PX446-15 Condensed Matter Physics II

26/27

Department
Physics
Level
Undergraduate Level 4
Module leader
Gavin Bell
Credit value
15
Module duration
10 weeks
Assessment
100% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

Many phenomena observed in condensed matter, like magnetism and superconductivity, are the result of interactions between electrons. This module looks at some of these phenomena, how to observe them and how to use them. An important concept in the modelling of these many-electron systems is Landau's idea of the quasiparticle. Excitations of a system of interacting particles can be put into one-to-one correspondence with excitations of non-interacting particles but with a finite lifetime. It's a brilliant idea and helps us understand many (almost all) measurable properties of interest. Landau also set up the most important models of the free energy of the magnets and superconductors in applied fields, which the module studies.

Module web page

Module aims

To offer an account of important functional aspects of modern materials. Topics covered will be magnetism, electronic transport, optical properties of matter and superconductivity. There should be a strong connection between theory and experiment, and emerging ideas such as quantum criticality and topology may be discussed.

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. Magnetism.
   Introduction (revision of topics covered by PX385 Condensed Matter Physics). Exchange interactions: ferromagnets; antiferromagnets; ferrimagnets and others. Symmetry and models, Landau theory, excitations. Experimental techniques in magnetism, contemporary magnetism.
2. Quasiparticles & Excitations.
   Bandstructure: tight-binding approach, quasiparticles. Experimental methods, semiconductor optics. Magnetism in semiconductors. Quasiparticles beyond the single particle picture.
3. Superconductivity.
   Basic properties of superconductors, electromagnetism of superconductors and the London equations, phase transitions and the Ginsburg-Landau theory. Phase coherence and the Josephson effects. Overview of BCS theory, experimental evidence for the energy gap. Unconventional superconductors. Superconducting technology

Learning outcomes

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

- Explain magnetic, electrical, optical and superconducting properties of materials
- Discuss functional materials and experiments used to probe their properties
- Discuss areas of research in condensed matter physics

Indicative reading list

Reading lists can be found in Talis

Specific reading list for the module

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 (20%)
Private study	120 hours (80%)
Total	150 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 B2

	Weighting	Study time	Eligible for self-certification
Assessment component			
Centrally-timetabled examination (On-campus) Answer 3 questions	100%		No

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

Reassessment component is the same

Feedback on assessment

Personal tutor, group feedback

Past exam papers for PX446

Availability

Courses

This module is Optional for:

- Year 4 of UPXA-F303 Undergraduate Physics (MPhys)

This module is Option list B for:

- Year 4 of UPXA-FG33 Undergraduate Mathematics and Physics (BSc MMathPhys)
- Year 4 of UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)
- Year 4 of UPXA-F3FA Undergraduate Physics with Astrophysics (MPhys)