UNSW Course Outline

MATS2003 Materials Characterisation - 2024

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General Course Information

Course Code : MATS2003
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 : Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

In this course students will learn the principles and applications of the main methods employed in the characterisation of the composition and structure of materials including specimen preparation, crystallography and diffraction, optical microscopy, electron microscopy,

spectroscopy, image analysis and microstructural quantification. Laboratory classes in the course will equip students with basic practical skills in specimen preparation and operation of selected characterisation instruments and related software, as well as cultivate safe laboratory working practices. This course is a Level 2 course and is core in the BE (Hons) (Materials Science and Engineering) program and in the Materials Science major of BSc and BAdvSc (Hons) programs, and is also suitable for science and engineering students who need a fundamental understanding and practical skills in the characterisation of materials. The course is completed as weekly lectures, self-learning online activities, and in-person laboratory classes.

Course Aims

The objectives of this course are to: (1) provide fundamental explanation of the principles underpinning the main methods used in Materials Science and Engineering and related disciplines to characterise the composition and structure of materials; (2) equip students with understanding and basic practical skills for the operation of relevant characterisation equipment and instrumentation; and (3) give students the ability to examine, describe and quantify the composition and structure of real materials.

Relationship to Other Courses

MATS2003 is a Level 2 course and is core in the BE (Hons) (Materials Science and Engineering) program and in the Materials Science major of BSc and BAdvSc(Hons) programs, and is also suitable for science and engineering students who need fundamental understanding and basic practical skills in the characterisation of materials. The course is built on learning from prior courses in materials science, computing, mathematics, chemistry, and physics.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Quantify the composition and structure of materials at the following scales: crystal structure; nanostructure; and microstructure.
CLO2 : Explain the principles of operation of major equipment and instruments used for characterisation of materials.
CLO3 : Demonstrate basic practical skills in examining and quantifying material structures.
CLO4 : Select the appropriate materials characterisation technique(s) to determine the composition and structure of a given material.

Course Learning Outcomes	Assessment Item
CLO1 : Quantify the composition and structure of materials at the following scales: crystal structure; nanostructure; and microstructure.	• Mid-term Test • Assignments • Final Examination • Laboratory work
CLO2 : Explain the principles of operation of major equipment and instruments used for characterisation of materials.	• Mid-term Test • Assignments
CLO3 : Demonstrate basic practical skills in examining and quantifying material structures.	• Laboratory work
CLO4 : Select the appropriate materials characterisation technique(s) to determine the composition and structure of a given material.	• Final Examination • Laboratory work

Learning and Teaching Technologies

Moodle - Learning Management System | Blackboard Collaborate

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Mid-term Test Assessment Format: Individual	20%	Start Date: Not Applicable Due Date: 28/03/2024 05:00 PM
Assignments Assessment Format: Individual	35%	
Final Examination Assessment Format: Individual	30%	Start Date: Not Applicable Due Date: Final exam is held in the UNSW Examination period at the end of Term 1.
Laboratory work Assessment Format: Individual	15%	

Assessment Details

Mid-term Test

Assessment Overview

You will be assessed on your understanding of the underlying principles of materials characterization techniques, as well as their application to the practical determination of the composition and structure of real materials, for the topics of Specimen Preparation, Crystallography, and X-ray Diffraction (as covered by formal lectures, nominated reading material, and assignments).

The mid-term test will consist of a combination of short-answer style questions and calculations. Any derivations will assume knowledge of the material with relevant background equations provided (except Bragg's Law), rather than resorting equations to memory.

The mid-term test will be 1.5 hours in duration and will be held in Week 7 of Term. You are required to achieve a mark of at least 35% in this mid-term test
(and at least 45% weighted average for this mid-term test and the final exam) to pass the course otherwise an Unsatisfactory Fail (UF) grade may be awarded.

Feedback: Students will receive their marked exams indicating what questions were answered correctly and incorrectly. Overall comments and worked solutions may be provided to the class.

Course Learning Outcomes

- CLO1 : Quantify the composition and structure of materials at the following scales: crystal structure; nanostructure; and microstructure.
- CLO2 : Explain the principles of operation of major equipment and instruments used for characterisation of materials.

Detailed Assessment Description

Refer to Moodle for detailed information about this assessment task.

Submission notes

MT-Test is a formal invigilated in-person written exam.

Assignment submission Turnitin type

Not Applicable

Hurdle rules

You are required to achieve a mark of at least 35% in this mid-term test (and at least 45% weighted average for this mid-term test and the final exam) to pass the course otherwise an Unsatisfactory Fail (UF) grade may be awarded.

Assignments

Assessment Overview

Five ongoing assignments to assess the students understanding and application of concept taught throughout the course.

Crystallography Assignment: You will be expected to determine basic crystallographic relationships and perform crystal structure calculations. (10%)

X-ray Diffraction Assignment: You will be expected to determine crystallographic structure factors and diffraction angles and intensities of a selected material from first principles and then use these to determine theoretical structural parameters of the material such as lattice parameter(s), unit cell volume, and density of the material. (10%)

Electron Microscopy Assignment: You will use an online interactive SEM simulator to learn the basic operation of an SEM and to determine how image appearance is affected by SEM operating conditions, and you will interpret topographical and compositional SEM images and data. (15%)

Feedback will be given two weeks after submission of the assignment including: your marked assignment, overall comments on how the class performed, and worked answers.

Course Learning Outcomes

- CLO1 : Quantify the composition and structure of materials at the following scales: crystal structure; nanostructure; and microstructure.
- CLO2 : Explain the principles of operation of major equipment and instruments used for characterisation of materials.

Detailed Assessment Description

Correction: the above description states "Five ongoing assignments" which is incorrect, there are only three.

The assignments complement specific lecture topics and are due in the following weeks:

• Crystallography Assignment due in Week 4

• X-ray Diffraction Assignment due in Week 7

• Electron Microscopy Assignment due in Week 9

Refer to Moodle for detailed information about each of the assignments.

Assignment submission Turnitin type

This is not a Turnitin assignment

Final Examination

Assessment Overview

You will be assessed on your understanding of the underlying principles of materials characterization techniques, as well as their application to the practical determination of the composition and structure of real materials, for the topics of Electron Microscopy, Spectroscopy, Optical Microscopy, Digital Image Analysis, and Stereology (as covered by formal lectures, nominated reading material, assignments, and laboratory classes).

The final exam will consist of a combination of multiple choice questions, short-answer style questions, and calculations. Any derivations will assume knowledge of the material with relevant background equations provided rather than requiring memorisation.

The final exam will provide summative assessment (no feedback) and will consist of a combination of short-answer style answers and calculations. Any derivations will assume knowledge of the material with relevant background equations provided, rather than resorting

equations to memory. The final exam will be 2 hours in duration and be held in the formal UNSW examination period at the end of term.

You are required to achieve a mark of at least 35% in this final exam
(and at least 45% weighted average for this final exam and the mid-term test) to pass the course otherwise an Unsatisfactory Fail (UF) grade may be awarded.

Course Learning Outcomes

- CLO1 : Quantify the composition and structure of materials at the following scales: crystal structure; nanostructure; and microstructure.
- CLO4 : Select the appropriate materials characterisation technique(s) to determine the composition and structure of a given material.

Detailed Assessment Description

Refer to Moodle for detailed information about this assessment task.

Submission notes

Final Examination is a formal invigilated in-person exam.

Assignment submission Turnitin type

Not Applicable

Hurdle rules

You are required to achieve a mark of at least 35% in this final exam (and at least 45% weighted average for this final exam and the mid-term test) to pass the course otherwise an Unsatisfactory Fail (UF) grade may be awarded.

Laboratory work

Assessment Overview

Lab. 1 Metallographic Sample Preparation: You will employ selected metallographic preparation steps learnt in lectures to prepare a specimen that is suitable for microstructural examination by optical microscopy and SEM. (2%)

Lab. 2 X-Ray Diffraction: You will be shown the main components and operating principle of a powder XRD unit and will complete XRD measurements to determine the phases present and/or lattice parameters of a material. (4%)

Lab. 3 Microscopy: You will work in small groups to: 1) learn the correct operation of an inverted optical microscope to examine and interpret the effect of microscope settings on the

resultant micrograph image; and 2) employ SEM operating principles learnt in the SEM online tutorial to an actual SEM instrument by performing compositional and topographical analyses of a specimen. (4%)

Lab. 4 Quantitative Microstructural Analysis: You will process selected material micrographs using digital image processing operations learnt in lectures to produce images suitable for publication or for stereological quantification. You will then use standard stereological relationships and methods to quantify selected microstructural parameters from these micrographs (5%)

Submission: The task for each laboratory class is due within one week of completion of the class.

Feedback: Students will receive their mark and individualised feedback on the areas they excelled at and which areas of the reports that were not answered correctly. Feedback will be provided within two weeks of submission.

Course Learning Outcomes

- CLO1 : Quantify the composition and structure of materials at the following scales: crystal structure; nanostructure; and microstructure.
- CLO3 : Demonstrate basic practical skills in examining and quantifying material structures.
- CLO4 : Select the appropriate materials characterisation technique(s) to determine the composition and structure of a given material.

Detailed Assessment Description

Refer to Moodle for detailed information about this assessment task including laboratory description, submission requirements, and due dates.

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students can see Turnitin similarity reports.

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

Requirements to pass course

You are required to achieve a mark of at least 35% in this final exam (and at least 45% weighted average for this final exam and the mid-term test) to pass the course otherwise an Unsatisfactory Fail (UF) grade may be awarded.

Course Schedule

Attendance Requirements

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

General Schedule Information

Please refer to Moodle for detailed information about the course schedule.

Course Resources

Prescribed Resources

No specific resources are prescribed for this course.

Recommended Resources

Specific online resources will be given in lectures during the course. In addition, the following classic textbooks may be useful for students:

• C. Barrett and T.B. Massalski, Structure of Metals, 3rd Revised Edition. Pergamon Press, Oxford, 1980.
• B.D. Cullity and S.R. Stock, Elements of X-ray Diffraction, 3rd Revised Edition. Prentice-Hall Inc., 2001.
• R. Jenkins & R.L. Snyder, Introduction to X-ray Powder Diffractometry. John Wiley & Sons Inc., 1996
• N.F. Kennon, Patterns in Crystals. John Wiley, Chichester, 1980.
• M.H.Loretto, Electron Beam Analysis of Materials, Second Edition. Chapman and Hall, New

York, 1994.
• Metals Handbook, Ninth Edition, Volume 9 Metallography and Microstructures. American Society for Metals, USA, 1985.
• J.C. Russ, The Image Processing Handbook, Third Edition. CRC Press, Boca Raton, Florida, 1999.
• G.F. Vander Voort, Metallography Principles and Practice. McGraw Hill, New York, 1984.
• Y. Waseda, E. Matsubara, and K. Shinoda, X-Ray Diffraction Crystallography: Introduction, Examples and Solved Problems. Springer, Berlin, 2011.

Additional Costs

Nil.

Course Evaluation and Development

Formal student feedback about the course will be gathered from enrolled students via the myExperience survey conducted at the end of term. This feedback will be used to evaluate the running and teaching of the course as well as to make improvements in the course for the following year to improve the student experience. Students are also welcome to make constructive comments and suggestions at any time during term to course staff. Any significant feedback from the previous running of the course and how it was used to improve the course will be discussed in the first lecture.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Owen Standard		Rm 243A Hilmer Building (E10)	(02) 9065 5356	Please send email to request appointment for consultation.	Yes	Yes
Lecturer	Shery Chang		Rm B65, Chemical Sciences Building (F10)	(02) 9385 6709	Please send email to request appointment for consultation.	No	No

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