Course Outline

MATS6105

Chemical Properties of Materials

Materials Science and Engineering

Science

T3, 2022

1. Staff

Position	Name	Email	Consultation times and locations	Contact Details
Course Convenor	Prof. Sammy L.I. Chan	sli.chan@unsw.edu.au	Room 245, School of Materials Science and Engineering (Building E10), by appointment	Phone: 9385 4441
Lecturer	Dr Kevin Laws	k.laws@unsw.edu.au	Room 301, School of Materials Science and Engineering (Building E10), by appointment	Phone: 9385 5234

2. Course information

Units of credit: 6

Pre-requisite(s):

Timetabling website: https://timetable.unsw.edu.au/2022/MATS6105.html

Teaching times and locations:

Part 1:	Lecture	Lecture	Lecture	Laboratory
Day	Monday	Wednesday	Friday	See Moodle for details
Location	Online	Online	Online	
Time	10:00-12:00	13:00-15:00	10:00-12:00	
Weeks	1-5, 7-10	1-5, 7-10	1-5, 7-10	TBC

2.1 Course summary

This course covers the chemical properties of materials, especially corrosion and oxidation. Focus is placed on strategies to prevent the corrosion and oxidation of engineering materials. Students will understand the practical consequences of corrosion and oxidation and the role of materials selection and design in reducing these phenomena.

2.2 Course aims

To learn the behaviour of surfaces, wear and friction phenomena, electrochemical series, corrosion and corrosion prevention, and applications of electrochemistry in materials technology. Examples of materials selection for corrosion and wear resistance, energy materials, and processing of materials by electrochemical means will be introduced to illustrate some of these principles involved.

2.3 Course learning outcomes (CLO)

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

1. Understand the theories of different surface treatment processes and the properties of surfaces produced, so as to employ surface treatment processes professionally in engineering applications
2. Understand the relationships between materials, microstructures and environments on corrosion behaviour of metals.
3. Enhanced critical thinking, analytical and problem-solving skills in corrosion science and engineering to stop or prevent corrosion from happening.
4. Understand advanced electrochemistry and its applications in materials technology.

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…	3	1 & 3
CLO 2	Understand…	2	1, 2 & 3
CLO 3	Enhanced…	2 & 5	1, 2, 3 & 4
CLO 4	Understand…	3 & 4	4

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

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

Week	Topics		Activity
1	Introduction to corrosion Basic principles and classifications of corrosion		
2	Thermodynamics of corrosion 1 Thermodynamics of corrosion 2 Electrode kinetics 1		
3	Electrode kinetics 2 Passivity and pitting		Assignment - Corrosion 1
4	Atmospheric corrosion and oxidation Corrosion in soil and biological corrosion		
5	Corrosion under stress Revision	Introduction to the Second Part of the Course	Assignment - Corrosion 2
6			
7	Structure of electric double layer	Mid-term exam on corrosion	Mid-term exam
8	More applications of Pourbaix diagrams Advanced electrode kinetics and applications 1		
9	Advanced electrode kinetics and applications 2 Energy Materials		Group Project
10	Project presentation		Group Project presentation Written assignment - Electrochemistry of Materials

Course Content

Part I - Corrosion and Control

- *Introduction to corrosion*- Importance of corrosion control, basic principles and classifications of corrosion

- *Thermodynamics of corrosion*- Electrochemical, galvanic and electrolytic cells, standard electrode potentials, Nernst equation, Pourbaix diagrams and their constructions, applications and limitations.
- *Electrode kinetics*- Exchange current density, polarization, electrode kinetics, Evans diagrams, combined polarization, effect of polarization on corrosion rate.
- *Passivity and pitting*- Anodic passivation, stability of passivity and Flade potential, maintenance of passivity and breakdown of passivity.
- *Atmospheric corrosion and oxidation*- Types of atmosphere for corrosion, atmospheric corrosion of different metals, introduction to high temperature corrosion.
- *Corrosion in soil and biological corrosion*- Corrosivity of soil, control of soil corrosion of metals, types of biological corrosion.
- *Corrosion under stress*- Stress corrosion cracking, hydrogen embrittlement and corrosion fatigue.

Part II- Advanced Chemistry of Materials

- *Structure of electric double layers*- Interfaces and interphases, electric double layers, structure of interphases, isotherms for ionic adsorption on electrodes, adsorption of molecules at interfaces.
- *More applications of Pourbaix diagrams*- Use of Pourbaix diagram in battery science, extraction, refining and processing of metals and materials.
- *Advanced electrode kinetics and applications*- Kinetics of interfacial charge transfer, thermal activation and activation energies of electrochemical reactions, current density/potential correlations for different limiting conditions, reaction controlled current voltage curve, electrocatalysis, electrodeposition, electroforming, electrochemical machining, electrochemical etching, electroplating, electroless plating.
- *Energy materials*- Battery characteristics, battery specifications, evaluation of battery performance, battery components, present battery systems, batteries under development, fuel cells, other energy materials.

5. Assessment

5.1 Assessment tasks

Assessment task	Description	Weight	Due date
Individual assignment:	Three short ongoing assignments on the following topics: 1: Corrosion (Part 1=5%, Part 2=5%) 2: Electrochemistry of materials (20%)	30%	Week 3 Week 5 Week 10
Corrosion Labs:	This will be an online lab and the students will be given set of results to be used for the preparation of the lab report. Details of the labs will be provided on Moodle during the term.	10%	Please refer to Moodle
Mid-term exam:	The in-class exam will cover the topics taught in weeks 1-5 (only the part on corrosion).	30%	Week 7
Group project:	Report: A detailed review of literature on a topical area selected by the group of students based on course material Presentation: 7-10 minute oral presentation given to the class based on the group's project	30% (25% report, 5% presentation)	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.

Students who fail to achieve a score of at least 40% for the mid-session exam but achieve a final mark >50% for the course, will be awarded a UF (Unsatisfactory Fail) for the course.

Please refer to the UNSW guide to grades: https://student.unsw.edu.au/grades

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.

- 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.
- Submit hardcopy of your assignments and lab reports in the Assignment Box next to the MSE School Office (Rm 137) by the due date. Also submit electronic copy to Moodle as proof of submission. Late submission without appropriate documentation will receive a penalty of 10% per day late. Work that is more than 10 days late will not be accepted and will receive zero mark.

5.4. Feedback on assessment

Assignments and group project: 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.

Lab reports: 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 through Moodle, two weeks after submission.

Midsession 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.

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

7. Readings and resources

Textbooks

- D.A. Jones, Principles and Prevention of Corrosion, 2nd Ed. Prentice Hall
- H. Wendt and G. Kreysa, Electrochemical Engineering, Springer, (1999).

References

- M.F. Ashby and D.R. Jones, *Engineering Materials*, (Pergamon, 1980), Ch. 25 and 26, p223-235.
- M.G. Fontana *Corrosion Engineering*, McGrew Hill
- H.H. Uhlig and R.W. Revie *Corrosion and Corrosion Control*, Wiley-Interscience
- K.R. Trethewey and J Chamberlain, Corrosion- for students of Science and Engineering, Longman
- J.M. West, E. Horwood *Basic Corrosion and Oxidation*, John Wiley & Sons
- U.R. Evans, An Introduction to Metallic Corrosion, Edward Arnold
- J. Bard and L. R. Faulkner, *Electrochemical Methods*, John Wiley & Sons (1980).
- J. O'M. Bockris and A. K. N. Reddy, *Modern Electrochemistry Vol. I and II*, Plenum Press, (1998).
- P. H. Rieger, *Electrochemistry*, 2nd Edition, Chapman & Hall, (1994).
- D. T. Sawyer, A. Sobkowiak and J. L. Roberts, *Electrochemistry for Chemist*, 2nd Edition, Wiley-Interscience, (1995).
- D.R. Crow, *Principles and Applications of Electrochemistry*, 4th Edition, Blackie Academic & Professional (1994).
- F. Hine, Electrode Processes and Electrochemical Engineering, Plenurn Press, New York, (1985).
- G. Prentice, Electrochemical Engineering Principles, Prentice Hall, (1991).
- E. Heitz and G. Kreysa, *Principles of Electrochemical Engineering*, VCH Verlag, (1986)
- F. Goodridge and K. Scott, *Electrochemical Processing Engineering*, Plenum Press, (1995).
- T. Kuhn, Editor, *Industrial Electrochemical Processes*, Elsevier, (1971).

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/

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