

# PX431-15 Structure & Dynamics of Solids

**26/27**

**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

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## 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 module looks at the structure of solids and the methods used to observe structure. It then looks at how the distribution of electric charge affects 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

[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

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## 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.

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## Assessment

You must pass all assessment components to pass the module.

### Assessment group B4

| Assessment component                                               | Weighting | Study time | Eligible for self-certification |
|--------------------------------------------------------------------|-----------|------------|---------------------------------|
| Centrally-timetabled examination (On-campus)<br>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 PX431](#)

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## **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)