UNSW Course Outline

MATS6104 Physical Properties of Materials - 2024

Published on the 08 Feb 2024

General Course Information

Course Code : MATS6104
Year : 2024
Term : Term 1
Teaching Period : T1
Is a multi-term course? : No
Faculty : Faculty of Science
Academic Unit : School of Materials Science & Engineering
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Postgraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

The course will give an overview of modern research topics in material physics, including conductivity, superconductivity, magnetism, lattice vibration, etc., to encourage students to engage in the latest research. The focus will be on introducing simple physical models with just

enough mathematical formalism to explain physics in materials. In the first part of the course, the fundamentals of modern electronic structure theory and electrical conductions in solids will be introduced. In the second part of the course, some fundamental physical properties of materials will be discussed. The second half of the course will have a stronger focus geared towards research at postgraduate level.

Course Aims

The aim of this course is to teach the principles of the relationships that exist between materials' electronic structure and structure and their physical properties. This will allow students to understand the physical properties of these materials and how they are applied in industry.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Apply the basic principles behind modern electronic structure theories of materials.
CLO2 : Explain how the electrical, thermal and other physical properties of materials relate to their electronic structures.
CLO3 : Predict how materials' physical properties can be affected by their electronic structures and lattice structures.
CLO4 : Explain how variations in size, defect concentration, etc. can lead to the tuning of properties for specific applications.

Course Learning Outcomes	Assessment Item
CLO1 : Apply the basic principles behind modern electronic structure theories of materials.	• Assignment 1 • Mid-term Test • Assignment 2 • Final Exam
CLO2 : Explain how the electrical, thermal and other physical properties of materials relate to their electronic structures.	• Assignment 1 • Mid-term Test • Assignment 2 • Final Exam
CLO3 : Predict how materials' physical properties can be affected by their electronic structures and lattice structures.	• Mid-term Test • Assignment 2 • Final Exam
CLO4 : Explain how variations in size, defect concentration, etc. can lead to the tuning of properties for specific applications.	• Assignment 2 • Final Exam

Learning and Teaching Technologies

Moodle - Learning Management System | Echo 360

Learning and Teaching in this course

Lectures will cover core concepts, theories, and approaches, which will then be contextualised and consolidated through assignments. Teaching material will utilise real-world key studies in the development of these materials to provide students with an opportunity to identify, evaluate and reflect on the innovative solutions these materials provide worldwide and locally. Where applicable, the course will use additional online learning technologies (e.g. videos or animations) to consolidate, support and extend student learning.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Assignment 1 Assessment Format: Individual	20%	Due Date: Week 3 and Week 5
Mid-term Test Assessment Format: Individual	30%	Due Date: Week 7: 25 March - 31 March
Assignment 2 Assessment Format: Individual	10%	Start Date: Not Applicable Due Date: Week 10: 15 April - 21 April
Final Exam Assessment Format: Individual	40%	Due Date: Exam period

Assessment Details

Assignment 1

Assessment Overview

This task comprises two equally weighted parts. You will be required to undertake calculations involving the application of modern electron theory to topics covered throughout the course including:
-The wave nature of electrons (submission due in Week 4)
-Electrical conduction in metals, semiconductors and insulators (submission due in Week 6).

For these tasks, you will be required to perform basic calculations manually, without the aid of programming or any software tools.

Feedback will be given two weeks after submission, including your marked assignment, overall

comments on how the class performed, and a solution sheet for each assignment with worked answers.

Course Learning Outcomes

- CLO1 : Apply the basic principles behind modern electronic structure theories of materials.
- CLO2 : Explain how the electrical, thermal and other physical properties of materials relate to their electronic structures.

Mid-term Test

Assessment Overview

The midterm test is designed as a summative assessment of the learning outcomes assesses for the topics covered in first part of the course (lecture material only). The midterm test will typically be scheduled in week 7 as a single attempt with a time limit of around 1.5 h. The test consists of multiple-choice questions and essay-style questions involving some calculations - examples will be given in the lectures. Any derivations will assume knowledge of the material rather than memorizing equations with relevant background equations provided. Feedback will be provided through Moodle within two weeks of completing the test.

Course Learning Outcomes

- CLO1 : Apply the basic principles behind modern electronic structure theories of materials.
- CLO2 : Explain how the electrical, thermal and other physical properties of materials relate to their electronic structures.
- CLO3 : Predict how materials' physical properties can be affected by their electronic structures and lattice structures.

Assignment 2

Assessment Overview

You will be assessed on knowledge learned from the first two weeks of the second part of the course, which covers electrical and superconducting materials. The format will be multiple choice questions. The assessment should be completed in one to two weeks and is due in Week 10.

Feedback will be given two weeks after submission, including your marked assignment, overall comments on how the class performed, and a solution sheet for each assignment with worked answers.

Course Learning Outcomes

- CLO1 : Apply the basic principles behind modern electronic structure theories of materials.
- CLO2 : Explain how the electrical, thermal and other physical properties of materials relate to their electronic structures.

- CLO3 : Predict how materials' physical properties can be affected by their electronic structures and lattice structures.
- CLO4 : Explain how variations in size, defect concentration, etc. can lead to the tuning of properties for specific applications.

Detailed Assessment Description

You will be required to undertake calculations involving the application of modern electron theory to topics covered throughout the course including

-The wave nature of electrons

-Electrical conduction in metals, semiconductors and insulators

Assessment Length

one or two pages

Final Exam

Assessment Overview

The final exam is designed to assess the topics covered in second part of the course. The final exam will be scheduled in the final exam period as a single attempt with a time limit of around 1.5 h. The test consists of multiple-choice questions and essay-style questions involving some calculations - details will be confirmed during the course. Any derivations will assume knowledge of the material rather than memorizing equations with relevant background equations provided. Feedback will be provided through the gradebook.

Course Learning Outcomes

- CLO1 : Apply the basic principles behind modern electronic structure theories of materials.
- CLO2 : Explain how the electrical, thermal and other physical properties of materials relate to their electronic structures.
- CLO3 : Predict how materials' physical properties can be affected by their electronic structures and lattice structures.
- CLO4 : Explain how variations in size, defect concentration, etc. can lead to the tuning of properties for specific applications.

General Assessment Information

Short Extensions:

The School of Materials Science and Engineering has reviewed its range of assignments and projects to determine their suitability for automatic short extensions as set out by the UNSW Short Extension Policy. After consultation with teaching staff and examination of our course offerings we consider our current deadline structures already accommodate the possibility of unexpected circumstances that may lead students to require additional days for submission.

Consequently, the School does not offer the Short Extension provision in its MATS courses but students, if needed, can apply for formal Special Consideration via the usual procedure.

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 0 : 5 February - 11 February	Other	O-Week
Week 1 : 12 February - 18 February	Lecture	Introduction and Fundamentals of Electron Theory
Week 2 : 19 February - 25 February	Lecture	Schrodinger Equation and Energy Band
Week 3 : 26 February - 3 March	Lecture	Energy Band Theory& Electrical Properties of Metals
Week 4 : 4 March - 10 March	Lecture	Intrinsic/Extrinsic Semiconductors
Week 5 : 11 March - 17 March	Lecture	p-n Junctions/ Revision
Week 6 : 18 March - 24 March	Other	Flexibility week
Week 7 : 25 March - 31 March	Lecture	Electronic devices
	Assessment	Mid-term Exam
Week 8 : 1 April - 7 April	Lecture	Thermal Properties of Materials
Week 9 : 8 April - 14 April	Lecture	Superconducting materials, Capacitance, Dielectrics, Polarization and Ferroelectricity
Week 10 : 15 April - 21 April	Lecture	Magnetic materials
	Tutorial	Revision and tutorial
Week 11 : 22 April - 28 April	Tutorial	Additional tutorials are available by appointment.
	Assessment	The final exam will take place in either week 11 or week 12. The venue and specific time will be announced on Moodle once confirmed.
Week 12 : 29 April - 5 May	Tutorial	Additional tutorials are available by appointment.
	Assessment	The final exam will take place in either week 11 or week 12. The venue and specific time will be announced on Moodle once confirmed.

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Resources

Prescribed Resources

Recommended Resources

Suggested books for various topics covered in the course:

- Materials for Semiconductor Devices, *C. R. M. Grosvenor, Institute of Metals, 1987.*
- The Science and Engineering of Materials (Sixth Edition), *Donald R. Askeland, Pradeep P. Fulay, Wendelin J. Wright, Cengage Learning, 2010.*
- Processing of Semiconductors, *ed. K.A. Jackson et al. VCH, 1996.*

- The Science and Engineering of Microelectronic Fabrication*, S. A. Campbell, OUP, 1996.*
- Dopants and Defects in Semiconductors, *M. D. McCluskey, E. E. Haller, CRC Press, 2013*
- Semiconductor Devices, *N.M. Morris, McMillan, 1976.*
- Nanoelectronics and Information Technology-Advanced Electronic Materials and Novel Devices, *Edited By Rainer Waser, Wiley-VCH, 2003.*
- The Defect Chemistry of Metal Oxides, *D. M. Smyth, Oxford University Press, 2000*
- Thermal Properties Measurement of Materials, *Yves Jannot Alain Degiovanni, 2018*
- Ferroelectric Materials for Energy Applications (1st edition), edited by Haitao Huang and James F. Scott. © 2018 Wiley-VCH Verlag GmbH & Co. KGaA.
- Introduction to Electrodynamics, *David J. Griffiths, Cambridge University Press, 2017.*

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Lecturer	Dewei Chu		Room 244, Building E10	92855090	By appointment	No	No
Convenor	Zhi Li		Room 240 Materials Science and Engineering (Bldg E10)		By appointment	No	Yes

Other Useful Information

Academic Information

Upon your enrolment at UNSW, you share responsibility with us for maintaining a safe, harmonious and tolerant University environment.

You are required to:

- Comply with the University's conditions of enrolment.
- Act responsibly, ethically, safely and with integrity.
- Observe standards of equity and respect in dealing with every member of the UNSW community.
- Engage in lawful behaviour.
- Use and care for University resources in a responsible and appropriate manner.
- Maintain the University's reputation and good standing.

For more information, visit the UNSW Student Code of Conduct Website.

Academic Honesty and Plagarism

Referencing is a way of acknowledging the sources of information that you use to research your

assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.
Further information about referencing styles can be located at https://student.unsw.edu.au/referencing

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits: honesty, trust, fairness, respect, responsibility and courage. At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.
Further information about academic integrity, plagiarism and the use of AI in assessments can be located at:

- The Current Students site,
- The ELISE training site, and
- The Use of AI for assessments site.

The Student Conduct and Integrity Unit provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct

Submission of Assessment Tasks

Penalty for Late Submissions

UNSW has a standard late submission penalty of:

- 5% per day,
- for all assessments where a penalty applies,
- capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and
- no permitted variation.

Any variations to the above will be explicitly stated in the Course Outline for a given course or assessment task.

Students are expected to manage their time to meet deadlines and to request extensions as early as possible before the deadline.

Special Consideration

If circumstances prevent you from attending/completing an assessment task, you must officially apply for special consideration, usually within 3 days of the sitting date/due date. You can apply

by logging onto myUNSW and following the link in the My Student Profile Tab. Medical documentation or other documentation explaining your absence must be submitted with your application. Once your application has been assessed, you will be contacted via your student email address to be advised of the official outcome and any actions that need to be taken from there. For more information about special consideration, please visit: https://student.unsw.edu.au/special-consideration

Important note: UNSW has a "fit to sit/submit" rule, which means that if you sit an exam or submit a piece of assessment, you are declaring yourself fit to do so and cannot later apply for Special Consideration. This is to ensure that if you feel unwell or are faced with significant circumstances beyond your control that affect your ability to study, you do not sit an examination or submit an assessment that does not reflect your best performance. Instead, you should apply for Special Consideration as soon as you realise you are not well enough or are otherwise unable to sit or submit an assessment.

Faculty-specific Information

Additional support for students

- The Current Students Gateway
- Student Support
- Academic Skills and Support
- Student Wellbeing, Health and Safety
- Equitable Learning Services
- UNSW IT Service Centre
- Science EDI Student Initiatives, Offerings and Guidelines