Course Outline

MATS6102

Kinetics and Phase Transformations

Materials Science and Engineering

Science

T3, 2020

1. Staff

Position	Name	Email	Consultation times and locations	Contact Details
Course Convenor	Assoc. Prof. Runyu Yang	r.yang@unsw.edu.au	Room 349, School of Materials Science and Engineering (Building E10), by appointment	Phone: 9385 6787
Lecturer	Dr Kevin Laws	k.laws@unsw.edu.au	Room 301, School of Materials Science and Engineering (Building E10), by appointment	Phone: 9385 5234
Lecturer	Dr Kim Lapere	k.lapere@unsw.edu.au	Room 133 Dalton Building (F12) School of Chemistry by appointment	Phone: 9385 4708

2. Course information

Units of credit: 6

Pre-requisite(s): None

Timetabling website: http://timetable.unsw.edu.au/2020/MATS6102.html#S3-8385

Teaching times and locations:

Part 1	Lecture	Lecture	Lecture	Lab
Day	Monday	Wednesday	Friday	See Moodle for details
Time	9:00-11:00	11:00-1:00	9:00-11:00	
Weeks	1-3, 5	1-5	1-5	

Part 2	Lecture	Lecture
Day	Monday	Friday
Location	Online	Online
Time	12:00-14:00	13:00-15:00
Weeks	7-10	7-10

2.1 Course summary

This course covers a background on the relationship between kinetics, diffusion, phase transformations and the prediction of materials microstructure. Students will understand how to predict materials structure based on the principles of phase transformations and apply this knowledge to commercial alloys.

Kinetics - Reaction rate definition, the rate law, rate constant and order. Experimental determination of the rate law: the method of initial rates, methods using integrated rate equations for 1st order and 2nd order reactions; rate constants, half-life. Effect of temperature on reaction rates: the Arrhenius equation, activation energy and frequency factor. Elementary reactions, mechanism, rate determining step; relation to the rate law. Complex reactions: opposing, consecutive and parallel reactions; catalysis and catalysts; enzyme catalysis, Michaelis-Menten mechanisms, molecular reaction kinetics and collision theory.

Diffusion Fundamentals - Introduction to diffusion in gasses, liquids, membrane transport, facilitated diffusion, osmosis, diffusion in solids and thin films, Fick's first and second laws and other factors affecting diffusion.

Diffusion and Kinetics case studies – We will see how the fundamentals of diffusion learnt in weeks 1-5 can be applied to solve real problems encountered for various materials processing phenomena. Based on such case studies an appreciation of the complexities of applying diffusion laws will be learnt. Finally, students will analyse a different set of topics of how the principles of Diffusion and Kinetics learnt in weeks 1-5 can be applied for their research paper.

2.2 Course aims

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

2.3 Course learning outcomes (CLO)

At the successful completion of this course you (the student) should be able to:

1. Understand the fundamentals of kinetics and diffusion
2. Apply kinetics and diffusion to prediction of phase transformations
3. Quantify chemical kinetics and diffusion in materials processing operations
4. Identify, formulate and solve reaction engineering problems from 1st principles

2.4 Relationship between course and program learning outcomes and assessments

Course Learning Outcome (CLO)	LO Statement	Program Learning Outcome (PLO)	Related Tasks & Assessment
CLO 1	Understand…	2	1, 2 & 3
CLO 2	Apply…	4	1, 2 & 3
CLO 3	Quantify…	1	1, 2 & 3
CLO 4	Identify…	5	1, 2 & 3

3. Strategies and approaches to learning

3.1 Learning and teaching activities

(based on UNSW Learning Guidelines)

- *Students are actively engaged in the learning process.*

  It is expected that, in addition to attending classes, students will read, write, discuss, and engage in analysing the course content.

- *Effective learning is supported by a climate of inquiry where students feel appropriately challenged.*

  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.

- *Learning is more effective when students' prior experience and knowledge are recognised and built on.*

  Coursework, tutorials, assignments, laboratories, 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.

- *Students become more engaged in the learning process if they can see the relevance of their studies to professional and disciplinary contexts*

  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.

3.2 Expectations of students

- Students must attend at least 80% of all classes with the expectation that students only miss classes due to illness or unforeseen circumstances
- Students must read through lecture notes and lab sheets prior to class
- During class, students are expected to engage actively in class discussions
- Students should work through lecture, tutorial and textbook questions
- Students should read through the relevant chapters of the prescribed textbook.
- Students should complete all assessment tasks and submit them on time.
- Students are expected to participate in online discussions through the Moodle page

4. Course schedule and structure

This course consists of 48 hours of class contact hours. You are expected to take an additional 102 hours of non-class contact hours to complete assessments, readings and exam preparation.

Week	Course Section	Topics	Activity
1	Kinetics	Introduction & Reaction Rates Catalysis, Enzymes & Molecular Reactions	
2		Catalysis, Enzymes & Molecular Reactions Tutorial Session & Practice Exam Questions	Exam
3	Diffusion Fundamentals	Introduction to Diffusion Diffusion in Liquids	
4		Diffusion in Gases Diffusion in Solids Diffusion in thin films	
5		Tutorial	Exam
6	Diffusion Case Studies	No lecture	
7		Kinetics in Process Metallurgy	
8		Kinetics in Hydrogen Battery, Diffusion in porous materials	
9		Diffusion in semiconductors,	
10		Research paper and group presentation	Presentation

5. Assessment

5.1 Assessment tasks

Assessment task	Description	Weight	Due date
Kinetics Exam:	The exam covers all kinetic content. Students will be asked to understand simple and complex kinetic systems, determine and apply rate equations, and interpret real data in terms of the theory provided.	25%	In class Week 2
Diffusion Fundamentals Exam:	Based on all diffusion fundamentals content. Students will be asked to understand basic principles of diffusion, fundamental theory, examples of diffusion process, and possible application.	30%	In class Week 5
Case study research paper:	You will be asked to analyse a particular research topic and apply what you have learnt in terms of diffusion and kinetics to the topic	45%	Week 10

Further information

UNSW grading system: https://student.unsw.edu.au/grades

UNSW assessment policy: https://student.unsw.edu.au/assessment

5.2 Assessment criteria and standards

Assessment criteria and standards for each assessment tasks are available on the course Moodle page.

5.3 Submission of assessment tasks

- UNSW operates under a Fit to Sit/ Submit rule for all assessments. If a student wishes to submit an application for special consideration for an exam or assessment, the application must be submitted prior to the start of the exam or before an assessment is submitted. If a student sits the exam/ submits an assignment, they are declaring themselves well enough to do so. Information on this process can be found here: https://student.unsw.edu.au/special-consideration. Medical certificates or other appropriate documents must be included. Students should also advise the lecturer of the situation.
- Unless otherwise specified in the task criteria, all assignments must be uploaded via Moodle prior to the due date for submission.
- Assignments/lab reports submitted after the due date for submission will receive a 10% of maximum grade penalty for every day late, or part thereof.
- Students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course coordinator prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit: https://student.unsw.edu.au/disability. Early notification is essential to enable any necessary adjustments to be made.
- Rules governing conduct during exams are given at: https://student.unsw.edu.au/exam-rules

5.4. Feedback on assessment

Assignments: Feedback will be given two weeks after submission of the assignment and take the form of the mark for the assignment, overall comments on how the class performed, any common areas that were not answered correctly. Additionally, personal feedback and how each student performed may be given.

Exams: 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.

6. Academic integrity, referencing 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.[1] 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 and **plagiarism** can be located at:

- The *Current Students* site https://student.unsw.edu.au/plagiarism**,** and
- The *ELISE* training site http://subjectguides.library.unsw.edu.au/elise/presenting

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

7. Readings and 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 Wadwsworth), 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

8. Administrative matters

School Office: Room 137, Building E10 School of Materials Science and Engineering
School Website: http://www.materials.unsw.edu.au/
Faculty Office: Robert Webster Building, Room 128
Faculty Website: http://www.science.unsw.edu.au/

[1] International Center for Academic Integrity, 'The Fundamental Values of Academic Integrity', T. Fishman (ed), Clemson University, 2013.

9. Additional support for students

- The Current Students Gateway: https://student.unsw.edu.au/
- Academic Skills and Support: https://student.unsw.edu.au/academic-skills
- Student Wellbeing, Health and Safety: https://student.unsw.edu.au/wellbeing
- Disability Support Services: https://student.unsw.edu.au/disability-services
- UNSW IT Service Centre: https://www.it.unsw.edu.au/students/index.html
- Assessment Implementation Procedure: https://www.gs.unsw.edu.au/policy/documents/assessmentimplementationprocedure.pdf
- Special Consideration: https://student.unsw.edu.au/special-consideration