PX157-10 Electricity and Magnetism

22/23

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

Description

Introductory description

This module is largely 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 in some detail. 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). Faraday discovered that time-dependent magnetic fields also generate electric fields. The module 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 the behaviour of simple passive circuits and networks.

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: Field forces, history, the concepts of charge and flux, stationary and moving charges.

Essential Mathematics I: Solid angle, integration and vectors, area as a vector, coordinate systems.

Elements: Gauss' Theorem, monopole and dipole sources.

Electrostatics:, electric field of a point charge, principle of superposition, application of Gauss' Theorem to E, Coulomb's law, work and electrical potential, exchange of electrostatic and kinetic energy.

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

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

Magnetostatics: Magnetic field of a current, magnetic dipole and Gauss' Theorem, 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.

Electromagnetic Induction: Faraday's law, Lenz's principle, motional e.m.f., flux - cutting law, electric generators, electric motors, self-inductance, mutual inductance, magnetic energy, inductors in series and in parallel.

Magnetic dipoles in materials, magnetization, paramagnetics, diamagnets and ferromagnets, magnetization surface current.

D.C. Circuits: The electric circuit, energy relationships, Kirchoff's laws, Maxwell loop currents, use of symmetry, superposition principle, Thevenin's theorem, Norton's theorem.

Essential Mathematics II: Complex numbers, Euler's representation.

Transient Response: Capacitors, inductors, LCR circuits.

Sinusoidal Currents and EMF's: Capacitors, Inductors, Resistors, the concept of phasors, complex impedance, a.c. power and the power factor, series resonant LCR circuits, quality factor, voltage magnification, parallel resonant LCR circuit, filters, a.c. bridges.

Learning outcomes

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

- Calculate self- and mutual inductance, explain the operation of generators and electric motors, and find the energy in simple magnetic fields.
- Compute the electrostatic and magnetic fields for simple distributions of monopoles or dipoles
- Calculate the current and potential distributions in simple DC networks and explain the phenomenon of resistance
- Describe how passive circuit elements (resistors, capacitors and inductors) behave when subject to alternating emf's, and be able to use complex impedances to simplify such problems
- Explain the concepts of charge, field and flux.

- Explain the interaction between electrostatic or magnetic fields and materials
- Explain the phenomena of capacitance and inductance

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 B

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

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

Reassessment component is the same

Feedback on assessment

Meeting with Personal Tutor

Past exam papers for PX157

Availability

Courses

This module is Core for:

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

This module is Option list B for:

- Year 1 of UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)

- Year 1 of UMAA-G100 Undergraduate Mathematics (BSc)
- UMAA-G103 Undergraduate Mathematics (MMath)
    - Year 1 of G100 Mathematics
    - Year 1 of G103 Mathematics (MMath)
- Year 1 of UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe
- Year 1 of UMAA-G1NC Undergraduate Mathematics and Business Studies
- Year 1 of UMAA-G1N2 Undergraduate Mathematics and Business Studies (with Intercalated Year)
- Year 1 of UMAA-GL11 Undergraduate Mathematics and Economics
- Year 1 of UECA-GL12 Undergraduate Mathematics and Economics (with Intercalated Year)
- Year 1 of UMAA-G101 Undergraduate Mathematics with Intercalated Year