



UNSW Course Outline

MATS2006 Diffusion and Kinetics - 2024

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General Course Information

Course Code : MATS2006

Year : 2024

Term : Term 3

Teaching Period : T3

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

This course provides an introduction to reaction kinetics, including elementary and non-elementary reactions, reaction order, activation energy, Arrhenius law, irreversible and reversible reactions, degree of reaction; heterogeneous reactions, kinetics of solid state-gas (fluid)

reactions, elementary steps, rate-controlling steps, intrinsic kinetics.

Through a series of lectures and a laboratory class, the course also explores: diffusion and mass transfer in the gas and fluid phases, solid state diffusion, atomistics of diffusion, Fick's first and second laws; thin film solution and tracer diffusion measurements, semi-infinite and infinite diffusion couples - diffusion in a concentration gradient; temperature effects; surface, grain boundary and dislocation pipe diffusion; diffusion in ionic solids, interdiffusion and the Kirkendall effect, measurement of variable diffusion coefficients and compares thermodynamics vs. kinetics in an applied environment.

Course Aims

The aim of this course is to introduce students to the fundamentals of kinetics and diffusion mechanisms pertinent to engineering materials. When successfully completed, students will be able to apply these fundamentals to quantify transport phenomena that occur in various materials processing applications.

Relationship to Other Courses

Prior learning/knowledge base from first-year core Chemistry and Materials Science and Engineering courses or their equivalent is expected.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Communicate scientific information relating to chemical kinetics using precise terminology relating to basic principles of diffusion and kinetics.
CLO2 : Derive fundamental kinetics and diffusion laws and use these to model material processes and behaviours.
CLO3 : Interpret and quantify time dependent chemical kinetics and mass transfer processes which occur in materials, materials processing and synthesis operations.
CLO4 : Demonstrate, describe and/or relate the role of microstructural features such as grain boundaries, dislocations and point defects in diffusion and kinetics.

Course Learning Outcomes	Assessment Item
CLO1 : Communicate scientific information relating to chemical kinetics using precise terminology relating to basic principles of diffusion and kinetics.	<ul style="list-style-type: none">• Kinetics Test• Laboratory report• Diffusion Fundamentals Test• Applied Diffusion and kinetics exam
CLO2 : Derive fundamental kinetics and diffusion laws and use these to model material processes and behaviours.	<ul style="list-style-type: none">• Kinetics Test• Laboratory report• Diffusion Fundamentals Test• Applied Diffusion and kinetics exam
CLO3 : Interpret and quantify time dependent chemical kinetics and mass transfer processes which occur in materials, materials processing and synthesis operations.	<ul style="list-style-type: none">• Kinetics Test• Diffusion Fundamentals Test• Applied Diffusion and kinetics exam
CLO4 : Demonstrate, describe and/or relate the role of microstructural features such as grain boundaries, dislocations and point defects in diffusion and kinetics.	<ul style="list-style-type: none">• Applied Diffusion and kinetics exam

Learning and Teaching Technologies

Moodle - Learning Management System | Microsoft Teams | Echo 360

Learning and Teaching in this course

You are expected to undertake a total of approximately 150 hours of work for this course, spread over the entire term, including attending classes, working through the online lessons, completing assessments, reading recommended textbooks and other resources, revising and preparing for the exam.

Students are expected to be challenged by the course content and to challenge their own

preconceptions, knowledge, and understanding by questioning information, concepts, and approaches during class and study.

Coursework, tutorials, laboratories, tests/examinations, and other forms of learning and assessment are intended to provide students with the opportunity to cross-reference these activities in a meaningful way with their own experience and knowledge.

The course content is designed to incorporate both theoretical and practical concepts, where the latter is intended to be applicable to real-world situations and contexts.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Kinetics Test Assessment Format: Individual	25%	Start Date: 24/09/2024 02:00 PM Due Date: 24/09/2024 04:00 PM
Laboratory report Assessment Format: Individual	10%	Start Date: Refer to your timetable Due Date: At the end of Lab session
Diffusion Fundamentals Test Assessment Format: Individual	30%	Start Date: 22/10/2024 02:00 PM Due Date: 22/10/2024 04:00 PM
Applied Diffusion and kinetics exam Assessment Format: Individual	35%	Start Date: Timetabled in Exam Period TBA

Assessment Details

Kinetics Test

Assessment Overview

You will complete a 90 min test which covers content from the kinetics section of the course.

This test is conducted during term in timetabled classes, typically in Week 3 of Term with a single attempt provided.

Questions typically include short sentence answers, calculations and hand-plotting of data.

You will be expected to describe and/or explain simple and complex kinetic systems, determine and apply rate equations, and interpret real data in terms of the theory provided.

Feedback: You will receive your test mark indicating what questions were answered correctly and incorrectly prior to the end of week 4.

Overall comments and worked solutions may be provided to you once all students have completed the test.

Course Learning Outcomes

- CL01 : Communicate scientific information relating to chemical kinetics using precise terminology relating to basic principles of diffusion and kinetics.
- CL02 : Derive fundamental kinetics and diffusion laws and use these to model material processes and behaviours.
- CL03 : Interpret and quantify time dependent chemical kinetics and mass transfer processes which occur in materials, materials processing and synthesis operations.

Assessment Length

90 minutes

Submission notes

Submitted at end of test

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.

For more information on Generative AI and permitted use please see [here](#).

Laboratory report

Assessment Overview

This assessment involves both a pre-laboratory online exercise and a submitted laboratory report.

The pre-laboratory exercise (worth 33% of the task marks) must be completed prior to undertaking the laboratory exercise. It requires you to apply laboratory safety and method standards.

The small-group laboratory exercise is typically timetabled in Week 4. It involves you determining initial reaction rates and correlating concentration dependence to determine the order of the reaction. This laboratory typically runs over 3 hours.

The associated laboratory report (worth 67% of the task mark) is due after the laboratory. This report requires you to report experimental results, apply content learned in the kinetics section of the course class to experimental results and determine the reaction rate order of the experiment/s.

Feedback: You will receive your mark and individualised feedback on which areas of the report that were not answered correctly typically two weeks after submission.

Course Learning Outcomes

- CLO1 : Communicate scientific information relating to chemical kinetics using precise terminology relating to basic principles of diffusion and kinetics.
- CLO2 : Derive fundamental kinetics and diffusion laws and use these to model material processes and behaviours.

Assessment Length

3 hours

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.

For more information on Generative AI and permitted use please see [here](#).

Diffusion Fundamentals Test

Assessment Overview

You will complete a 90 min test which covers content from the Diffusion Fundamentals section of the course.

This test is conducted during term in timetabled classes, typically in Week 7 of Term with a single attempt provided.

Questions typically include short sentence answers, and calculations.

You will be expected to describe and/or explain diffusion processes/mechanisms and associated theory, determine and apply diffusion rate equations.

Feedback: You will receive your test mark indicating what questions were answered correctly and incorrectly prior to the end of week 8.

Overall comments and worked solutions may be provided to you once all students have completed the test.

Course Learning Outcomes

- CL01 : Communicate scientific information relating to chemical kinetics using precise terminology relating to basic principles of diffusion and kinetics.
- CL02 : Derive fundamental kinetics and diffusion laws and use these to model material processes and behaviours.
- CL03 : Interpret and quantify time dependent chemical kinetics and mass transfer processes which occur in materials, materials processing and synthesis operations.

Assessment Length

90 minutes

Submission notes

Hand in test paper at end of test period

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

No Assistance

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For more information on Generative AI and permitted use please see [here](#).

Applied Diffusion and kinetics exam

Assessment Overview

This Exam covers content from the Applied Diffusion and Kinetics section of the course and is held during the official exam period.

The exam runs over a duration of 2 hours. You will be allowed one attempt at this exam.

Questions typically include single-word, short sentence and essay type answers, and the incorporation of hand-drawn figures to explain your answers.

You will be expected to describe and/or explain applied diffusion and kinetic processes/mechanisms and associated theory.

Feedback is available through inquiry with the course convenor or lecturer/demonstrator responsible for the appropriate section of the course.

Overall comments and worked solutions may be provided to you once all students have completed the test.

Course Learning Outcomes

- CL01 : Communicate scientific information relating to chemical kinetics using precise terminology relating to basic principles of diffusion and kinetics.
- CL02 : Derive fundamental kinetics and diffusion laws and use these to model material processes and behaviours.
- CL03 : Interpret and quantify time dependent chemical kinetics and mass transfer processes which occur in materials, materials processing and synthesis operations.
- CL04 : Demonstrate, describe and/or relate the role of microstructural features such as grain boundaries, dislocations and point defects in diffusion and kinetics.

Assessment Length

2 hours

Submission notes

Exam paper to be submitted at end of Exam

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.

For more information on Generative AI and permitted use please see [here](#).

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

To pass the course, you must achieve an overall grade of at least 50%.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 9 September - 15 September	Lecture	Tuesday; 14:00 - 16:00; E19 Patricia O'Shane G03 (K-E19-G03) KINETICS - Introduction Lecture; Dr C Hanson
	Lecture	Wednesday; 16:00 - 18:00; F10 June Griffith M10 (K-F10-M10) KINETICS - Reaction Rates; Dr C Hanson
	Tutorial	Thursday; 14:00 - 16:00; Old Main Building G31 (K-K15-G31) KINETICS - TUTORIAL; Dr C Hanson
Week 2 : 16 September - 22 September	Lecture	Tuesday; 14:00 - 16:00; E19 Patricia O'Shane G03 (K-E19-G03) KINETICS - Catalysis; Dr C Hanson
	Lecture	Wednesday; 16:00 - 18:00; F10 June Griffith M10 (K-F10-M10) KINETICS - Molecular Reaction Dynamics; Dr C Hanson
	Tutorial	Thursday; 14:00 - 16:00; Old Main Building G31 (K-K15-G31) KINETICS - TUTORIAL; Dr C Hanson
Week 3 : 23 September - 29 September	Assessment	Tuesday; 14:00 - 16:00; E19 Patricia O'Shane G03 (K-E19-G03) OR TBA EXTRA VENUE KINETICS TEST - Held in Class; Dr C Hanson
	Lecture	Wednesday; 16:00 - 18:00; F10 June Griffith M10 (K-F10-M10) DIFFUSION FUNDAMENTALS - Introduction to Diffusion; A.Prof. R Joshi
	Lecture	Thursday; 14:00 - 16:00; Old Main Building G31 (K-K15-G31) DIFFUSION FUNDAMENTALS - Diffusion in Liquids 1
	Laboratory	See your Timetabled Laboratory selection and Moodle updates for details. Involves pre-laboratory exercise.
Week 4 : 30 September - 6 October	Lecture	Tuesday; 14:00 - 16:00; E19 Patricia O'Shane G03 (K-E19-G03) DIFFUSION FUNDAMENTALS - Diffusion in Liquids 2; A.Prof. R Joshi
	Lecture	Wednesday; 16:00 - 18:00; F10 June Griffith M10 (K-F10-M10) DIFFUSION FUNDAMENTALS - Diffusion in Gasses; A.Prof. R Joshi
	Lecture	Thursday; 14:00 - 16:00; Old Main Building G31 (K-K15-G31) DIFFUSION FUNDAMENTALS - Diffusion in Solids; A.Prof. R Joshi
Week 5 : 7 October - 13 October	Lecture	Tuesday; 14:00 - 16:00; E19 Patricia O'Shane G03 (K-E19-G03) DIFFUSION FUNDAMENTALS - Diffusion in Thin Films; A.Prof. R Joshi
	Tutorial	Wednesday; 16:00 - 18:00; F10 June Griffith M10 (K-F10-M10) DIFFUSION FUNDAMENTALS - TUTORIAL & PRACTICE TEST; A.Prof. R Joshi
	Tutorial	Thursday; 14:00 - 16:00; Old Main Building G31 (K-K15-G31) DIFFUSION FUNDAMENTALS - OPTIONAL TUTORIAL; A.Prof. R Joshi
Week 6 : 14 October - 20 October	Other	NO CLASSES DURING WEEK 6
Week 7 : 21 October - 27 October	Assessment	Tuesday; 14:00 - 16:00; E19 Patricia O'Shane G03 (K-E19-G03) DIFFUSION FUNDAMENTALS TEST - Held in Class; A.Prof. R Joshi
	Lecture	Wednesday; 16:00 - 18:00; F10 June Griffith M10 (K-F10-M10) APPLIED DIFFUSION & KINETICS - Introduction Lecture; A.Prof. Kevin J Laws
Week 8 : 28 October - 3 November	Lecture	Tuesday; 14:00 - 16:00; E19 Patricia O'Shane G03 (K-E19-G03) APPLIED DIFFUSION & KINETICS - Introduction to Nucleation; A.Prof. Kevin J Laws
	Lecture	Wednesday; 16:00 - 18:00; F10 June Griffith M10 (K-F10-M10) APPLIED DIFFUSION & KINETICS - Nucleation Theory; A.Prof. Kevin J Laws
Week 9 : 4 November - 10 November	Lecture	Tuesday; 14:00 - 16:00; E19 Patricia O'Shane G03 (K-E19-G03) APPLIED DIFFUSION & KINETICS - Crystal Growth & Transformation Kinetics; A.Prof. Kevin J Laws
	Lecture	Wednesday; 16:00 - 18:00; F10 June Griffith M10 (K-F10-M10) APPLIED DIFFUSION & KINETICS - Recrystallisation; A.Prof. Kevin J Laws
Week 10 : 11 November - 17 November	Lecture	Tuesday; 14:00 - 16:00; E19 Patricia O'Shane G03 (K-E19-G03) APPLIED DIFFUSION & KINETICS - Grain Boundary & Surface Diffusion; A.Prof. Kevin J Laws
	Lecture	Wednesday; 16:00 - 18:00; F10 June Griffith M10 (K-F10-M10) APPLIED DIFFUSION & KINETICS - Segregation & Homogenisation; A.Prof. Kevin J Laws
	Tutorial	Thursday; 14:00 - 16:00; Old Main Building G31 (K-K15-G31) APPLIED DIFFUSION & KINETICS - TUTORIAL & PRACTICE EXAM; A.Prof. Kevin J Laws

Attendance Requirements

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

Course Resources

Recommended Resources

Kinetics

- P.W. Atkins and J. De Paula, Elements of Physical Chemistry, 5th edition, Oxford University Press, 2009.

Diffusion

- Marcel Mulder, Basic Principles of Membrane Technology Kluwer Academic Publishers, ISBN-13:978-0-7923-4248-9
- Paul Shewmon, Diffusion in Solids, 2nd Edition, ISBN-13: 978-0873391054
- J. E. Brady, J. W. Russell and John R. Holum, Chemistry Matter and Its Changes, John Wiley & Sons, Inc. New York, 3 Edition, 2000 (Chapter 13)
 - Levenspiel, Chemical Reaction Engineering, John Wiley & Sons, any edition, freely available in electronic version.
- H. Y. Sohn, Fundamentals of the Kinetics of Heterogeneous Reaction Systems in Extractive Metallurgy, Rate Processes of Extractive Metallurgy (Eds. H Y Sohn and M E Wadsworth), Plenum Press, 1979.
- H S Ray, Kinetics of Metallurgical Reactions, International Science Publisher, 1993.
- N.J. Themelis, Transport and Chemical Rate Phenomena, Gordon and Breach, 1995.
- DA. Porter and K.E. Easterling, Phase Transformations in Metals and Alloys, Chapman & Hall, London, 1991.
- P.Shewmon, Diffusion in Solids, 2nd Edition, Minerals, Metals & Materials Society, Warrendale, PA, 1989.
- Robert Reed-Hill, Physical Metallurgy Principles, PWS-Kent Pub. 1992

Course Evaluation and Development

Feedback will be gathered through the myExperience process at the end of the term. Students should provide specific feedback so the action required to improve the course is clear.

While the myExperience process will help to improve the course for future cohorts, we also want to make the learning experience the best possible for current students. Students are welcome to provide feedback to the lecturers at any time, either by email, in person or using the anonymous

feedback forum in Moodle. There are many changes that can be made during the term to improve the students' learning experience, but improvements can only be made if students make staff aware of the issues that are affecting their learning experience.

An example of a change made to MATS2006 based on previous feedback: students commented that there were too many parallel learning topics (formerly four topics taught in parallel), leading to overload and/or a lower focus, priority or value placed on each learning stream. This was amended within the course to teach three new independent learning topics, taught in series to provide more focussed block learning and faster feedback mechanisms.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Kevin Law s		Office 301; School of Materials Science and Engineering; Hilmer Bulding (E10)		by email appointme nt	Yes	Yes
Lecturer	Christoph er Hanson		Room 602, E8 Science & Engineering Building.		by email appointme nt	No	No
	Rakesh Jo shi				by email appointme nt	No	No
Lab director	Ron Haines				by email appointme nt	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 Plagiarism

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](#)