Course Outline

MATS1101

Engineering Materials and Chemistry

Materials Science and Engineering

Science

T3, 2019
1. Staff

<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
<th>Email</th>
<th>Consultation times and locations</th>
<th>Contact Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Convenor</td>
<td>A/Prof John Daniels</td>
<td><a href="mailto:j.daniels@unsw.edu.au">j.daniels@unsw.edu.au</a></td>
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<tr>
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<tr>
<td>Lecturer</td>
<td>Dr Hongxu Lu (Chemistry)</td>
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<td>Chemistry Tutorial and Laboratory Administrator</td>
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</tr>
</tbody>
</table>

2. Course information

Units of credit: 6
Pre-requisite(s): None
Timetabling website: TBA
Teaching times and locations:

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Lecture</th>
<th>Tutorial</th>
<th>Lecture</th>
<th>Lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Weeks</td>
<td>1-10</td>
<td>1-10</td>
<td>1-10</td>
<td>10</td>
</tr>
</tbody>
</table>

Students will enrol in the chemistry/materials laboratories and the chemistry tutorials individually.
2.1 Course summary

Materials Strand: Structure-property relationships of the main types of engineering materials (metals, ceramics, polymers and composites). Micromechanisms of elastic and plastic deformation. Fracture mechanisms for ductile, brittle, creep and fatigue modes of failure; corrosion. Phase equilibria of alloys; microstructural control by thermomechanical processing and application to commercial engineering materials. Laboratory and tutorial work includes experiments on mechanical testing, cast and recrystallised structures, ferrous and non-ferrous microstructures, and fracture and failure analysis.

Chemistry strand: Chemistry in engineering; understanding the properties of materials at an atomic and molecular level; relating macroscopic engineering properties to the underlying structure of the material. (in the following, 'S' refers to the text Silberberg 'Chemistry – The Molecular Nature of Matter and Change', 4th Edn).

- Introduction (S Ch. 2, 3, 4): Elementary atomic structure, isotopes, nomenclature; the mole concept, atomic and molar mass; stoichiometry, formulae, equations; chemical reaction types, precipitation, acid-base, and redox reaction; oxidation numbers, oxidation state; molarity, limiting reactants, and product yields.
- Structure and Bonding (S Ch. 8, 9): Electronic configuration; metallic, ionic and covalent bonding; electronegativity, bond polarity, and bond strength; molecular shape and Lewis structure.
- States of Matter (S Ch. 9, 12): Solids, liquids and gases; intermolecular forces; properties of liquids, melting and boiling points; solvent properties and solubility; metallic, ionic, covalent networks and molecular solids; chemical aspects of ceramics and glasses; chemical vapour deposition.
- Chemical Equilibrium in Aqueous Solution (S Ch. 17, 18, 19): The equilibrium state, equilibrium constants, Le Chatelier's principle, quantitative calculations; acid-base equilibria, pH, buffers.
- Organic Chemistry and Polymers (S Ch. 15): The systematic chemistry of carbon compounds; nomenclature and properties of common organic functional groups; isomer and stereochemistry; organic reactions, oxidation, reduction, addition, substitution, and elimination; fundamentals of polymer chemistry.

2.2 Course aims

Materials Strand: To provide an understanding of engineering materials in terms of the factors which dictate their behaviour.

Chemistry strand: To introduce the chemistry necessary to understand the structure and properties of engineering materials.

2.3 Course learning outcomes (CLO)

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

1. Describe relationships between materials structures, properties and processes
2. Make informed decisions in materials selection for engineering design
3. Connect chemical concepts to real-world applications through a firm foundation in the fundamentals of chemistry for materials science
4. Demonstrate an ability to work safely in a chemistry laboratory, to perform quantitative and qualitative chemical analyses, and to correctly use the language of chemistry to describe and interpret observations
2.4 Relationship between course and program learning outcomes and assessments

<table>
<thead>
<tr>
<th>Course Learning Outcome (CLO)</th>
<th>LO Statement</th>
<th>Program Learning Outcome (PLO)</th>
<th>Related Tasks &amp; Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLO 1</td>
<td>Describe…</td>
<td>1 &amp; 2</td>
<td>Mid-term exam, Materials laboratories &amp; Final exam</td>
</tr>
<tr>
<td>CLO 2</td>
<td>Make…</td>
<td>1 &amp; 2</td>
<td>Mid-term exam &amp; Final exam</td>
</tr>
<tr>
<td>CLO 3</td>
<td>Connect…</td>
<td>1</td>
<td>Mid-term exam, Chemistry laboratories &amp; Final exam</td>
</tr>
<tr>
<td>CLO 4</td>
<td>Demonstrate…</td>
<td>5 &amp; 6</td>
<td>Materials laboratories &amp; Chemistry laboratories</td>
</tr>
</tbody>
</table>

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.

**Lectures:** The core concepts will be taught in lectures, students will have access to the lectures notes before class for annotation during the lecture. Students will be engaged in the learning process through class discussions and problem-solving questions independently and working together with partners and groups.

**Labs:** Experimental techniques and procedures will be taught through laboratories classes and laboratory reports following the class. Students will actively complete the experiments gaining
experience of important materials testing and characterisation techniques. Students will be able to reflect on the experiments and learn to process data through the lab reports after class.

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 59 hours of class contact hours. You are expected to take an additional 91 hours of non-class contact hours to complete assessments, readings and exam preparation.

<table>
<thead>
<tr>
<th>Week</th>
<th>Materials</th>
<th>Topics</th>
<th>Chemistry Topics</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>Bonding between atoms</td>
<td>Elementary atomic structure Isotopes Nomenclature The mole concept Atomic and molar mass Stoichiometry Formulae</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Packing of atoms in solids</td>
<td>Young’s modulus Yield and tensile strength Dislocations</td>
<td>Equations Chemical reaction types Precipitation reaction Acid-base reaction Molarity</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Strengthening methods</td>
<td>Fracture Toughness Micromechanisms of fast fracture</td>
<td>Redox reaction Oxidation numbers Oxidation state Limiting reactants and product yields Ionic, covalent and metallic bonding Electronic configuration</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Fatigue mechanisms</td>
<td>Creep Creep fracture and mechanisms Creep resistance</td>
<td>Electronegativity Bond polarity and strength Molecular shape Lewis structure</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Oxidation</td>
<td>Wet corrosion</td>
<td>Solids, liquids and gases Intermolecular forces Melting and boiling points Solvent and solubility</td>
<td>Mid-term exam</td>
</tr>
<tr>
<td>6</td>
<td>Metal structures</td>
<td>Phase diagrams</td>
<td>Types of solids Ceramics and glasses Chemical vapour deposition</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Kinetics of structural change</td>
<td></td>
<td>The equilibrium state Equilibrium constants Le Chatelier’s principle Quantitative calculations pH and buffers</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Light alloys</td>
<td>Steel Alloy steels</td>
<td>Organic compound Hydrocarbons Nomenclature of hydrocarbons</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Polymers</td>
<td>Ceramics and glasses</td>
<td>Common organic functional groups Isomer and stereochemistry Organic reactions</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Composites Revision</td>
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<td></td>
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<tr>
<td>#</td>
<td>Oxidation, reduction, addition, substitution, and elimination</td>
<td></td>
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<tr>
<td>10</td>
<td>Major types of polymers</td>
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<tr>
<td></td>
<td>Properties of polymers</td>
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<tr>
<td></td>
<td>Synthesis of polymers</td>
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<tr>
<td></td>
<td>Application of polymers</td>
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</table>

**Chemistry Tutorials**

General times and locations are shown on your enrolment timetable on MyUNSW. Be aware that the rooms may have been changed in response to changes in student numbers, so download a fresh timetable often from MyUNSW.

The Chemistry Manual containing tutorial sets and the laboratory manual can be purchased from the UNSW Bookshop. **Make sure you get your copy well before your first lab – as there is no guarantee that the bookshop will be able to supply a copy at short notice.**

**Chemistry Labs**

**Attendance at labs is compulsory.** You must READ THE INTRODUCTION IN THE LABORATORY MANUAL to be aware of all the requirements for passing the laboratory component of this course. Here are some of the main points regarding laboratory classes:

Depending on the lab stream you have enrolled in you will carry out your chemistry labs either in odd numbered semester weeks or even numbered semester weeks. You will do the experiments in the order they are listed in the laboratory manual.

Before the first lab, complete the general ‘Safety in the Chemical Laboratory’ pre-lab, AND the specific safety pre-lab for Experiment 1. Use the link provided in ‘Laboratory’ folder in the ‘Chemistry Strand’ section on Moodle to log on and complete these two tasks. You will need to do a specific safety pre-lab before each subsequent lab.

For your timetabled lab, go to lab 133 or 165 (as allocated) in the Chemical Sciences Building, bringing your lab coat and safety glasses (see details below) and wearing enclosed footwear. Students must bring their chemistry lab notes with them to each lab class. The lab manual contains details of requirements for submission of lab reports.

**Safety**

You need to do a pre-lab safety exercise for each chemistry experiment. This must be done online via the link provided in Moodle, any time before your experiment. The answers should be written in the spaces provided in the lab notes of the experiment.

You must provide your own safety eyewear and laboratory coat and wear enclosed footwear in the laboratory. No exceptions can be made. Currently safety glasses and lab coats suitable for chemistry labs can be purchased from several shops on campus (disposable paper lab coats are not acceptable). The Optometry Clinic (in the Rupert Myers Building; between the hours of 9 am to 5 pm weekdays) also sells safety glasses and provides expert fittings.
5. Assessment

5.1 Assessment tasks

<table>
<thead>
<tr>
<th>Assessment task</th>
<th>Description</th>
<th>Weight</th>
<th>Due date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-term exam:</td>
<td>2 hr exam that will cover the content taught in the first 5 weeks of both strands.</td>
<td>30%</td>
<td>Week 5</td>
</tr>
<tr>
<td>Materials laboratory reports:</td>
<td>4 laboratory worksheets that include short answer and numerical questions. All working must be shown. The laboratories cover the following topics: 1) Tensile testing 2) Fracture of materials 3) Casting and recrystallisation 4) Composite mechanical testing A pre-lab quiz is to be completed prior to accessing the labs.</td>
<td>15%</td>
<td>1 week after the lab</td>
</tr>
<tr>
<td>Chemistry laboratory reports:</td>
<td>5 laboratory reports consist of observations, calculations and short answer questions that are to be completed during class and after if necessary. The worksheets from your lab manual must be submitted to the demonstrator. The laboratories cover the following topics: 1) Determination of the molar mass of an acid by titration 2) Redox reaction and corrosion 3) Determination of iron in haematite 4) Synthesis of aspirin 5) Reactions of organic functional groups</td>
<td>15%</td>
<td>See lab manual</td>
</tr>
<tr>
<td>Final exam:</td>
<td>The exam will cover the content taught in weeks 5-10 of both strands.</td>
<td>40%</td>
<td>Final exam period</td>
</tr>
</tbody>
</table>

Further information

UNSW grading system: [https://student.unsw.edu.au/grades](https://student.unsw.edu.au/grades)


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](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

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.

Final exam: Students will receive their final mark.

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. 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.

5. Readings and resources

- Engineering Materials, Volumes 1 & 2 Ashby & Jones, Butterworth Heinemann, 2005

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8. Administrative matters

Materials School Office: Room 137, Building E10 School of Materials Science and Engineering
Materials School Website: http://www.materials.unsw.edu.au/
Chemistry Student Centre: Room 105, Dalton Building
Chemistry School Website: http://www.chemistry.unsw.edu.au/current-students
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
- Special Consideration: https://student.unsw.edu.au/special-consideration