PHYS202

Electricity and Magnetism

S2 Day 2016

Dept of Physics and Astronomy

Contents

General Information

Unit convenor and teaching staff
Lecturer
Thomas Volz
thomas.volz@mq.edu.au
Contact via thomas.volz@mq.edu.au
E6B 2.611

Lab professional officer
Adam Joyce
adam.joyce@mq.edu.au
Contact via adam.joyce@mq.edu.au
E7B 214

Lecturer, Unit convener
Judith Dawes
judith.dawes@mq.edu.au
Contact via judith.dawes@mq.edu.au
E6B 2.708

Demonstrator
Ewa Goldys
ewa.goldys@mq.edu.au
Contact via email ewa.goldys@mq.edu.au
E6B 2.704

Demonstrator
Michael Withford
michael.withford@mq.edu.au
Contact via michael.withford@mq.edu.au
W1A 4.460

Demonstrator
Doug Little
douglas.little@mq.edu.au
Contact via douglas.little@mq.edu.au
C5A 417

Credit points
3

Prerequisites (MATH133 or MATH136) and [(PHYS140 and PHYS143) or (PHYS106 and PHYS107)]	
Corequisites MATH235	
Co-badged status	
Unit description The theory of electromagnetism, one of the most successful and most widely applied theories of modern physics, describes the properties and behaviour of electric and magnetic fields and their interaction with charged matter. This theory underlies all of modern optics, telecommunication and electrical engineering, and has played an important role in furthering our understanding of the fundamental forces of nature. The basic laws of electromagnetism are introduced in this unit, and their important consequences and applications in electrostatics, magnetostatics and electrodynamics are studied. It is also shown how these laws can be re-expressed in terms of the more powerful mathematical language of vector calculus, which leads to the development of Maxwell's equations. These equations give a fully unified description of electromagnetism in both static and dynamic situations. The overwhelming success of these equations in describing electromagnetic phenomena is illustrated by studying electric and magnetic fields in matter, and electromagnetic waves. More advanced techniques of experimental physics including indirect measurement of microscopic quantities are covered in weekly guided laboratory sessions, as are further data analysis techniques and regular report writing.	

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:

Understanding and skill in differential and integral calculus with scalar and vector fields in cartesian, spherical, and cylindrical coordinates.

Understanding of and a facility for solving problems involving electric fields in the vacuum.

Ability to use symmetry arguments to derive electric and magnetic fields from various configurations of charges and currents.

Understanding of and a facility for solving problems involving time dependent electric and magnetic fields.

Understanding and applying thermodynamic principles to describe physical systems and

solve quantitative and qualitative problems concerning thermodynamic systems.
Developing experimental physics skills in setting up and safely operating laboratory equipment to perform specific measurements, and analysing and interpreting the results of the experiments in the context of discipline knowledge.

General Assessment Information

This unit has hurdle requirements, specifying a minimum standard that must be attained in aspects of the unit. To pass this unit you must obtain a mark of at least:

- 50% in the unit overall

as well as

- 40% in the final examination

- 40% in the laboratory activities

- at least 40% in at least 8 of 12 quizzes

Assessment Tasks

Name	Weighting	Due
Tutorial quizzes	20%	Weekly
Final Examination (3 hours)	45%	University Examination Period
Laboratory reports	20%	Week
Mid-semester assignment	15%	Week 8

Tutorial quizzes

Due: **Weekly**
Weighting: **20%**

Students will work on assigned problems related to the lecture material each week. These will be discussed in the Tutorials, and a 15-minute quiz related to the previous week's tutorial questions will also be completed each week during the tutorial. The best 7 quiz marks out of a possible 11 marks will contribute 20% to the final grade.

Satisfactory performance in quizzes is a hurdle requirement. You must obtain a mark of at least 40% in at least 7 out of the 11 scheduled quizzes to pass the unit. No additional quizzes will be offered for those who fail to meet this requirement.

On successful completion you will be able to:

- Understanding and skill in differential and integral calculus with scalar and vector fields in

cartesian, spherical, and cylindrical coordinates.
- Understanding of and a facility for solving problems involving electric fields in the vacuum.
- Ability to use symmetry arguments to derive electric and magnetic fields from various configurations of charges and currents.
- Understanding of and a facility for solving problems involving time dependent electric and magnetic fields.
- Understanding and applying thermodynamic principles to describe physical systems and solve quantitative and qualitative problems concerning thermodynamic systems.

Final Examination (3 hours)

Due: **University Examination Period**
Weighting: **45%**

The final examination is a hurdle requirement. You must obtain a mark of at least 40% to pass the unit. If your mark in the final examination is between 30% and 39% inclusive then you will be a given a second and final chance to attain the required level of performance.

You are expected to present yourself for examination at the time and place designated in the University Examination Timetable. The draft timetable will be available approximately eight weeks before the commencement of the examinations and the final timetable approximately four weeks before the commencement of the examinations. Exam timetables are available at http://www.timetables.mq.edu.au/exam.

If you do not sit the final examination at the designated time due to documented illness or unavoidable disruption, you may wish to consider applying for Special Consideration. Supplementary Examinations will be scheduled after the conclusion of the official examination period.

It is Macquarie University policy not to set early examinations for individuals or groups of students. All students are expected to ensure that they are available until the end of the official examination period.

The final examination will include material from both halves of the unit, with more emphasis on the material taught in the final 6 weeks of the unit.

On successful completion you will be able to:

- Understanding and skill in differential and integral calculus with scalar and vector fields in cartesian, spherical, and cylindrical coordinates.
- Understanding of and a facility for solving problems involving electric fields in the vacuum.
- Ability to use symmetry arguments to derive electric and magnetic fields from various configurations of charges and currents.

- Understanding of and a facility for solving problems involving time dependent electric and magnetic fields.
- Understanding and applying thermodynamic principles to describe physical systems and solve quantitative and qualitative problems concerning thermodynamic systems.

Laboratory reports

Due: **Week**
Weighting: **20%**

Laboratory work will begin in week 2 . Students must bring a laboratory notebook to the first class. Lab notes for each experiment will be provided in the lab. Each experiment is allotted two weeks for completion and you are expected to complete 5 experiments.

You must keep a laboratory notebook, in which you keep a record of all activities. In addition you will be required to write a full report on one experiment of your choice. Some notes about laboratory log books and report writing are included in an appendix at the end of this outline.

The purpose of the laboratory work is to expose you to a range of physical concepts and experimental techniques which spread beyond the coverage of the lectures. In addition we hope that your ability to maintain a written record of your laboratory work and to write reports on your work will develop further. To this end, the laboratory will be assessed in the following way:

(i) Your laboratory notebook will be marked each fortnight. If it is less than satisfactory, it will be returned to you for correcting, and then re-marked. All relevant calculations must be done, the appropriate graphs drawn, and uncertainties assessed where appropriate.

(ii) You are required to submit a full report on one two-week experiment of your choosing from the first three experiments that you have completed. This report will be submitted in draft form initially. It will be marked and returned to you with comments for its improvement. When the report is resubmitted, your first attempt should also be handed in for comparison. The mark awarded for the report will be that obtained in the second marking. (However, if you obtain more than 7 out of 10 for the initial submission, then handing in the final version is optional.) This strategy gives you the opportunity to use the feedback from staff to help you develop professional report-writing skills before your work is finally graded.

The draft report is to be submitted by the end of week 9 with the final version by the beginning of week 13.

Permission may be granted for late submission of laboratory reports if the request for consideration is made prior to the due date. Reports submitted late may be subject to a marking penalty of one-half mark (out of ten marks) for each working day that the report is late, unless a valid, extraordinary, substantiated reason for late submission is presented to the Unit Convenor.

An increasing number of students are choosing to submit laboratory reports in word-processed form. This is a good procedure, however there are some points which need to be kept in mind. If you are not accustomed to using a word processor, the process can take much longer than writing a report by hand. In addition, problems with hardware can arise which cause delays and frustration. As a general rule we are not sympathetic to late reports caused by computer faults.

If you are planning to word-process your report it may also be advisable to bring a memory stick to the lab sessions. Some experiments have data recorded on PCs which can be saved direct to your memory stick, then included in your report.

The relative weighting of the components of the laboratory assessment will be

Laboratory log book 14%

Report 6%

TOTAL 20%

Satisfactory completion of laboratories is a hurdle requirement. You must obtain a mark of at least 40% in the laboratory activities to pass the unit. If you miss or fail an activity, you must within two weeks arrange a new time to perform the activity.

On successful completion you will be able to:

- Understanding of and a facility for solving problems involving electric fields in the vacuum.
- Understanding of and a facility for solving problems involving time dependent electric and magnetic fields.
- Understanding and applying thermodynamic principles to describe physical systems and solve quantitative and qualitative problems concerning thermodynamic systems.
- Developing experimental physics skills in setting up and safely operating laboratory equipment to perform specific measurements, and analysing and interpreting the results of the experiments in the context of discipline knowledge.

Mid-semester assignment

Due: **Week 8**
Weighting: **15%**

A mid-semester assignment based on the first 7 weeks of material in the unit will be announced during Week 6. It will be due in week 8 after the midsemester break.

On successful completion you will be able to:

- Understanding of and a facility for solving problems involving electric fields in the vacuum.
- Ability to use symmetry arguments to derive electric and magnetic fields from various configurations of charges and currents.
- Understanding of and a facility for solving problems involving time dependent electric and magnetic fields.

Delivery and Resources

Classes

Lectures

Tutorials will commence in the first week of semester

Laboratory will commence in the second week of semester

Required and Recommended Texts and/or Materials

Required Texts

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

Stephen Blundell and Katherine Blundell, *Concepts in Thermal Physics,* (Oxford University Press, Oxford, 2006)

Recommended Readings

- John R Reitz, Frederick J Milford and Robert W Christy, *Foundations of Electromagnetic Field Theory, 4th ed* (Addison-Wesley, Reading, MA, 1993)
- Paul Lorrain, Dale R Corson, and Francois Lorrain, *Electromagnetic Fields and Waves, 3rd ed* (W H Freeman, New York, 1988)
- David K Cheng, *Field and Wave Electromagnetics, 2nd Ed* (Addison Wesley, New York, 1989)
- John D Kraus, *Electromagnetics 4th Ed* (McGraw-Hill, New York, 1991)
- Les Kirkup, *Experimental Methods* (Wiley, Brisbane, 1994), chapter 7; QC371557
- Pamela Peters, *Strategies for Student Writers: a Guide to Writing* (Wiley, Milton, Queensland, 1985); PE1471P42

Technology Used and Required

Unit Web Page

The web page for this unit can be found at:

http://physics.mq.edu.au/current/undergraduate/units/PHYS202/index.html

Teaching and Learning Strategy

The first part of PHYS202 concerns Electromagnetism. Although we will be following the text by Griffiths, this material is fairly standard and many texts cover it. The actual physics will not be new to you; it has been covered in previous physics units. What will be new are the mathematical methods used to describe it - in particular vector calculus.

In the text by Griffiths, chapter 1 gives an outline of vector calculus. This unit will cover a large part of the material in chapters 2, 5, and 7 and selected topics from chapters 4, 6 and 9 of the text.

The second part of PHYS202 concerns Thermodynamics. Carefully defining temperature, heat, energy, and entropy, we will explore the implications of the first and second laws of thermodynamics. In particular, we will apply thermodynamic concepts to the processes in heat engines and to the modeling of internal energy, enthalpy, the Helmholtz function and the Gibbs function.

In the text by Blundell and Blundell, we will concentrate on chapters 1 and 2, chapter 4, chapters 11, 12, 13, 14, and chapter 16.

NOTE: To succeed in this course you will need to do many practice exercises from the textbooks and the tutorial questions. You are encouraged to work on the tutorial questions in advance of the tutorials to make the best use of the tutorial time for feedback. This will help build intuition for the physical concepts and skill in the mathematics involved. If you are comfortable with solving the tutorial and end-of-chapter textbook problems independently then you should perform well in the mid-semester and final exams.

Unit Schedule

First half:

- (Week 1) Review of mathematical tools for treating scalar and vector fields.
- (Week 2,3) Electric fields, the electric potential, work and energy, and conductors. Multipole expansions.
- (Week 4,5) The Lorentz force law, the Biot-Savart Law, and the divergence and curl of the magnetic field. Magnetic vector potential.
- (Weeks 6,7) Electric motive force, electromagnetic induction, the displacement current. Overview of Maxwell's equations.

Second half:

- (Week 8) Temperature, heat and heat capacity (B&B Chapters 1,2, 4)
- (Week 9) First Law of Thermodynamics (B&B Chapters 11, 12)
- (Week 10) Second Law of Thermodynamics (B&B Chapter 13)
- (Week 11) Entropy (B&B Chapter 14)
- (Week 12) Applications of Thermodynamics (B&B Chapter 16)
- (Week 13) Revision

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central. Students should be aware of the following policies in particular with regard to Learning and Teaching:

Academic Honesty Policy http://mq.edu.au/policy/docs/academic_honesty/policy.html

New Assessment Policy in effect from Session 2 2016 http://mq.edu.au/policy/docs/assessment/policy_2016.html. For more information visit http://students.mq.edu.au/events/2016/07/19/new_assessment_policy_in_place_from_session_2/

Assessment Policy prior to Session 2 2016 http://mq.edu.au/policy/docs/assessment/policy.html

Grading Policy prior to Session 2 2016 http://mq.edu.au/policy/docs/grading/policy.html

Grade Appeal Policy http://mq.edu.au/policy/docs/gradeappeal/policy.html

Complaint Management Procedure for Students and Members of the Public http://www.mq.edu.au/policy/docs/complaint_management/procedure.html

Disruption to Studies Policy http://www.mq.edu.au/policy/docs/disruption_studies/policy.html *The Disruption to Studies Policy is effective from March 3 2014 and replaces the Special Consideration Policy.*

In addition, a number of other policies can be found in the Learning and Teaching Category of 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/support/student_conduct/

Results

Results shown in *iLearn*, 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.

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

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:

Assessment tasks

- Tutorial quizzes
- Final Examination (3 hours)
- Laboratory reports

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 outcome

- Developing experimental physics skills in setting up and safely operating laboratory equipment to perform specific measurements, and analysing and interpreting the results of the experiments in the context of discipline knowledge.

Assessment tasks

- Final Examination (3 hours)
- Mid-semester assignment

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:

Assessment tasks

- Tutorial quizzes
- Final Examination (3 hours)
- Laboratory reports
- Mid-semester assignment

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

- Understanding and skill in differential and integral calculus with scalar and vector fields in cartesian, spherical, and cylindrical coordinates.
- Understanding of and a facility for solving problems involving electric fields in the vacuum.
- Ability to use symmetry arguments to derive electric and magnetic fields from various configurations of charges and currents.
- Understanding of and a facility for solving problems involving time dependent electric and magnetic fields.
- Understanding and applying thermodynamic principles to describe physical systems and solve quantitative and qualitative problems concerning thermodynamic systems.

- Developing experimental physics skills in setting up and safely operating laboratory equipment to perform specific measurements, and analysing and interpreting the results of the experiments in the context of discipline knowledge.

Assessment tasks

- Tutorial quizzes
- Final Examination (3 hours)
- Laboratory reports
- Mid-semester assignment

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

- Understanding and skill in differential and integral calculus with scalar and vector fields in cartesian, spherical, and cylindrical coordinates.
- Understanding of and a facility for solving problems involving electric fields in the vacuum.
- Ability to use symmetry arguments to derive electric and magnetic fields from various configurations of charges and currents.
- Understanding of and a facility for solving problems involving time dependent electric and magnetic fields.
- Understanding and applying thermodynamic principles to describe physical systems and solve quantitative and qualitative problems concerning thermodynamic systems.

Assessment tasks

- Tutorial quizzes
- Final Examination (3 hours)
- Laboratory reports
- Mid-semester assignment

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

- Understanding and skill in differential and integral calculus with scalar and vector fields in cartesian, spherical, and cylindrical coordinates.
- Understanding of and a facility for solving problems involving electric fields in the vacuum.
- Understanding of and a facility for solving problems involving time dependent electric and magnetic fields.
- Understanding and applying thermodynamic principles to describe physical systems and solve quantitative and qualitative problems concerning thermodynamic systems.
- Developing experimental physics skills in setting up and safely operating laboratory equipment to perform specific measurements, and analysing and interpreting the results of the experiments in the context of discipline knowledge.

Assessment tasks

- Tutorial quizzes
- Final Examination (3 hours)
- Laboratory reports
- Mid-semester assignment

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 outcomes

- Understanding of and a facility for solving problems involving electric fields in the vacuum.
- Understanding of and a facility for solving problems involving time dependent electric and magnetic fields.
- Understanding and applying thermodynamic principles to describe physical systems and solve quantitative and qualitative problems concerning thermodynamic systems.

- Developing experimental physics skills in setting up and safely operating laboratory equipment to perform specific measurements, and analysing and interpreting the results of the experiments in the context of discipline knowledge.

Assessment tasks

- Laboratory reports
- Mid-semester assignment

Changes from Previous Offering

Thermodynamics has been added to this unit to ensure a better preparation for 300 level physics and astronomy. Some topics on electro magnetism in materials have been removed.

Electricity and Magnetism background test - week 1

We will administer a revision test of electricity and magnetism concepts from first year physics during the week 1 tutorial. This test will not contribute to the final assessment.

Changes since First Published

Date	Description
18/10/2016	We updated the hurdle requirement for quizzes to 7 out of 11 from 8 out of 12. This is because we skipped a week of quizzes when Judith started lecturing in week 8.