

MATH0055 Mathematics of Electromagnetism and Special Relativity

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| <i>Year:</i> | 2024{2025 |
| <i>Code:</i> | MATH0055 |
| <i>Level:</i> | 5 (UG) |
| <i>Normal student group(s):</i> | UG: Year 2 and 3 Mathematics degrees |
| <i>Value:</i> | 15 credits (= 7.5 ECTS credits) |
| <i>Term:</i> | 2 |
| <i>Assessment:</i> | The final weighted mark for the module is given by: 90% examination, 10% coursework |
| <i>Normal Pre-requisites:</i> | MATH0016 |
| <i>Lecturer:</i> | Dr M Kwasigroch |

Course Description and Objectives

"'Let there be light,' and there was light.' Maxwell's equations are a set of partial differential equations which describe light and many other phenomena related to electromagnetism. Many optical, electrical, and radio technologies are covered by the Maxwell equations. This includes simple examples like the electrical field around a wire or modern applications like bluetooth wireless technology. Perhaps surprisingly, the Maxwell equations contain the initial seeds of Einstein's theory of special relativity which is required for a functioning GPS tracking system, for example. They also contain the seeds of quantum mechanics.

The course motivates Maxwell's equations from the wave equation and continues with simple applications of the theory, following by establishing solutions which can describe the propagation of electromagnetic waves, i.e. light! The final part of the course develops Einstein's special relativity and derives the wonderful equation $E = mc^2$.

The course aims to provide students who have an interest in mathematical physics with an introduction to classical electromagnetism and relativistic mechanics. The course should also be of interest to students wishing to see further application of the ideas covered in mathematical methods courses.

By the end of this course students should have

An understanding of steady and time-varying electric and magnetic fields and their description through Maxwell's equations, both in integral and differential form and scalar and vector potentials.

The ability to calculate steady solutions to these equations for simple geometries and as far-field expansions for more general situations. The ability to calculate electrostatic and magnetic energy, capacitance and inductance for simple geometries.

Introduction to Electrodynamics, D.J. Griffiths, ISBN: 9780138053260, Pearson.

The Feynman Lectures on Physics - Volume II, R.P. Feynman, R.B. Leighton, M.L. Sands,
and M.A. Gottlieb, ISBN: 9780805390476, Pearson/Addison-Wesley.