Physics 3040: Electromagnetism (Normal)

Lecturer: Dr Zdenka Kuncic (Room 464, A29, Annexe Building)

Textbook and reference books

The textbook is *Introduction to Electrodynamics (Third Edition)* by David J. Griffiths. All students will be expected to have access to a copy. It can be bought from the Co-Op book shop, and there are also copies on closed reserve[1] in the Physics library. Note that Griffiths will also be used as a reference book for the Physics Honours course on "Advanced Electromagnetic Theory."

There are many other suitable books on electromagnetism. One of the best is *The Feynman Lectures on Physics*, Volume 2, by Feynman, Leighton & Sands. A few copies are held on closed reserve in the Physics Library, while Fisher Undergraduate Library has many copies that can be borrowed for one week.

We will always follow the notation in Griffiths, but be aware of differences in other books. For example, Griffiths uses V for electric potential, whereas Feynman uses ϕ.

Lectures

There will be 19 lectures in weeks 1–10 of Semester 1. The week-by-week timetable can be found on the Senior Physics Web site. Lectures for PHYS 3040 will be in Lecture Theatre 4.

Assignments

There will be two assignments, counting a maximum of 25% to your mark for the whole unit. They should be done individually and handed in to the Student Support Office. Make sure you identify your course as PHYS 3040.

Assignment 1 is due by 5pm on Wednesday 12-Apr-2006 (Week 6)
Assignment 2 is due by 5pm on Friday 26-May-2006 (Week 11)

COURSE OUTLINE

This course develops the classical theory of electromagnetism, one of the cornerstones of physics. It builds on courses in Junior and Intermediate Physics, which introduced Maxwell's equations in their integral form. In this course we will develop the equations in differential form, using the power of vector calculus. The main application will be to electromagnetic waves, including the interaction of waves with matter through reflection and absorption. These have application in fields such as optics, plasma physics and astrophysics. This course lays the foundation for more advanced treatments, such as a full description of the origin of electromagnetic radiation. The course content is defined in terms of the textbook. However, the material may not necessarily be covered in the same order as in the textbook.

Chapter 1: Vector Analysis

- this chapter should be read for mathematical background, and will be referred to as needed
- Omit: Section 1.5 (The Dirac delta function)

Chapter 2: Electrostatics

- Section 2.1: Coulomb's law, principle of superposition, definition of electric field, continuous charge distributions
- Section 2.2: field lines, flux, Gauss's Law in integral and differential form (omit Section 2.2.2)
- Section 2.3: electric potential, boundary conditions
- Section 2.4: work and energy in electrostatics

[1] Books on closed reserve can be borrowed for two hours, or overnight provided they are returned by 10am the next day.

- Section 2.5: conductors, capacitors

Chapter 4: Electric fields in matter

- Not explicitly examinable (mostly revision, but with differential forms)

Chapter 5: Magnetostatics

- Section 5.1: magnetic forces, currents
- Section 5.2: Biot-Savart Law
- Section 5.3: divergence and curl, Ampere's law
- Section 5.4: Magnetic vector potential ($\mathbf{A}$)

Chapter 6: Magnetic fields in matter

- Not explicitly examinable (mostly revision, but with differential forms)

Chapter 7: Electrodynamics

- Sections 7.1 and 7.2 not examinable (mostly revision, but with differential forms)
- Section 7.3 (Maxwell's equations)

Chapter 8: Conservation Laws

- main results (omit full derivations): conservation of charge (Eq. 8.4), Poynting vector (Eq. 8.10), energy (Eq. 8.13), momentum (Eq. 8.30)
- omit Section 8.2.2 (Maxwell's Stress Tensor) and Section 8.2.4 (Angular momentum)

Chapter 9: Electromagnetic Waves

- Section 9.1: waves in one dimension, exponential notation
- Section 9.2: electromagnetic waves in vacuum, exponential notation, energy and momentum
- Section 9.3: electromagnetic waves in matter, reflection and transmission
- Section 9.4.1: electromagnetic waves in conductors