momentum in electromagnetism; the potential formulation of Maxwell's equations and gauge transformations; phase and group velocities and dispersion; complex field representations and Fourier transforms; causality and Kramers-Krönig relations; special relativity, Lorentz transformations, and the Lorentz invariance of the Maxwell equations. An advanced laboratory program provides the opportunity for students to develop skills in self-directed experimental physics using a wide variety of measurement techniques and equipment.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

- Use their knowledge of mathematical formalisms to explain fundamental concepts and phenomena in electromagnetism
- Explain how the underlying theory of electromagnetism is linked to everyday phenomena, as well as scientific and engineering applications
- Use mathematical formalism to describe special relativity and the physical motivations behind this formalism
- Solve a range of basic problems in special relativity
- Carry out investigations of various physical phenomena experimentally, including performing measurements, analysing the data obtained, and writing detailed reports on these investigations

General Assessment Information

This unit has a hurdle requirement on the laboratory assessment and on the final exam. To the pass the unit, as well as achieving a total mark of at least 50%, you must also achieve a mark of at least 40% in all of the four assessed tasks associated with the laboratory as well as in the final exam.

Assessment Tasks

Name	Weighting	Hurdle	Due
Assignments	20%	No	See Unit Schedule
Laboratory work	30%	Yes	See Unit Schedule
End-of-session examination	50%	Yes	University Examination Period

Assignments

Due: **See Unit Schedule**
Weighting: **20%**

As for all physics units, problem solving is an essential aid to understanding the physical concepts involved and the mathematical tools that must be used. Regular assignments will be set and the problems marked and returned within two weeks. There will be four assignments overall: two assignments in the first half of the course on electromagnetism, and two assignments in the second half of the course on electromagnetism and special relativity. Together the assignments count as 20% of the final assessment. Informal group discussion regarding the assignment problems is encouraged, but students should present their own solutions and should explicitly acknowledge those they have worked with on the assignment. You should also note that the examination in general contains material related to the assignment work.

300-level students should not need to be reminded that working on problems is an essential part of any physics course. It is only by attempting problems that an understanding of new (and sometimes strange) concepts is obtained. Do not hesitate to seek help if you are having difficulties with the assignment problems.

Extension Requests: Given the importance we place on assignments as a key aid to learning we expect assignments to be submitted on time. In turn, we undertake to return your assignments (provided they were submitted on time), marked and with feedback within two weeks of their due date. This will allow us to provide you feedback in time to aid your ongoing learning through the course. Extensions will only be considered if requested with valid reasons **prior to the due date**.

If for any reason a student is unable to submit an assignment by the due date, the student should contact the relevant staff member as soon as possible, explain the situation, and request an extension. If such contact is not made, then the student will be penalised 20% for each working day that the assignment is late (i.e. an assignment due on a Friday and handed in on a Monday is penalised as if it is one day late). As complete solutions for an assignment are usually handed out to the class a week after the assignment is due, an extension beyond a week is generally not possible, and in any case would receive a grade of zero.

On successful completion you will be able to:

- Use their knowledge of mathematical formalisms to explain fundamental concepts and phenomena in electromagnetism
- Explain how the underlying theory of electromagnetism is linked to everyday phenomena, as well as scientific and engineering applications
- Use mathematical formalism to describe special relativity and the physical motivations behind this formalism
- Solve a range of basic problems in special relativity

Laboratory work

Due: **See Unit Schedule**
Weighting: **30%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

Labs start in the second week of term. During the session, you are required to carry out four experiments, each taking no more than two weeks to complete.

You will submit one draft report, and two final reports according to the lab timetable (see 'Unit Schedule' in this Guide). These dates are not negotiable except in cases of serious illness or misadventure. A late penalty may otherwise be imposed. The two final reports are **each** worth 10% of the unit total.

Your draft report is not formally assessed, but will be carefully reviewed and returned to you with corrections and feedback to enable you to produce a improved final report to resubmit for grading. This submission of a first draft is a necessary part of acquiring the skills for constructing a professional scientific report. No draft of the second report is required, but you can of course ask for informal feedback.

Logbooks with the record of experimental data are to be kept, and will be retained at the end of the session. Your records of the two experiments that you did not write full reports for will be assessed, **each** of the two worth 5% of the unit total. Logbooks will be assessed for readability, layout, completeness and clarity. While not a formal report, a full record of the experiment in your logbook must include relevant calculations and graphs for each experiment. Raw results with no analysis are not acceptable.

The two formal reports (20%) and the two lab book records (10%) make a total of 30% for the laboratory assessment.

Satisfactory completion of the laboratory assessment is a hurdle task. You must achieve at least 40% in each of the four assessed tasks to pass the unit. If you fail to reach this mark, you must arrange to retake that assessment item, after discussion with the marker.

On successful completion you will be able to:

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- Explain how the underlying theory of electromagnetism is linked to everyday phenomena, as well as scientific and engineering applications
- Carry out investigations of various physical phenomena experimentally, including performing measurements, analysing the data obtained, and writing detailed reports on these investigations

End-of-session examination

Due: **University Examination Period**
Weighting: **50%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

There will be a 3 hour end-of-session final exam to be held in the University Examination Period.

You should have a scientific calculator for use during the final examination. Note that calculators with text retrieval are not permitted for the final examination.

You are expected to present yourself for the final examination at the time and place designated in the University examination timetable (https://iexams.mq.edu.au/timetable). The timetable will be available in draft form approximately eight weeks before the commencement of examinations and in final form approximately four weeks before the commencement of examinations.

The final examination is a hurdle requirement. You must obtain a mark of at least 40% in the final exam to be eligible to pass the unit. If your mark in the final examination is between 30% and 39% inclusive, you may be a given a second and final chance to attain the required level of performance; the mark awarded for the second exam towards your final unit mark will be capped at 40%, and you will be allowed to sit the second exam only if this mark would be sufficient to pass the unit overall.

If you receive special consideration for the final exam, a supplementary exam will be scheduled in the week of July 15-26 2019. By making a special consideration application for the final exam you are declaring yourself available for a resit during the supplementary examination period and will not be eligible for a second special consideration approval based on pre-existing commitments. Please ensure you are familiar with the policy prior to submitting an application. Approved applicants will receive an individual notification one week prior to the exam with the exact date and time of their supplementary examination.

If you are given a second opportunity to sit the final examination as a result of failing to meet the minimum mark required, you will be offered that chance during the same supplementary examination period and will be notified of the exact day and time after the publication of final results for the unit.

On successful completion you will be able to:

- Use their knowledge of mathematical formalisms to explain fundamental concepts and phenomena in electromagnetism

- Explain how the underlying theory of electromagnetism is linked to everyday phenomena, as well as scientific and engineering applications
- Use mathematical formalism to describe special relativity and the physical motivations behind this formalism
- Solve a range of basic problems in special relativity

Delivery and Resources

Classes

Mixed Lecture and Tutorial/discussion

The timetable for classes can be found on the University web site at: https://timetables.mq.edu.au/2019/

Laboratories will commence in the second week of semester.

Required and Recommended Texts and/or Materials

Required Text

Electromagnetism: Introduction to Electrodynamics, DJ Griffiths, 3rd or 4th edition (Prentice Hall, Englewood Cliffs, N J).

Recommended Readings

The Feynman Lectures on Physics, Vol II, Addison Wesley

Technology Used and Required

Unit Web Page

This unit will be administered through iLearn. Please check this site regularly for lecture and extension material available for downloading and look out for announcements. We will run one or more discussion fora through the iLearn page for both technical physics and administrative issues. Staff will ignore emails and discussion questions about issues which are already explained in this document or which have been covered in the announcements and discussion features of the iLearn page.

Teaching and Learning Strategy

The theoretical aspects of this unit are taught in lectures and tutorials with fortnightly assignments to strengthen the understanding of the material. The theoretical material is heavily mathematical in nature, and often abstract, and true understanding can only be achieved through testing and refining understanding through problem solving.

The experimental aspects of the unit require students to attend laboratories where they will be expected to set up experiments, take data, analyse the data within the context of the physical phenomena that are being studied, maintain a laboratory log-book, and report on their findings in clearly written laboratory reports.

Schedule of topics

Review of Maxwell’s Equations of electro and magneto statics in vacuum

Electro and magneto-statics in media

Electrodynamics in vacuum

Properties of electromagnetic waves

Electromagnetic waves in matter

Propagation and dispersion

Dipole radiation

Introduction to special relativity

The structure of space-time

Relativistic Kinematics

Relativistic Dynamics

Electromagnetism and relativity

Unit Schedule

Schedule of assessable tasks and related materials

Assignments

There will be four assignments. Dates available and due dates will be given during the course.

Laboratory Schedule

You are required to carry out four different experiments and each should take not more than two weeks to complete. You will be submitting two full lab reports and two experiments will be assessed based on your log book. Due dates are shown below. These dates are not negotiable except in cases of serious illness or misadventure. A late penalty may otherwise be imposed.

Regular labs run from week 2 to week 11. There are no labs scheduled in weeks 4 and 7; you should use this time wisely to work on your reports.

Week 1:   No lab

Week 2:   Experiment 1

Week 3:   Experiment 1

Week 4:   Free week to write draft report for Experiment 1, due **Monday of week 5**.

Week 5:   Experiment 2

Week 6:   Experiment 2

Week 7:   Free week to work on your reports.

Mid-session break

Week 8: Experiment 3. Final report for experiment 1 **due Monday of week 8**.

Week 9: Experiment 3

Week 10: Experiment 4.

Week 11: Experiment 4. Final report for experiment 2 or 3 **due Monday of week 11**.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
- Special Consideration Policy *(**Note:** The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.)*

Undergraduate students seeking more policy resources can visit the Student Policy Gateway (https://students.mq.edu.au/support/study/student-policy-gateway). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/student-conduct

Results

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

If you are a Global MBA student contact globalmba.support@mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcomes

- Solve a range of basic problems in special relativity
- Carry out investigations of various physical phenomena experimentally, including performing measurements, analysing the data obtained, and writing detailed reports on these investigations

Assessment tasks

- Assignments
- Laboratory work
- End-of-session examination

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcomes

- Use their knowledge of mathematical formalisms to explain fundamental concepts and phenomena in electromagnetism
- Solve a range of basic problems in special relativity
- Carry out investigations of various physical phenomena experimentally, including performing measurements, analysing the data obtained, and writing detailed reports on these investigations

Assessment tasks

- Assignments
- Laboratory work
- End-of-session examination

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning outcomes

- Use their knowledge of mathematical formalisms to explain fundamental concepts and phenomena in electromagnetism
- Explain how the underlying theory of electromagnetism is linked to everyday phenomena, as well as scientific and engineering applications

- Use mathematical formalism to describe special relativity and the physical motivations behind this formalism
- Solve a range of basic problems in special relativity
- Carry out investigations of various physical phenomena experimentally, including performing measurements, analysing the data obtained, and writing detailed reports on these investigations

Assessment tasks

- Assignments
- Laboratory work
- End-of-session examination

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- Use their knowledge of mathematical formalisms to explain fundamental concepts and phenomena in electromagnetism
- Explain how the underlying theory of electromagnetism is linked to everyday phenomena, as well as scientific and engineering applications
- Use mathematical formalism to describe special relativity and the physical motivations behind this formalism
- Solve a range of basic problems in special relativity
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Assessment tasks

- Assignments
- Laboratory work
- End-of-session examination

Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Use their knowledge of mathematical formalisms to explain fundamental concepts and phenomena in electromagnetism
- Explain how the underlying theory of electromagnetism is linked to everyday phenomena, as well as scientific and engineering applications
- Use mathematical formalism to describe special relativity and the physical motivations behind this formalism
- Solve a range of basic problems in special relativity
- Carry out investigations of various physical phenomena experimentally, including performing measurements, analysing the data obtained, and writing detailed reports on these investigations

Assessment tasks

- Assignments
- Laboratory work
- End-of-session examination

Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- Use their knowledge of mathematical formalisms to explain fundamental concepts and phenomena in electromagnetism
- Explain how the underlying theory of electromagnetism is linked to everyday phenomena, as well as scientific and engineering applications

- Use mathematical formalism to describe special relativity and the physical motivations behind this formalism
- Solve a range of basic problems in special relativity
- Carry out investigations of various physical phenomena experimentally, including performing measurements, analysing the data obtained, and writing detailed reports on these investigations

Assessment tasks

- Assignments
- Laboratory work
- End-of-session examination

Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Learning outcome

- Use their knowledge of mathematical formalisms to explain fundamental concepts and phenomena in electromagnetism

Assessment tasks

- Assignments
- Laboratory work
- End-of-session examination

Feedback

Student Liaison Committee

The Physics Department values quality teaching and engages in periodic student evaluations of its units, external reviews of its programs and course units, and seeks formal feedback from students via focus groups and the Student Liaison Committee. Please consider being a member of this committee, which meets once during the semester (lunch provided), with the purpose of improving teaching via student feedback. The class will be asked to nominate two students as representatives for the PHYS301 unit on the student liaison committee. This nomination process will be conducted during lectures and the lecturer will forward the names to the Head of Department. The SLC meetings are minuted and student representatives receive copies of the minutes from the two preceding SLC meetings prior to the meeting. An update on the responses that have been made by the department to the feedback obtained at the two preceding SLC meetings are reported by the Head of Department at the beginning of each SLC meeting. These responses are also minuted. The feedback is acted upon in a number of ways mostly initiated via Department of Physics and Astronomy meetings, where decisions on actions are taken.

Standards Expectation

Grading

An aggregate standard number grade (SNG) corresponding to a pass (P) is required to pass this unit.

High Distinction (HD, 85-100%): provides consistent evidence of deep and critical understanding in relation to the learning outcomes. There is substantial originality and insight in identifying, generating and communicating competing arguments, perspectives or problem solving approaches; critical evaluation of problems, their solutions and their implications; creativity in application.

Distinction (D, 75-84%): provides evidence of integration and evaluation of critical ideas, principles and theories, distinctive insight and ability in applying relevant skills and concepts in relation to learning outcomes. There is demonstration of frequent originality in defining and analysing issues or problems and providing solutions; and the use of means of communication appropriate to the discipline and the audience.

Credit (Cr, 66-74%): provides evidence of learning that goes beyond replication of content knowledge or skills relevant to the learning outcomes. There is demonstration of substantial understanding of fundamental concepts in the field of study and the ability to apply these concepts in a variety of contexts; plus communication of ideas fluently and clearly in terms of the conventions of the discipline.

Pass (P, 50-65%): provides sufficient evidence of the achievement of learning outcomes. There is demonstration of understanding and application of fundamental concepts of the field of study; and communication of information and ideas adequately in terms of the conventions of the discipline. The learning attainment is considered satisfactory or adequate or competent or capable in relation to the specified outcomes.

Fail (F, 0-49%): does not provide evidence of attainment of all learning outcomes. There is missing or partial or superficial or faulty understanding and application of the fundamental concepts in the field of study; and incomplete, confusing or lacking communication of ideas in ways that give little attention to the conventions of the discipline.