PHYS303
Atomic and Solid-State Physics
S1 Day 2016
Dept of Physics and Astronomy

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## General Information

Unit convenor and teaching staff

**Unit Convenor**
Daniel Terno  
daniel.terno@mq.edu.au  
Contact via daniel.terno@mq.edu.au  
e6b 2.715  
by appointment

**Thomas Volz**  
thomas.volz@mq.edu.au  
Contact via thomas.volz@mq.edu.au  
E6B 2.609  
by appointment

Credit points
3

Prerequisites
PHYS201 and PHYS202

Corequisites

Co-badged status
Important Academic Dates
Information about important academic dates including deadlines for withdrawing from units are available at https://students.mq.edu.au/important-dates

Learning Outcomes

1. Know the basic premises of quantum mechanics. Identify and use standard solutions of Schrödinger equation [free, infinite well, step, Coulomb potential]
2. Know the experimental basis of the orbital angular momentum and spin; being able to implement their basic math and physics in calculations
3. Know the basic rules of the atomic transitions; be able to apply them in the spectral analysis. Understand the elements involved in the many-body physics. Ability to qualitatively predict structure of atoms and ions and periodic table and their spectra in external magnetic and electric fields
4. Be aware of the current developments [optical lattices, condensates] and techniques. Know and be able to calculate some of the relevant processes
5. Understand the applications of Fourier theory to condensed matter physics and be able to perform the standard Fourier analysis manipulations.
6. Have an understanding of how the quantization of crystal lattice vibrations leads to the concept of phonons and estimate their basic properties
7. Have an understanding of how the periodic potential of the crystal lattice leads to the formation of delocalised electronic states. Have an understanding of the concept of crystal momentum and how this applies to the quantization of electronic states in...
crystals.

8. Have an understanding of the electronic structure and properties of intrinsic semiconductors. Have an understanding of the changes produced by semiconductor doping and the application of this to electronic device operation.

Assessment Tasks

<table>
<thead>
<tr>
<th>Name</th>
<th>Weighting</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>exam</td>
<td>60%</td>
<td>set by the University</td>
</tr>
<tr>
<td>assignment</td>
<td>20%</td>
<td>continuous</td>
</tr>
<tr>
<td>tests</td>
<td>20%</td>
<td>TBA</td>
</tr>
</tbody>
</table>

exam

Due: set by the University

Weighting: 60%

A three hour final exam will be set from approx 75% of the unit content. Specifically named topics covered in the class summary tests as specified below are excluded from the final examination. All other topics may be covered in the final exam. The exam will consist of two parts, dealing with the atomic and condensed matter physics, respectively. All the necessary physical and mathematical formulas will be provided.

This Assessment Task relates to the following Learning Outcomes:

- Know the basic premises of quantum mechanics. Identify and use standard solutions of Schrodinger equation [free, infinite well, step, Coulomb potential]
- Know the experimental basis of the orbital angular momentum and spin; being able to implement their basic math and physics in calculations
- Be aware of the current developments [optical lattices, condensates] and techniques. Know and be able to calculate some of the relevant processes
- Understand the applications of Fourier theory to condensed matter physics and be able to perform the standard Fourier analysis manipulations.
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- Have an understanding of how the periodic potential of the crystal lattice leads to the formation of delocalised electronic states. Have an understanding of the concept of crystal momentum and how this applies to the quantization of electronic states in
crystals.

- Have an understanding of the electronic structure and properties of intrinsic semiconductors. Have an understanding of the changes produced by semiconductor doping and the application of this to electronic device operation.

**assignment**

**Due:** continuous  
**Weighting:** 20%

Assignments will be set and marked for assessment purposes and issued approximately once a week. Solutions will not be issued, but the submitted assignments will be individually corrected.

The best four assignments [unless agreed otherwise] in each half of the course (i.e. 4+4) will be selected to contribute to the assignment grade.

This Assessment Task relates to the following Learning Outcomes:

- Know the basic premises of quantum mechanics. Identify and use standard solutions of Schrödinger equation [free, infinite well, step, Coulomb potential]
- Know the experimental basis of the orbital angular momentum and spin; being able to implement their basic math and physics in calculations
- Know the basic rules of the atomic transitions; be able to apply them in the spectral analysis. Understand the elements involved in the many-body physics. Ability to qualitatively predict structure of atoms and ions and periodic table and their spectra in external magnetic and electric fields
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- Have an understanding of the electronic structure and properties of intrinsic semiconductors. Have an understanding of the changes produced by semiconductor doping and the application of this to electronic device operation.
tests

Due: TBA
Weighting: 20%

Some topics have been chosen for assessment via two class tests. This represents approximately one quarter of the unit content that will not be examined in the final exam. The topics are:

1. Energy Levels of Multi-Electron Atoms

2. Bonding & Crystal Structure

There is some flexibility in setting the test times and the selected material. Please use the dedicated iLearn discussion forum to make suggestions for the alternative times.

Decision deadline: Mar 18

The form of these test tasks is the following. Students can prepare their own hand written summary notes on the topic(s) of the summary test to take into the test. Students can use these notes freely to complete the test question(s) which will have been broadly defined prior to the test.

The summary notes and the test script will be collected and assessed to ensure the notes were independently prepared and for the quality/ correctness of the test answer(s). Summary notes are limited to only one A4 page (double side).

Weight of each test: 10%.

This Assessment Task relates to the following Learning Outcomes:

- Know the basic premises of quantum mechanics. Identify and use standard solutions of Schrodinger equation [free, infinite well, step, Coulomb potential]
- Know the experimental basis of the orbital angular momentum and spin; being able to implement their basic math and physics in calculations
- Know the basic rules of the atomic transitions; be able to apply them in the spectral analysis. Understand the elements involved in the many-body physics. Ability to qualitatively predict structure of atoms and ions and periodic table and their spectra in
external magnetic and electric fields

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Delivery and Resources

Lecture materials, additional reading and assignments will be posted to iLearn

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central. Students should be aware of the following policies in particular with regard to Learning and Teaching:


Disruption to Studies Policy http://www.mq.edu.au/policy/docs/disruption_studies/policy.html The Disruption to Studies Policy is effective from March 3 2014 and replaces the Special Consideration Policy.

In addition, a number of other policies can be found in the Learning and Teaching Category of Policy Central.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/support/student_conduct/

Results

Results shown in iLearn, or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au.
Student Support
Macquarie University provides a range of support services for students. For details, visit [http://students.mq.edu.au/support/](http://students.mq.edu.au/support/)

Learning Skills
Learning Skills ([mq.edu.au/learningskills](http://mq.edu.au/learningskills)) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Enquiry Service
For all student enquiries, visit Student Connect at [ask.mq.edu.au](http://ask.mq.edu.au)

Equity Support
Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

IT Help
For help with University computer systems and technology, visit [http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/](http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/).

When using the University’s IT, you must adhere to the [Acceptable Use of IT Resources Policy](http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/).

The policy applies to all who connect to the MQ network including students.

**Graduate Capabilities**

**Commitment to Continuous Learning**

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

**Learning outcomes**

- Know the basic premises of quantum mechanics. Identify and use standard solutions of Schrödinger equation [free, infinite well, step, Coulomb potential]
- Know the basic rules of the atomic transitions; be able to apply them in the spectral...
analysis. Understand the elements involved in the many-body physics. Ability to qualitatively predict structure of atoms and ions and periodic table and their spectra in external magnetic and electric fields

- Have an understanding of the electronic structure and properties of intrinsic semiconductors. Have an understanding of the changes produced by semiconductor doping and the application of this to electronic device operation.

**Assessment tasks**
- assignment
- tests

**Problem Solving and Research Capability**

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

**Learning outcomes**

- Know the basic premises of quantum mechanics. Identify and use standard solutions of Schrödinger equation [free, infinite well, step, Coulomb potential]
- Know the experimental basis of the orbital angular momentum and spin; being able to implement their basic math and physics in calculations
- Know the basic rules of the atomic transitions; be able to apply them in the spectral analysis. Understand the elements involved in the many-body physics. Ability to qualitatively predict structure of atoms and ions and periodic table and their spectra in external magnetic and electric fields
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- Understand the applications of Fourier theory to condensed matter physics and be able to perform the standard Fourier analysis manipulations.
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Assessment tasks

• exam
• assignment
• tests

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcomes

• Be aware of the current developments [optical lattices, condensates] and techniques. Know and be able to calculate some of the relevant processes
• Have an understanding of how the quantization of crystal lattice vibrations leads to the concept of phonons and estimate their basic properties
• Have an understanding of the electronic structure and properties of intrinsic semiconductors. Have an understanding of the changes produced by semiconductor doping and the application of this to electronic device operation.

Assessment task

• exam

Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Assessment tasks

• exam
• assignment
Engaged and Ethical Local and Global citizens
As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

This graduate capability is supported by:

**Learning outcome**

- Have an understanding of the electronic structure and properties of intrinsic semiconductors. Have an understanding of the changes produced by semiconductor doping and the application of this to electronic device operation.

Socially and Environmentally Active and Responsible
We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

**Learning outcomes**

- Know the basic premises of quantum mechanics. Identify and use standard solutions of Schrodinger equation [free, infinite well, step, Coulomb potential]
- Know the basic rules of the atomic transitions; be able to apply them in the spectral analysis. Understand the elements involved in the many-body physics. Ability to qualitatively predict structure of atoms and ions and periodic table and their spectra in external magnetic and electric fields

Capable of Professional and Personal Judgement and Initiative
We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

**Learning outcomes**

- Know the basic rules of the atomic transitions; be able to apply them in the spectral
analysis. Understand the elements involved in the many-body physics. Ability to qualitatively predict structure of atoms and ions and periodic table and their spectra in external magnetic and electric fields

- Have an understanding of the electronic structure and properties of intrinsic semiconductors. Have an understanding of the changes produced by semiconductor doping and the application of this to electronic device operation.

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

**Learning outcomes**

- Know the basic premises of quantum mechanics. Identify and use standard solutions of Schrödinger equation [free, infinite well, step, Coulomb potential]
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Assessment tasks

- exam
- assignment
- tests

Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Know the basic premises of quantum mechanics. Identify and use standard solutions of Schrodinger equation [free, infinite well, step, Coulomb potential]
- Know the basic rules of the atomic transitions; be able to apply them in the spectral analysis. Understand the elements involved in the many-body physics. Ability to qualitatively predict structure of atoms and ions and periodic table and their spectra in external magnetic and electric fields
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Assessment tasks

- exam
- assignment