

MA302-15 Electromagnetism

26/27

Department

Warwick Mathematics Institute

Level

Undergraduate Level 3

Module leader

Ferran Brosa Planella

Credit value

15

Module duration

10 weeks

Assessment

Multiple

Study location

University of Warwick main campus, Coventry

Description

Introductory description

Electromagnetism is one of the fundamental forces of the universe. This subject is not only a cornerstone of modern physics, but also plays a crucial role in our day-to-day lives, from enabling almost instantaneous communication across the world to explaining many natural phenomena. This module will cover the basic topics of electromagnetism to provide a core understanding of the subject.

Module aims

The main aims of this module are to:

- Provide the student with the background necessary to understand basic electromagnetism concepts and Maxwell's equations.
- Apply this knowledge to write and solve models for simple electromagnetism setups.
- Highlight the connections of electromagnetism to practical applications in our day-to-day lives.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be

covered. Actual sessions held may differ.

1. Introduction: Introduction; Charge, Current and Conservation; Forces and Fields; Maxwell Equations.
2. Electrostatics: Gauss' Law; Coulomb Law; Electrostatic Potential; Electrostatic Energy; Conductors.
3. Magnetostatics: Ampere's Law; The Vector Potential; Magnetic Monopoles; Gauge Transformations; Biot-Savart Law; Magnetic Dipoles; Magnetic Forces.
4. Electrodynamics: Faraday's Law of Induction; Inductance; Magnetostatic Energy; Resistance; Displacement Current; Light; Polarisation; Poynting Vector.

Learning outcomes

By the end of the module, students should be able to:

- Define and derive Maxwell's equations.
- Solve Maxwell's equations for simple electromagnetic setups.
- Translate the basic concepts and equations of electromagnetism into physical intuition.

Interdisciplinary

Electromagnetism is a fundamental area of physics and engineering, but with a very strong mathematical foundation. This course will build on the students' mathematical background and demonstrate the connections between mathematics, physics and engineering.

Subject specific skills

- Ability to state and understand Maxwell's equations.
- Ability to solve differential equations related to electromagnetism.
- Ability to apply concepts from vector calculus to electromagnetism, and to work with various coordinate systems.
- Ability to apply concepts from complex analysis to electromagnetism.

Transferable skills

- Mathematical modelling: ability to translate back and forth between mathematical ideas and physical applications.
- Problem solving: ability to identify, analyse, and develop effective solutions to challenges encountered in various contexts.
- Critical thinking: capacity to evaluate, analyse, and synthesise information; and make reasoned judgments based on this information.
- Interdisciplinary understanding: ability to integrate and apply knowledge and methodologies from multiple academic fields.

Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (20%)
Tutorials	9 sessions of 1 hour (6%)
Private study	71 hours (47%)
Assessment	40 hours (27%)
Total	150 hours

Private study description

The private study will include revising the material covered in the lectures and working through the exercises in the problem sheets. The exercises in the problem sheets will be classified (using a symbol at the beginning of the exercise) as basic, intermediate and advanced so students can focus their efforts.

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Assessment group D

	Weighting	Study time	Eligible for self-certification
Moodle quizzes	15%	20 hours	No
Centrally-timetabled examination (On-campus)	85%	20 hours	No

- Answerbook Gold (24 page)

Assessment group R

	Weighting	Study time	Eligible for self-certification
Resit exam	100%		No

- Answerbook Gold (24 page)

Feedback on assessment

Exam feedback, and discussion of the Moodle quizzes in the support classes

[Past exam papers for MA302](#)

Availability

Courses

This module is Optional for:

- Year 1 of TMAA-G1P0 Postgraduate Taught Mathematics
- TMAA-G1PC Postgraduate Taught Mathematics (Diploma plus MSc)
 - Year 1 of G1PC Mathematics (Diploma plus MSc)
 - Year 2 of G1PC Mathematics (Diploma plus MSc)
- Year 3 of UCSA-G4G1 Undergraduate Discrete Mathematics
- UCSA-G4G3 Undergraduate Discrete Mathematics
 - Year 3 of G4G1 Discrete Mathematics
 - Year 3 of G4G3 Discrete Mathematics
- Year 4 of UCSA-G4G4 Undergraduate Discrete Mathematics (with Intercalated Year)
- Year 4 of UCSA-G4G2 Undergraduate Discrete Mathematics with Intercalated Year

This module is Core option list C for:

- Year 3 of UMAA-GV17 Undergraduate Mathematics and Philosophy
- Year 3 of UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations

This module is Core option list F for:

- Year 4 of UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations

This module is Option list A for:

- UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
 - Year 4 of G105 Mathematics (MMath) with Intercalated Year
 - Year 5 of G105 Mathematics (MMath) with Intercalated Year
- Year 3 of UMAA-G100 Undergraduate Mathematics (BSc)
- UMAA-G103 Undergraduate Mathematics (MMath)
 - Year 3 of G100 Mathematics
 - Year 3 of G103 Mathematics (MMath)
 - Year 4 of G103 Mathematics (MMath)
- Year 4 of UMAA-G107 Undergraduate Mathematics (MMath) with Study Abroad
- Year 3 of UPXA-GF13 Undergraduate Mathematics and Physics (BSc)

- UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)
 - Year 3 of GF13 Mathematics and Physics
 - Year 3 of FG31 Mathematics and Physics (MMathPhys)
 - Year 4 of FG31 Mathematics and Physics (MMathPhys)
- Year 4 of USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)
- Year 4 of UMAA-G101 Undergraduate Mathematics with Intercolated Year

This module is Option list B for:

- Year 3 of USTA-GG14 Undergraduate Mathematics and Statistics (BSc)

This module is Option list C for:

- Year 3 of USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)
- Year 4 of USTA-G1G4 Undergraduate Mathematics and Statistics (BSc MMathStat) (with Intercolated Year)