University of Glasgow | School of Physics & Astronomy

Maxwell's Equations

$$\nabla \cdot \mathbf{E}(\mathbf{r},t) = \frac{\rho(\mathbf{r},t)}{\varepsilon_0} \quad (1)$$

$$\nabla \cdot \mathbf{B}(\mathbf{r},t) = 0 \quad (2)$$

$$\nabla \times \mathbf{E}(\mathbf{r},t) = -\frac{\partial \mathbf{B}(\mathbf{r},t)}{\partial t} \quad (3)$$

$$\nabla \times \mathbf{B}(\mathbf{r},t) = \mu_0 \left(\mathbf{J}(\mathbf{r},t) + \varepsilon_0 \frac{\partial \mathbf{E}(\mathbf{r},t)}{\partial t} \right) \quad (4)$$

PHYS5005 Electromagnetic Theory 2

Course Guide

1 Course Details

Lecturer: Prof. Christoph Englert
Credits: 10
Level: Level 5 (SCQF level 11)
Typically Offered: Semester 2
Available to Visiting Students: Yes
Available to Erasmus Students: Yes

2 Assessment

Examination in April/May (100%)

3 Course Aims

To provide students with an opportunity to develop knowledge and understanding of the key principles and applications of Electromagnetic Theory, and their relevance to current developments in physics, at a level appropriate for a professional physicist.

4 Intended Learning Outcomes

By the end of the course students will be able to:

- demonstrate a knowledge and broad understanding of electromagnetic theory;
- show a critical awareness of the significance and importance of the topics, methods and techniques discussed in the lectures and their relationship to concepts presented in other courses;
- describe and analyse quantitatively processes, relationships and techniques relevant to the topics included in the course outline, applying these ideas and techniques to analyse critically and solve advanced or complex problems which may include unseen elements;
- write down and, where appropriate, either prove or explain the underlying basis of physical laws relevant to the course topics, and discuss their applications.

5 Course Outline

Maxwell's equations

- Review
- Physical meaning of Maxwell's equations

- Electromagnetic potentials
- Charge conservation

Electromagnetic waves

- Derivation of the wave equation
- Plane-wave solutions
- Poynting's theorem
- Plane waves in dielectrics
- Waves in the presence of charges
- Plane waves in good conductors
- Electromagnetic waves in a waveguide

Electromagnetic radiation

- Charges and currents as sources of radiation, including use of the Lorentz gauge and retarded potentials

Electric dipole radiation

- Fields generated by an electric dipole
- Poynting vector and power generated

Radiation by an accelerated charge

- Analysis of the field radiated by an accelerated charge
- Power radiated and the Larmor formula
- Instability of a classical atom

Electromagnetism and relativity

- Introduction to relativistic effects in electromagnetism, including the acceleration of a charged particle

6 Further Information

Further information can be found on the course Moodle page and the online course catalogue:

- Course catalogue
- Moodle page