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 Scitech 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. There are several copies in the Scitech Library.

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 \( \phi \).

LECTURES: There will be 20 lectures in Lecture Theatre 2: Wednesdays at 1pm and Fridays at 12pm. The detailed week-by-week timetable can be found on the Senior Physics Web site.

ASSIGNMENTS: There will be two assignments, counting for 25% of your total mark. They should be done individually and handed in to the Student Support Office. Be sure to include a signed cover sheet. The due dates can be found on the Senior Physics Web site.

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 guided waves and 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 radiation. The course content is defined in terms of the textbook.

Chapter 1: Vector Analysis

- this chapter should be read for mathematical background, and will be referred to as needed
- note that Section 1.5 (The Dirac delta function) was included in 2010 for the first time

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 (note that Section 2.2.2 is included in 2010 for the first time)
- Section 2.3: electric potential, boundary conditions
- Section 2.4: work and energy in electrostatics
- Section 2.5: conductors, capacitors

\(^1\)Books on closed reserve can be borrowed for two hours, or overnight provided they are returned by 10am the next day.
Chapter 3: Special techniques

- omit whole chapter. Note that Section 3.1 (Laplace’s equation, uniqueness theorems) was part of the syllabus prior to 2010

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 (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: absorption and dispersion
  - Section 9.4.1: electromagnetic waves in conductors
  - omit: Sections 9.4.2 (reflection off conductor) and Section 9.4.3 (dispersion)
- Section 9.5: guided waves (included in 2010 for the first time)

Chapter 10: Potentials and Fields

- Section 10.1 (potentials and gauges)

When looking at past exam papers, note that the course changed slightly in 2010. Material on Laplace’s equation (Section 3.1) is now covered in PHYS 2912. The new material is the Dirac delta function (Sections 1.5 and 2.2.2) and Guided Waves (Section 9.5).