# ELECTROMAGNETIC THEORY III

## PHYS3050

**DR ZBIGNIEW FICEK**
**Co-ordinator and Lecturer**

# Electromagnetic Theory III
# PHYS3050
# Semester 2, 2003

## Purpose of the course

The course is intended to introduce classical electromagnetic theory embodying Maxwell's equations
with applications mainly to situations where electric charge can be treated as a continuous fluid.

## Staff

Dr. Zbigniew Ficek (Coordinator and Lecturer)
Room 2.24 Physics Annexe(6)
Tel: 3365 2331
ficek@physics.uq.edu.au
Office Hours: Wednesday 2.00pm – 4.00pm.

## Class contact hours

**4C**

## Web page

The course profile and course material can be found on the web at the following address:
http://www.physics.uq.edu.au/subjects/phys3050

This also contains up-to-date news about the course material and announcements for students.

## Course goals

On completing this course students will:

- Understand the logical structure of the classical electromagnetic theory.
- Understand the experimental basis of the classical theory.
- Be able to work problems on topics listed in the syllabus below.

## Assumed background

- An introductory (first level) course on electric and magnetic fields.
- An introductory (second level) course on Einstein's special theory of relativity.
- The mathematics of vector fields including differential point functions and Gauss' & Stokes' theorems.

## Teaching and learning methods

There are four contact hours per week. The total contact hours will be divided in to approximately 26 lectures and 24 hours of tutorials. Lectures will cover the formal course content. Typed lecture notes and tutorial problems will be available on web. In the problem solving tutorials, students will be expected to work on and to discuss the tutorial problems provided. Typed solutions to the tutorial problems will be provided. The tutorials are problem solving sessions. The importance of the tutorials is emphasized.

## Assessment program

A mid-semester examination contributing 30% of the overall assessment will be held in the seventh week of semester (12 September). A final 2-hour examination in the normal end-of-semester examination period will account for the remaining 70% of the overall assessment.

## Assessment and grading

A 1 1/2 hour mid-semester test in the tutorial period of the seventh week of semester (12 September) counting for 30% of the total assessment.
A two hour end of semester examination centrally timetabled and conducted in the end of semester examination period counting for 70% of the total assessment.

## Assessment criteria

The assessment will be criteria based. The student’s achievement of the goals of the course will be shown by their being able to

- Define, explain and interrelate the key concepts involved in the course.
- Recognise the regime of applicability of the theory presented.
- Use the basic theory to describe quantitatively the behaviour of important physical systems treated.
- Apply the theory to new physical problems.
- Utilise the appropriate mathematical and other techniques to derive relationships for physical quantities.
- Have an appreciation of the orders of magnitude of important quantities.
- Discuss and present solutions to prepared problems in the tutorial and answer related questions.

## Criteria for the award of grades

Your grade for this course will be determined by which of the following levels of achievement that you consistently display in the items of summative assessment.

Grade of 7: the student demonstrates an excellent understanding of the theory of the topics listed in the course outline and is highly proficient in applying the techniques to solve both theoretical and practical problems.

Grade of 6: the student demonstrates a comprehensive understanding of the theory of the topics listed in the course outline and is proficient in applying the techniques to solve both theoretical and practical problems.

Grade of 5: the student demonstrates a good understanding of the theory of the topics listed in the course outline and can apply the techniques to solve problems.

Grade of 4: the student demonstrates an understanding of the theory of the topics listed in the course outline and demonstrates a knowledge of the techniques used to solve problems.

Grade of 3: the student demonstrates some understanding of the theory of the topics listed in the course outline and demonstrates a knowledge of the techniques used to solve problems.

Grade of 2: the student demonstrates limited understanding of the theory of the topics listed in the course outline and demonstrates limited knowledge of the techniques used to solve problems. This includes attempts at expressing their deductions and explanations and attempts to answer a few questions accurately.

Grade of 1: the student demonstrates very limited understanding of the theory of the topics listed in the course outline and of the basic concepts in the course material. This includes attempts at answering some questions but demonstrating very limited understanding of the key concepts.

## Assessment policies

Students who miss the mid-semester examination due to illness may be assessed on the final examination only. Students who perform poorly on the mid-semester test may be assessed for a passing grade (4) on the final examination only (if necessary).

## Plagiarism

Students are encouraged to study together and to discuss ideas, but this should not result in students handing in the same or similar assessment work. Do not allow another student to copy your work. While students may discuss approaches to tackling a problem, care must be taken to submit individual answers to the problem. Submitting the same or largely similar answers may constitute misconduct.

Experimental work will normally be performed in pairs from which each student will have the same raw data. Students are encouraged to discuss the results and analysis but each student must complete their own analysis and laboratory report. Extra material obtained from other sources (text books, internet) must be appropriately referenced in the report. Failure to do so may result in a loss of marks.

Below is the University's definition of plagiarism

Plagiarism is the action or practice of taking and using as one's own the thoughts or writings of another (without acknowledgement). The following practices constitute acts of plagiarism and are a major infringement of the University's academic values:

(a) where paragraphs, sentences, a single sentence or significant part of a sentence which are copied directly, are not enclosed in quotation marks and appropriately footnoted;

(b) where direct quotations are not used, but are paraphrased or summarised, and the source of the material is not acknowledged either by footnoting or other simple reference within the text of the paper;

(c) where an idea which appears elsewhere in print, film or electronic medium is used or developed without reference being made to the author or the source of that idea.

For more information on the University policy on plagiarism, please refer to

http://www.uq.edu.au/hupp/contents/view.asp?s1=3&s2=40&s3=12

## Special examinations

If a student is unable to sit a scheduled examination for medical or other adverse reasons, she/he can and should apply for a special examination. Applications made on medical grounds should be accompanied by a medical certificate; those on other grounds must be supported by a personal declaration stating the facts on which the application relies; other corroborative evidence may also be accepted.

Applications for special examinations for central exams must be made to the Director of Studies in the Faculty. Applications for special examinations in departmental exams must be made to the course coordinator.

More information on the University's assessment policy may be found
http://www.uq.edu.au/hupp/contents/view.asp?s1=3&s2=30&s3=5

EPSA Faculty policy on the award of special and supplementary exams may be found at
http://www.epsa.uq.edu.au/pdf/specialexam.pdf

## Feedback on assessment

You may request feedback on assessment in this course progressively throughout the semester from the course coordinator. Feedback on assessment may include discussion, written comments on work, model answers, lists of common mistakes and the like.

Students may peruse examinations scripts and obtain feedback on performance in a final examination provided that the request is made within six months of the release of final course results. After a period of six months following the release of results, examination scripts may be destroyed.

Information on the University's policy on access to feedback on assessment may be found at
http://www.uq.edu.au/hupp/contents/view.asp?s1=3&s2=30&s3=5

EPSA Faculty policy on feedback and re-marking may be found at
http://www.epsa.uq.edu.au/student/current/assessmentfeedback.pdf

## Graduate Attributes

The following graduate attributes will be developed in the course:

In-Depth Knowledge Of The Field Of Study

- A comprehensive and well-founded knowledge of the field of study.
- An understanding of how other disciplines relate to the field of study.
- An international perspective on the field of study.

Effective Communication

- The ability to collect, analyse and organise information and ideas and to convey those ideas clearly and fluently, in both written and spoken forms.
- The ability to interact effectively with others in order to work towards a common outcome.
- The ability to select and use the appropriate level, style and means of communication.
- The ability to engage effectively and appropriately with information and communication technologies.

Independence And Creativity

- The ability to work and learn independently.
- The ability to identify problems, create solutions, innovate and improve current practices.

Critical Judgement

- The ability to define and analyse problems.
- The ability to apply critical reasoning to issues through independent thought and informed judgement.
- The ability to evaluate opinions, make decisions and to reflect critically on the justifications for decisions.

Ethical And Social Understanding

- An understanding of social and civic responsibility.
- An appreciation of the philosophical and social contexts of a discipline.
- A knowledge and respect of ethics and ethical standards in relation to a major area of study.

The following tables expand on these concepts.

***PHYS3050 Graduate Attributes developed and how achieved (ie embedding)***

| Learning experience | In-Depth Knowledge of the Field of Study | Effective Communication | Independence and Creativity | Critical Judgment | Ethical And Social Understanding |
|---|---|---|---|---|---|
| **Lectures** | subject matter covered | listening, note-taking, questioning, accessing web information | | identification of essential physics of situation and synthesising links between pieces of information | a knowledge and respect of the scientific method |
| **Tutorials** | understanding and synthesising links between pieces of information | comprehending, effective interaction, conveying ideas in written, spoken and symbolic forms | identifying problems and producing own solutions | | ethical standards in collaborations |
| **Independent study** | use of texts and other resource material, problem solving | | working independently | | |
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For more information on development of Graduate Attributes in courses refer to http://www.uq.edu.au/teaching_learning/ then Graduate Attributes and Curriculum Review

## *PHYS3050 Graduate Attributes assessed ( ie mapping)*

| Assessment task | In-Depth Knowledge of the Field of Study | Effective Communication | Independence and Creativity | Critical Judgment | Ethical And Social Understanding |
|---|---|---|---|---|---|
| **Solutions to tutorial problems** | encompassing competency in mathematical and analytical skills | writing, understanding of questions, drawing diagrams | ability to understand principles and develop own coherent solution | critical evaluation of solutions presented | applications of ethical standards in qualitative and quantitative solutions |
| **End of semester exam (proofs and formula derivation+ problem-solving)** | in depth understanding and application of standard techniques, conceptualising physical situations, numerical problem-solving | writing, drawing diagrams, comprehending written questions | supervised independent work, free response, adaptation to unfamiliar problems | identification & analysis of problem | |
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For more information on development of Graduate Attributes in courses refer to http://www.uq.edu.au/teaching_learning/ then Graduate Attributes and Curriculum Review

## Library contact

The liaison librarian for Physics is located in the Physical Sciences and Engineering Library in the Hawken Building and may be consulted for assistance in the course:

Leith Woodall
Email: l.woodall@library.uq.edu.au
Tel: 3365 2367

## Student Liaison Officer

The School of Physical Sciences has a Student Liaison Officer as an independent source of advice to assist students with resolving academic difficulties.
The Student Liaison officer during Semester II, 2003 will be Dr Peter Adams, Priestley Building (email: pa@maths.uq.edu.au).

## Students with disabilities

Any student with a disability who may require alternative academic arrangements in the course is encouraged to seek advice at the commencement of the semester from a Disability Adviser at Student Support Services.

## Recommended texts and references:

**Jackson, John D. "Classical Electrodynamics", 3rd ed. Wiley 1999.**
**Wangsness, Roald K. "Electromagnetic Fields", 2nd ed. Wiley 1986.**
The course is aimed at this level of treatment.

**Plonsey, R. and Collin, R.E. "Principles and Applications of Electromagnetic Fields", McGraw Hill 1961.**
This is a good general text on electromagnetic fields.

**Bleaney, B.I. & Bleaney, B. "Electricity and Magnetism", 3rd ed. Oxford U.P. 1983.**
A very readable book ranging over circuit theory,electronics,electrical properties of matter and of course field theory.

**Stratton, J.A. "Electromagnetic Theory", McGraw Hill, 1941.**
This is a very comprehensive reference on electromagnetic theory, particularly as applied to macroscopic systems.

Texts of particular use in restricted areas :
On the manifestly relativistic representation of electromagnetism :
**Panofsky, W.K.H. & Phillips M. "Classical Electricity and Magnetism", 2nd ed. Addison-Wesley 1962.**

On the physics of the emission of radiation :
**Feynman, R.P., Leighton, R.B., Sands, M. "The Feynaman Lectures on Physics", Vol 2 (particularly chapter 21) Addison Wesley, 1964.**

It is not essential for a student to own a textbook for this course.

## Syllabus:

**Introduction to electromagnetic theory (about 12 lectures)**
Elementary aspects of electromagnetism.
Mathematical description of vector fields (review).
Historical development of electromagnetic theory in the $19^{th}$ century (Maxwell's equations).
Einstein's theory of special relativity. A deeper understanding of Maxwell's equations.
Energy in the electromagnetic field - Poynting's theorem.
Momentum in the electromagnetic field :
The Maxwell stress tensor.
The general momentum conservation theorem for electromagnetism.
Solution of Maxwell's equations with source terms present (generation of electromagnetic waves).
The electromagnetic potentials.
Electromagnetic field of an element of AC current.

**Electromagnetic theory of polarizable materials (about 4 lectures)**
Electric fields in dielectrics.
Magnetic fields in magnetizable materials.
The mean Poynting vector for sinusoidal fields.
Plane wave propagation in various media.

**Transmission across boundaries for electromagnetic fields (about 8 lectures)**
Continuity of various field components.
Reflection and transmission of waves - Fresnel equations.
Polarization by reflection. Reflection at metallic surfaces.
Guided waves in rectangular pipes.

**Relativistic transformation of the electromagnetic field (about 2 lectures)**

The principle of relativity and its application to the EM theory.
Transformation of electric and magnetic field components.
Transformation rules in terms of parallel and normal components.
Transformation of the components of a plane EM wave.
Doppler effect.
Transformation of energy of a plane EM wave.
Tensor formulation of Maxwell's equations.