PX157-10 Electricity and Magnetism

25/26

Department
Physics
Level
Undergraduate Level 1
Module leader
Neil Wilson
Credit value
10
Module duration
10 weeks
Assessment
100% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

This module is concerned with the great developments in electricity and magnetism, which took place during the nineteenth century. The sources and properties of electric and magnetic fields in free space and in materials are discussed. We will see that charges are a source of electric fields (Gauss's law) while moving charges are the source of magnetic fields (Ampere's law). We will study Faraday's law which describes how time-dependent magnetic fields generate electric fields. The module also deals with dc and ac circuit theory including the use of complex impedance.

Module web page

Module aims

To introduce the properties of electrostatic and magnetic fields, and their interaction with dielectrics, conductors and magnetic materials. To introduce some of their practical effects and to discuss the behaviour of electrical circuits.

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.

Introduction: fields and forces. Concepts of charge and flux, stationary and moving charges, the Lorentz force

Electrostatics: electric field of a point charge, principle of superposition, application of Gauss' theorem to E, Coulomb's law, work and electrical potential, equipotentials and field lines

The electric dipole: field and moment, addition of dipole moments, forces on dipoles in electric fields, dielectric materials and polarisation

Capacitance: capacitors, stored energy, capacitors in series, capacitors in parallel.

Magnetostatics: magnetic field due to a current, magnetic dipole and the solenoidal condition. The Biot-Savart Law, Ampere's circuital law, forces on and between conductors, forces on individual moving charges, torque on a current loop/magnetic dipole, the dipole moment

Magnetic dipoles in materials: magnetisation, paramagnetics, diamagnets and ferromagnets

Electromagnetic Induction: Faraday's law, Lenz's principle, motional electromotive force (emf), flux-cutting law, self-inductance, mutual inductance, magnetic energy, transformers, inductors in series and in parallel.
DC circuits: the electric circuit, emf, energy relationships, Kirchoff's laws, Maxwell loop currents, transient response of LCR circuits

AC circuits: sinusoidal currents and emf's, phasors, complex impedance, ac power and the power factor, series resonant LCR circuits

Learning outcomes

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

- State Gauss's and Ampere's laws, and use these to compute the electric and magnetic fields for simple distributions of monopoles, dipoles and currents
- Compute and analyse the effect of forces on charged particles resulting from electric and magnetic fields
- State Faraday's law and use it to describe inductance and motional emfs
- Use Kirchoff's laws, Maxwell loops and the notion of a complex impedance to find the current-voltage characteristics of passive AC and DC circuits
- Explain the interaction between electric and magnetic fields and materials

Indicative reading list

H D Young and R A Freedman, University Physics , Pearson. also W.J.Duffin, Electricity and Magnetism, McGraw-Hill; R Feynman, Feynman Lectures on Physics vol. II, Addison-Wesley.

View reading list on Talis Aspire

Subject specific skills

Knowledge of mathematics and physics. Skills in modelling, reasoning, thinking.

Transferable skills

Analytical, communication, problem-solving, self-study

Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (30%)
Seminars	(0%)
Private study	70 hours (70%)
Total	100 hours

Private study description

Working through lecture notes, solving problems, wider reading, discussing with others taking the module, revising for exam, practising on past exam papers

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group B1

	Weighting	Study time	Eligible for self-certification
In-person Examination Answer 4 questions	100%		No

- Answerbook Pink (12 page)
- Students may use a calculator

Feedback on assessment

Meeting with Personal Tutor

Past exam papers for PX157

Availability

Courses

This module is Core for:

- UPXA-GF13 Undergraduate Mathematics and Physics (BSc)
  - Year 1 of GF13 Mathematics and Physics
  - Year 1 of GF13 Mathematics and Physics
- UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)
  - Year 1 of GF13 Mathematics and Physics
  - Year 1 of FG31 Mathematics and Physics (MMathPhys)
  - Year 1 of FG31 Mathematics and Physics (MMathPhys)
- UPXA-F300 Undergraduate Physics (BSc)
  - Year 1 of F300 Physics
  - Year 1 of F300 Physics
  - Year 1 of F300 Physics
- UPXA-F303 Undergraduate Physics (MPhys)
  - Year 1 of F300 Physics
  - Year 1 of F303 Physics (MPhys)
  - Year 1 of F303 Physics (MPhys)
  - Year 1 of F303 Physics (MPhys)
- UPXA-F3F5 Undergraduate Physics with Astrophysics (BSc)
  - Year 1 of F3F5 Physics with Astrophysics
  - Year 1 of F3F5 Physics with Astrophysics
- Year 1 of UPXA-F3FA Undergraduate Physics with Astrophysics (MPhys)
- Year 1 of UPXA-F3N2 Undergraduate Physics with Business Studies

This module is Optional for:

- UMAA-G100 Undergraduate Mathematics (BSc)
  - Year 1 of G100 Mathematics
  - Year 1 of G100 Mathematics
  - Year 1 of G100 Mathematics
- UMAA-G103 Undergraduate Mathematics (MMath)
  - Year 1 of G100 Mathematics
  - Year 1 of G103 Mathematics (MMath)
  - Year 1 of G103 Mathematics (MMath)
- Year 1 of UMAA-G1NC Undergraduate Mathematics and Business Studies