



PHYS202

Electromagnetism and Thermodynamics

S2 Day 2019

Dept of Physics and Astronomy

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General Information

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Credit points

3

Prerequisites

(MATH133 or MATH136) and [(PHYS140 and PHYS143) or (PHYS106 and PHYS107)]

Corequisites

MATH235

Co-badged status

Unit description

This unit introduces the principles, theory and application of the two great pillars of 19th century classical physics: electromagnetism and thermodynamics. We first develop the theory of electromagnetism, which describes the properties and behaviour of electric and magnetic fields and their interaction with charged matter. Maxwell's four laws of electromagnetism are revisited, in the powerful language of vector calculus. We explore their power for understanding phenomena in electrostatics, magnetostatics and electrodynamics. We then address the thermodynamic principles which guide our understanding of the physical world: the conservation of energy and the increase in entropy. We motivate the introduction of macroscopic state functions such as temperature, pressure, and volume to characterise the state of a system, and connect them with the concept of the equation of state, including the case of ideal and Van der Waals gases. The formulation of the Zeroth through the Third Laws of Thermodynamics are used to understand the concepts of reversible and irreversible engines as exemplars of all thermodynamic systems. Finally, we make a connection between entropy and information theory. Advanced techniques of experimental physics including indirect measurement of microscopic quantities are covered in guided laboratory sessions, as are data analysis techniques and 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.

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 constant as well as 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

and

- 40% in each individual laboratory activity (report or lab book).

Assessment Tasks

Name	Weighting	Hurdle	Due
<u>Tutorial Quizzes</u>	25%	No	Weeks 3 - 13
<u>Final Examination (3 hours)</u>	40%	Yes	University Examination Period
<u>Laboratory Reports</u>	20%	Yes	Fortnightly
<u>Assignment</u>	5%	No	Week 7
<u>Pre-class Annotations</u>	10%	No	Weeks 7 - 12

Tutorial Quizzes

Due: **Weeks 3 - 13**

Weighting: **25%**

Tutorials will start in week 2. Students will work on assigned problems related to the lecture material each week. These will be discussed in the tutorials, and a short 10-minute quiz related to the previous week's questions will also be completed each week during the tutorials. Quizzes will start in week 3 for a total of 11 quizzes.

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.

- 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 constant as well as 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: **40%**

This is a hurdle assessment task (see [assessment policy](#) for more information on hurdle assessment tasks)

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>.

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.

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 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 after results are released. Please see FSE101 in iLearn for dates. 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. Second chance exams for hurdle assessments will also be scheduled in this period.

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.

- 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 constant as well as 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: **Fortnightly**

Weighting: **20%**

This is a hurdle assessment task (see [assessment policy](#) for more information on hurdle assessment tasks)

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 will be posted on iLearn.

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 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.

If you are planning to word-process your report (optional) 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 each individual laboratory assessment task (i.e. for each of the lab book reports AND for the full report) 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 constant as well as 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.

Assignment

Due: **Week 7**

Weighting: **5%**

You will be given one assignment in the first half of the unit which is intended to further develop your understanding of the unit topics. While we encourage you to discuss the assignment problems with your colleagues, you must submit your own original work.

On successful completion you will be able to:

- 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 constant as well as time dependent electric and magnetic fields.

Pre-class Annotations

Due: **Weeks 7 - 12**

Weighting: **10%**

In the second half of the course, you will be required to read material before class and discuss with your colleagues using the Online-platform Perusall.

Perusall helps you master readings faster, understand the material better, and get more out of your classes. To achieve this goal, you will be collaboratively annotating assigned pre-readings with others in your class. The help you'll get and provide your classmates will get you past confusions quickly and will make the process more fun. While you read, you'll receive rapid answers to your questions, help others resolve their questions (which also helps you learn), and advise the lecturer how to make class time most productive. You can start a new annotation thread in *Perusall* by highlighting text, asking a question, or posting a comment; you can also add a reply or comment to an existing thread. Each thread is like a chat with one or more members of your class, and it happens in real time. Your goals in annotating each reading assignment are *to stimulate discussion by posting good questions or comments* and *to help others by answering their questions*.

Each weekly reading assignment (weeks 7 - 12) will be posted on Monday. You will be marked on the annotations you submit before the Thursday lecture each week. Your final score will be based on the overall quality and quantity of your annotations.

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.
- 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 constant as well as time dependent electric and magnetic fields.

Delivery and Resources

Classes

Lectures will commence in the first week of semester

Tutorials will commence in the second week of semester

Laboratories will commence in the second week of semester

Required and Recommended Texts and/or Materials

Required Texts

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

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

The first 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.

The second 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, 3, 5, and 7 and selected topics from other chapters of the text.

As discussed in the assessment tasks section, you will also be given pre-readings at the start of each week in weeks 7-12. These will be based on the text by Griffith and will complement your learning.

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

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 quizzes and the final exam.

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) (<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) (<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) (<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:

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)
- Assignment
- Pre-class Annotations

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
- Assignment
- Pre-class Annotations

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.
- 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 constant as well as 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
- Assignment
- Pre-class Annotations

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.
- 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 constant as well as 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

- Assignment
- Pre-class Annotations

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 constant as well as 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
- 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 constant as well as 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
- Assignment
- Pre-class Annotations

Engaged and Ethical Local and Global citizens

As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

This graduate capability is supported by:

Assessment task

- Pre-class Annotations

Changes from Previous Offering

The lecture material will be delivered in 2 hours per week, and the tutorials have been extended to 2 hours per week, to encourage greater practice in problem solving and understanding applications of the lecture topics. This approach has been successfully adopted in first year teaching for a few years.