

PX431-15 Structure & Dynamics of Solids

23/24

Department

Physics

Level

Undergraduate Level 4

Module leader

Thomas Hase

Credit value

15

Module duration

10 weeks

Assessment

100% exam

Study location

University of Warwick main campus, Coventry

Description

Introductory description

Characterising and, where possible, controlling the structure of materials is one of the most important areas of research in science. The microscopic structure of a material determines its mechanical strength, its electrical properties and, at surfaces, the way the material interacts with the outside world (for example as a catalyst, in electrical contacts or as it corrodes). The first half of this module looks at the methods for identifying and studying structure. The second half studies how the distribution of charge and current flows affect the structural and electrical properties of insulators and semiconductors.

[Module web page](#)

Module aims

To cover a range of theoretical concepts and practical techniques used in experimental condensed matter physics. Topics covered will be in the areas of the structural and electrical properties of solids.

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. Revision of second and third year material on bonding, crystal structure and symmetry; Crystal growth; Phase Transitions and Phase Diagrams; Kinematical X-ray diffraction: revision, theory and analysis; Real crystals and their defects; Surfaces, thin films and growth techniques
2. Electron diffraction and imaging for materials characterisation -Introduction to Transmission Electron Microscopy (TEM): Resolution with electrons, Electron scattering, Instruments to achieve atomic resolution; Electron diffraction from crystals: Indexing diffraction patterns; Bright field and dark field imaging, Atomic resolution contrast mechanisms, STEM Z-contrast imaging, Defects and interface characterisation, 3D imaging; Practical aspects of the techniques
3. Semiconductors Devices; Revision of second and third year material on semiconductors and the photoelectric effect; electronic transport in semiconductor devices; metal-semiconductor contacts; Metal-oxide-semiconductor transistors; Devices based on quantum tunnelling; Non-volatile memories; Piezoelectric and pyroelectric materials and applications; Ferroelectric materials and multiferroics

Learning outcomes

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

- Describe experimental techniques to measure physical properties of materials
- Characterise crystal structures
- Explain the operation of an electron microscope and how to interpret the data obtained
- Describe the physics of some semiconductor devices
- Explain piezo- pyro- and ferroelectricity and its uses

Indicative reading list

M.T. Dove, Structure and Dynamics, OUP; S. R. Elliott, The physics and chemistry of solids, Wiley; D.P. Woodruff and T.A. Delchar, Modern Techniques of Surface Science, CUP; S Blundell, Magnetism in Condensed Matter, OUP.

[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 (20%)
Seminars	(0%)
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 B3

	Weighting	Study time
In-person Examination	100%	
Answer 3 questions		

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

Feedback on assessment

Personal tutor, group feedback

[Past exam papers for PX431](#)

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