UNSW Course Outline

ZPEM3503 Advanced Materials - 2024

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General Course Information

Course Code : ZPEM3503
Year : 2024
Term : Semester 1
Teaching Period : Z1
Is a multi-term course? : No
Faculty : UNSW Canberra
Academic Unit : UC Science
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : UNSW Canberra at ADFA
Campus : UNSW Canberra
Study Level : Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

The first part of the course is concerned with the propagation and interaction of electromagnetic radiation as employed in remote sensing situations. Even before it reaches the antenna the radiation must pass through cables and waveguides, and this also involves propagation and

interaction. Fundamental to all of this are Maxwell's equations and an understanding of what they can tell us. The second part of the course provides an introduction to advanced materials with an emphasis on their structural and magnetic properties. The various structural states and phase diagrams are considered in terms of microstructure and its influence on mechanical properties. Finally, the basic theories of magnetism and the different types of magnetic materials are described and the use of modern magnetic materials is discussed with particular reference to permanent magnets, transformers, and data storage.

Course Aims

In the Advanced Materials section there is particular emphasis on magnetism and magnetic materials. However, it is also a vehicle to introduce many concepts and ideas fundamental, more generally, to modern physics and materials science.

The Electromagnetic Waves section can be summed up in two words, propagation and interaction. Imagine any remote sensing situation involving electromagnetic radiation: a radar system is an obvious example with extensive civilian and military applications. The important processes are the propagation of the radiation to and from the object being sensed, the interaction of this radiation with the medium through which it propagates and its interaction with the material the object is made of. Fundamental to these processes are Maxwell’s equations, and it is important to reach an understanding of what they can tell us about the electromagnetic radiation.

Relationship to Other Courses

The course is one of the Level 3 Physics courses leading to a major in Physics. It will be assumed that students have a good working knowledge from the foundation Physics 1 courses ZPEM1501 and ZPEM1502 and the Physics 2 course ZPEM2502, and that the student is conversant with Level 1 Mathematics and Level 2 Mathematical Tools for Science (ZPEM2302).

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Mastered the key concepts in the topic areas of advanced materials, magnetic materials and electromagnetic wave propagation, demonstrated by the ability to discuss, describe and explain the topics.
CLO2 : Demonstrate the ability to solve problems relating to advanced materials and electromagnetic wave propagation.
CLO3 : Develop an appreciation of how the basic Physics in the areas of magnetic materials and electromagnetism foster current directions in related research and can drive technological advances.
CLO4 : Apply theoretical knowledge of materials physics and electromagnetism and demonstrate proper scientific methodology when conducting laboratory experiments. In addition gain an appreciation of some of the techniques employed in the fields of magnetic materials research and electromagnetic remote sensing, and develop skills in team work and self-direction.

Course Learning Outcomes	Assessment Item
CLO1 : Mastered the key concepts in the topic areas of advanced materials, magnetic materials and electromagnetic wave propagation, demonstrated by the ability to discuss, describe and explain the topics.	• two class tests • Four in-class quizzes • Examination
CLO2 : Demonstrate the ability to solve problems relating to advanced materials and electromagnetic wave propagation.	• two class tests • Four in-class quizzes • Examination
CLO3 : Develop an appreciation of how the basic Physics in the areas of magnetic materials and electromagnetism foster current directions in related research and can drive technological advances.	• two class tests • Four in-class quizzes • Examination
CLO4 : Apply theoretical knowledge of materials physics and electromagnetism and demonstrate proper scientific methodology when conducting laboratory experiments. In addition gain an appreciation of some of the techniques employed in the fields of magnetic materials research and electromagnetic remote sensing, and develop skills in team work and self-direction.	• 12-hour laboratory program • two class tests • Examination

Learning and Teaching Technologies

Moodle - Learning Management System | Echo 360

Learning and Teaching in this course

Teaching Strategies

Enrolment in this course or participation in any activity that is recorded constitutes consent to be recorded during tutorial and other teaching sessions. Recordings will only be used for the purposes of teaching this course. If you do not consent to be recorded, you must notify your course convenor immediately so other arrangements can be made.

The fundamental physics will be developed in lectures, short demonstrations, video/dvd material, short example problems and workshops (essentially problem solving sessions). The laboratory program will aid in practical understanding of some aspects of the course materials.

It is expected that students will review each lecture in their own time, shortly after the lecture has been delivered. Lecture notes/presentations will be posted on Moodle, but it is expected that students will use more than one source in their reading.

The problems either in the notes or in assignments will require either numerical or descriptive answers or explanations. They are specifically designed to consolidate the lecture material, to develop conceptual understanding, to develop problem solving skills, and to help students assess their own progress.

Additional Course Information

This course comprises a total of 47 lectures and tutorials/workshops plus 12 hours of related laboratory classes and is a core unit in the Level 3 Physics program. It builds on the subject matter of the level 2 course *Physics 2B* and is divided into two equal sections:

Advanced Materials, covering aspects of condensed matter physics and materials science, and

Semiconductor Devices covering basics of operation of various devices that are used in the modern electronics industry.

In the ***Advanced Materials*** *section* there is particular emphasis on magnetism and magnetic materials. However, it is also a vehicle to introduce many concepts and ideas fundamental, more generally, to modern physics and materials science.

In the ***Semiconductor devices*** section we will review the electronic structure of semiconductors and show how they can be used to build useful electronic devices such as p-n junctions, bipolar and field effect transistors, light emitting diodes and junction lasers.

The course is one of the Level 3 Physics courses leading to a major in Physics. It will be assumed that students have a good working knowledge from the foundation Physics 1 courses ZPEM1501 and ZPEM1502 and the Physics 2 course ZPEM2502, and that the student is conversant with Level 1 Mathematics and Level 2 Mathematical Tools for Science (ZPEM2302).

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
two class tests	30%	Start Date: Not Applicable Due Date: Not Applicable
12-hour laboratory program	20%	Start Date: Not Applicable Due Date: Not Applicable
Four in-class quizzes	20%	Start Date: Not Applicable Due Date: Not Applicable
Examination	30%	Start Date: Not Applicable Due Date: Not Applicable

Assessment Details

two class tests

Course Learning Outcomes

- CLO1 : Mastered the key concepts in the topic areas of advanced materials, magnetic materials and electromagnetic wave propagation, demonstrated by the ability to discuss, describe and explain the topics.
- CLO2 : Demonstrate the ability to solve problems relating to advanced materials and electromagnetic wave propagation.
- CLO3 : Develop an appreciation of how the basic Physics in the areas of magnetic materials and electromagnetism foster current directions in related research and can drive technological advances.
- CLO4 : Apply theoretical knowledge of materials physics and electromagnetism and demonstrate proper scientific methodology when conducting laboratory experiments. In addition gain an appreciation of some of the techniques employed in the fields of magnetic materials research and electromagnetic remote sensing, and develop skills in team work and self-direction.

Detailed Assessment Description

Two **class tests**, worth 15% of the course, closed book, held on 25 March and 29 April. Students will be required to demonstrate their ability to solve problems, make calculations, reason conceptually and explain concepts;

Assignment submission Turnitin type

Not Applicable

12-hour laboratory program

Course Learning Outcomes

- CLO4 : Apply theoretical knowledge of materials physics and electromagnetism and demonstrate proper scientific methodology when conducting laboratory experiments. In addition gain an appreciation of some of the techniques employed in the fields of magnetic materials research and electromagnetic remote sensing, and develop skills in team work and self-direction.

Detailed Assessment Description

A 12-hour **laboratory** program, timetabled over 4 x 3h periods, counting 20% towards the final course mark. Assessment is via submission of 2 formal lab reports.

Assignment submission Turnitin type

This is not a Turnitin assignment

Four in-class quizzes

Course Learning Outcomes

- CLO1 : Mastered the key concepts in the topic areas of advanced materials, magnetic materials and electromagnetic wave propagation, demonstrated by the ability to discuss, describe and explain the topics.
- CLO2 : Demonstrate the ability to solve problems relating to advanced materials and electromagnetic wave propagation.
- CLO3 : Develop an appreciation of how the basic Physics in the areas of magnetic materials and electromagnetism foster current directions in related research and can drive technological advances.

Detailed Assessment Description

Four short in-class closed book **quizzes**, held in approximately in weeks 2, 4, 10 and 12, worth 5% each; 20% in total;

Assignment submission Turnitin type

Not Applicable

Examination

Course Learning Outcomes

- CLO1 : Mastered the key concepts in the topic areas of advanced materials, magnetic materials and electromagnetic wave propagation, demonstrated by the ability to discuss,

describe and explain the topics.
- CLO2 : Demonstrate the ability to solve problems relating to advanced materials and electromagnetic wave propagation.
- CLO3 : Develop an appreciation of how the basic Physics in the areas of magnetic materials and electromagnetism foster current directions in related research and can drive technological advances.
- CLO4 : Apply theoretical knowledge of materials physics and electromagnetism and demonstrate proper scientific methodology when conducting laboratory experiments. In addition gain an appreciation of some of the techniques employed in the fields of magnetic materials research and electromagnetic remote sensing, and develop skills in team work and self-direction.

Detailed Assessment Description

2-hour **examination**, held during the scheduled examination period, contributing 30% to the final course mark. Examination will be closed book, invigilated style.

Assignment submission Turnitin type

Not Applicable

General Assessment Information

There are four types of assessment task associated with this course:

- A 12-hour **laboratory** program, timetabled over 4 x 3h periods, counting 20% towards the final course mark. Assessment is via submission of 2 formal lab reports.
- Four short in-class **quizzes**, held in approximately in weeks 2, 4, 10 and 12, worth 5% each; 20% in total;
- two **class tests**, worth 15% of the course, held on 25 March and 29 April. Students will be required to demonstrate their ability to solve problems, make calculations, reason conceptually and explain concepts;
- a 2-hour **examination**, held during the scheduled examination period, contributing 30% to the final course mark. Like the class tests, the examination assesses “physics knowledge” by way of problem-solving, calculations, and conceptual reasoning.

Missed Assessment Tasks

Students who miss assessment tasks (e.g. in-class quizzes and laboratory experiments) must contact the lecturer at the earliest practicable date to discuss the absence. If the student provides written evidence such as a medical certificate or a note from a Divisional Officer explaining why the absence was necessary and the reason for the absence is deemed acceptable by the lecturer, an extension or alternative assessment date will be arranged. Otherwise, a zero mark will be awarded for that task. When absences are foreseeable, students must advise the lecturer prior to the absence. In some circumstances of missed assessment, a

formal application for special consideration may also be appropriate.

Late Submission of Laboratory Reports

Laboratory logbooks are expected to be written up during the laboratory experiment. They are due at the end of the experiment unless prior arrangements have been made with the lecturer in charge of that experiment.

NO ASSISTANCE is permitted from generative AI in this course: It is prohibited to use any software or service to search for or generate information or answers.

If its use is detected, it will be regarded as serious academic misconduct and subject to the standard penalties, which may include 00FL, suspension and exclusion.

Grading Basis

Standard

Requirements to pass course

All marks obtained for assessment items during the session are provisional. The final mark as published by the university following the assessment review group meeting is **the only official mark.**

The assessment for the course has been designed so that an overall mark of 50% or greater indicates that the student has unambiguously demonstrated satisfactory completion of each learning outcome.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 26 February - 1 March	Lecture	Lectures AM-01 to AM04
Week 2 : 4 March - 8 March	Blended	Class AM05 to AM06 lectures, AM-07 tutorial on problem set 1. AM-08 will be quiz 1 (on problem sheet 1).
Week 3 : 11 March - 15 March	Blended	Canberra day, missed class. Classes AM-09 and AM-10 lectures; AM11 a tutorial on problem sheet 2.
Week 4 : 18 March - 22 March	Blended	AM-12: quiz 2 on problem set 2; AM-13 to 15 lectures and revision for test 1
Week 5 : 25 March - 29 March	Assessment	25 March: Class test 1
	Lecture	AM-16 and AM-17 Lectures; Good Friday
Week 6 : 1 April - 5 April	Blended	Easter Monday; Lectures AM-18 and AM18. Friday lab classes
Week 7 : 22 April - 26 April	Blended	AM-20 tutorial/revision; missed classes due to Mil. and ANZAC. Lab week 2 using Friday class.
Week 8 : 29 April - 3 May	Assessment	Monday 29 April, class test 2.
	Lecture	SD-01 to SD-03 lectures.
Week 9 : 6 May - 10 May	Blended	3 Class SD-04 to SD-06 and lost day (military training Friday)
Week 10 : 13 May - 17 May	Blended	SD-07 to SD-10 includes lectures, tutorial and quiz no 3.
Week 11 : 20 May - 24 May	Lecture	SD-11 to SD-14
Week 12 : 27 May - 31 May	Blended	SD-15 (Tuesday with Monday timetable) to SD-18 includes lectures, tutorial and quiz no 4.
Week 13 : 3 June - 7 June	Lecture	SD-19 to SD-22; final lectures, problem solving and revision.

Attendance Requirements

Students are expected to attend all lectures, tutorials, laboratory sessions and assessments unless their absence has been approved by the course coordinator. Students who have missed assessments or a laboratory, or expect to miss such a requirement, must inform the appropriate staff member(s) below **by email** at the earliest practicable date:

- **Laboratory:** email the lecturer concerned
- **Quiz or Test:** email the lecturer and copy the course coordinator
- **Final Examination:** email the lecturer and copy the course coordinator

In typical circumstances of missed assessments, a formal application for Special Consideration via the prescibed University procedure is appropriate. Alternative assessment can then be arranged. Otherwise, in the case of absence a mark of zero will be awarded for the assessment.

General Schedule Information

Topics covered in the course are:

Advanced Materials (AM)

- *Atomic structure, valence and bonding*

- *Crystal structure (mainly revision).*
- *Crystalline and non-crystalline materials*
- *Atomic magnetic moments - origin of magnetism*
- *Introduction to magnetism*
- *Ordered magnetic systems*
- *Determination of crystal and magnetic structures - diffraction techniques.*
- *Bulk magnetic properties and applications.*
- *Imperfections in solids.*
- *Phase diagrams and binary alloy systems.*

Semiconductor devices (SD)

- *Crystal structure of Semiconductors*
- *Semiconductor Band Theory*
- *Electrons and Holes in Semiconductors*
- *Electrical transport in semiconductors*
- *The p-n junction*
- *The Field Effect Transistor*
- *The Bipolar Junction Transistor*
- *Optoelectronics and Light Emitting Devices*
- *Light Detecting Devices*

Course Resources

Prescribed Resources

Lecture notes will be made available on Moodle and the prescribed textbooks for the course are:

Introduction to Solid State Physics, C. Kittel (8th Ed, Wiley, 2005) ISBN 978-0-471-41526-8.

Semiconductor Devices: Physics and Technology,

S.M. Sze, (3rd Edition Wiley, 2012) ISBN 978-0-470-91407-6.

Recommended Resources

In addition, the following books will provide more in-depth descriptions of various sections and are recommended as supplementary reading. They are available the ADFA library and/or the Co-op bookshop.

Materials Science and Engineering: An Introduction, W.D. Callister Jr, (7th Ed Wiley, 2006) ISBN 978-0-471-73696-7.

Introduction to Magnetism and Magnetic Materials, D. Jiles, (2nd Ed Chapman and Hall, 1998)

ISBN 978-0-412-79850-4.

•*Semiconductor device physics and design, J. Singh (Springer, 2008) ISBN: 1402064802*

Additional Costs

N/A

Course Evaluation and Development

One of the key priorities in the 2025 Strategy for UNSW is a drive for academic excellence in education. One of the ways of determining how well UNSW is progressing towards this goal is by listening to our own students. Students will be asked to complete the myExperience survey towards the end of this course.

Students can also provide feedback during the semester via: direct contact with the lecturer, the "On-going Student Feedback" link in Moodle, Student-Staff Liaison Committee meetings in schools, informal feedback conducted by staff, and focus groups. Student opinions really do make a difference. Refer to the Moodle site for this course to see how the feedback from previous students has contributed to the course development. **Important note:** Students are reminded that any feedback provided should be constructive and professional and that they are bound by the Student Code of Conduct Policy.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Wayne Hutchison		G22 B26 ADFA campus	+61 2 5114 5040	Normal hours and early most days, appointments encouraged	No	Yes
Lecturer	Oleh Klochan		G24 B26 ADFA campus	02 5114 5021	By appointment	No	No

Other Useful Information

Academic Information

Course Evaluation and Development

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listening to our own students. Students will be asked to complete the myExperience survey towards the end of each course.

Students can also provide feedback during the semester via: direct contact with the lecturer, the "On-going Student Feedback" link in Moodle, Student-Staff Liaison Committee meetings in schools, informal feedback conducted by staff, and focus groups (where applicable). Student opinions really do make a difference. Refer to the Moodle site for your course to see how the feedback from previous students has contributed to the course development.

Important note: Students are reminded that any feedback provided should be constructive and professional and that they are bound by the Student Code of Conduct.

https://www.gs.unsw.edu.au/policy/documents/studentcodepolicy.pdf

Equitable Learning Services (ELS)

Students living with neurodivergent, physical and/or mental health conditions or caring for someone with these conditions may be eligible for support through the Equitible Learning Services team. Equitable Learning Services is a free and confidential service that provides practical support to ensure your mental or physical health conditions do not adversely affect your studies.

Our team of dedicated **Equitable Learning Facilitators** (ELFs) are here to assist you through this process. We offer a number of services to make your education at UNSW easier and more equitable.

Further information about ELS for currently enrolled students can be found at: https://www.student.unsw.edu.au/equitable-learning

Academic Honesty and Plagarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW staff and students have a responsibility to adhere to this principle of academic integrity. All students are expected to adhere to UNSW's Student Code of Conduct. Find relevant information at: Student Code of Conduct (unsw.edu.au)

Plagiarism undermines academic integrity and is not tolerated at UNSW. It is defined as using the words or ideas of others and passing them off as your own, and can take many forms, from

deliberate cheating to accidental copying from a source without acknowledgement.

For more information, please refer to the following:

https://student.unsw.edu.au/plagiarism

Submission of Assessment Tasks

Special Consideration

Special Consideration is the process for assessing and addressing the impact on students of short-term events, that are beyond the control of the student, and that affect performance in a specific assessment task or tasks.

Applications for Special Consideration will be accepted in the following circumstances only:

- Where academic work has been hampered to a substantial degree by illness or other cause;
- The circumstances are unexpected and beyond the student's control;
- The circumstances could not have reasonably been anticipated, avoided or guarded against by the student; and either:

(i) they occurred during a critical study period and was 3 consecutive days or more duration, or a total of 5 days within the critical study period; or

(ii) they prevented the ability to complete, attend or submit an assessment task for a specific date (e.g. final exam, in class test/quiz, in class presentation)

Applications for Special Consideration must be made as soon as practicable after the problem occurs and at the latest within three working days of the assessment or the period covered by the supporting documentation.

By sitting or submitting the assessment task the student is declaring that they are fit to do so and cannot later apply for Special Consideration (UNSW 'fit to sit or submit' requirement).

Sitting, accessing or submitting an assessment task on the scheduled assessment date, after applying for special consideration, renders the special consideration application void.

Find more information about special consideration at: https://www.student.unsw.edu.au/special/consideration/guide

Or apply for special consideration through your MyUNSW portal.

Late Submission of assessment tasks (other than examinations)

UNSW has a standard late submission penalty of:

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

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

Electronic submission of assessment

Except where the nature of an assessment task precludes its electronic submission, all assessments must be submitted to an electronic repository, approved by UNSW or the Faculty, for archiving and subsequent marking and analysis.

Release of final mark

All marks obtained for assessment items during the session are provisional. The final mark as published by the university following the assessment review group meeting is the only official mark.