Course Outline

CHEM1011

Chemistry 1A: Atoms, Molecules and Energy

School of Chemistry

Faculty of Science

Term 1, 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>Michael Gandy</td>
<td><a href="mailto:firstyearchem@unsw.edu.au">firstyearchem@unsw.edu.au</a></td>
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<td>9385 4651</td>
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</tr>
<tr>
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</tr>
<tr>
<td>Lecturers</td>
<td>See Moodle for details</td>
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2. Course information

Units of credit: 6
Pre-requisite(s): none
Teaching times and locations: [http://timetable.unsw.edu.au/](http://timetable.unsw.edu.au/)

2.1 Course summary

This course builds on an elementary knowledge of chemistry (equivalent to one year of high school chemistry, such as Year 11 chemistry, or CHEM1001 at UNSW) to explore the quantum mechanical structure of atoms leading to an understanding of the periodic trends in the properties of the elements. This knowledge is applied to understanding chemical bonding and intermolecular forces which together are responsible for determining the properties of materials. General principles of chemical equilibrium are developed and applied to chemical reactions involving acids and bases. The applications of the laws of thermodynamics to chemical processes are described and ultimately linked to chemical equilibrium. The course includes an overview of chemical reactions involving electron transfer, including their applications in biology, corrosion and energy storage for portable electronic devices. The course concludes with the "capstone" topic of molecular machines, which provides an opportunity to consolidate many aspects of the syllabus including bonding, intermolecular forces, equilibrium, acids/bases, electrochemistry and thermodynamics.

Notes: (1) Assumed knowledge equivalent to year 11 chemistry or CHEM1001; (2) Students who complete CHEM1011 are unable to subsequently enrol in CHEM1001. However, students who have completed CHEM1001 will be permitted to proceed to enrol in CHEM1011.
2.2 Course aims

CHEM1011 aims to provide a sound understanding of the physical principles underlying modern chemistry supported by laboratory work which also prepares a student for further studies in chemistry and related disciplines. CHEM1011 focuses on understanding the structures of atoms and molecules and relating these to the chemical properties of substances. On completing CHEM1011 students should also understand the connection between energy changes and other thermodynamic functions, and chemical reactions. Students should acquire a knowledge of the concepts and language of two of the broadest classes of chemical reaction (acid-base and electron transfer). The laboratory component aims to instil an appreciation of safe working practices in a chemistry laboratory and laboratory skills widely used in chemistry and chemistry-related laboratories.

2.3 Course learning outcomes (CLO)

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

1. Evaluate the structures of chemical substances in terms of atomic structure, bonding, and intermolecular forces, and relate these to the physicochemical properties of the substance.
2. Apply the concept of chemical equilibrium to evaluate phenomena related to chemical reactions, particularly in the contexts of acids/bases and buffers.
3. Apply the principles of thermodynamics, including the concepts of entropy, enthalpy and Gibbs energy, to predict the spontaneity of chemical reactions.
4. Apply the concepts of oxidation and reduction in the contexts of corrosion and electrochemical cells.
5. Demonstrate an ability to work safely in a laboratory, to perform quantitative and qualitative chemical analyses, to evaluate the accuracy and precision of experimental measurements, and to interpret results.
6. Apply the concepts of intermolecular forces, equilibrium and thermodynamics to explain the phenomenon of energy storage.
2.4 Relationship between course and program learning outcomes and assessments

<table>
<thead>
<tr>
<th>Course Learning Outcome (CLO)</th>
<th>Program Learning Outcome (PLO)</th>
<th>Related Tasks &amp; Assessment</th>
</tr>
</thead>
</table>
| CLO 1                         | Upon completion of a bachelor degree with a major in chemistry, graduates will be able to demonstrate a knowledge of, and apply the principles and concepts of chemistry:  
  - Electrons, protons and neutrons are the fundamental atomic particles. Distribution of electron density is rationalised using the concept of orbitals.  
  - The Periodic Table is a structured presentation of the elements which relates the position of an element in the table to its macroscopic properties and chemical reactivity.  
  - Chemical bonds form through the sharing or transfer of electrons between atoms. The nature and quantity of chemical bonds in a chemical species give rise to the shape, structure and microscopic properties of that species.  
  - Spectroscopic methods are based on transitions between discrete energy levels and diffraction methods are based on scattering from periodic arrangements of atoms.  
  - The size and location of the constituent atoms within a chemical species influences the shape and hence the chemical and physical properties of that species.  
  - Interactions within and between chemical species are essentially electrostatic in nature and influence chemical and physical properties, and with the available energy define the states of matter.  
  - The nature and strength of intra- and intermolecular forces / secondary interactions contribute to the macroscopic properties of a chemical species.  
  - The properties of a substance can be influenced by both physical and chemical environment.  
  - The properties of a mixture can differ from those of the individual components of the mixture.  
  - Matter extends beyond the molecular to include metals, crystals, ionic solids and giant covalent complexes. | Weekly online quizzes; validation tests; final exam |
| CLO 2 | Upon completion of a bachelor degree with a major in chemistry, graduates will be able to demonstrate a knowledge of, and apply the principles and concepts of chemistry:  
• All chemical changes are, in principle, reversible; chemical processes often reach a state of dynamic equilibrium. | Weekly online quizzes; validation tests; final exam |
|-------|-------------------------------------------------------------------------------------------------|---------------------------------------------|
| CLO 3 | Upon completion of a bachelor degree with a major in chemistry, graduates will be able to demonstrate a knowledge of, and apply the principles and concepts of chemistry:  
• Different chemical species have different energies. Most chemical changes are accompanied by a net change of energy of the system.  
• Energy is conserved in chemical changes: breaking chemical bonds requires energy; formation of chemical bonds releases energy.  
• Spontaneity of a chemical change is determined by a balance between energy change, available energy and entropy change.  
• Starting and finishing states are independent of path, and may be predicted.  
• Thermodynamics provides a detailed capacity to understand energy change at the macroscopic level and to understand equilibrium systems quantitatively. | Weekly online quizzes; validation tests; final exam |
| CLO 4 | Upon completion of a bachelor degree with a major in chemistry, graduates will be able to demonstrate a knowledge of, and apply the principles and concepts of chemistry:  
• Chemical reaction processes can be classified systematically into general types – this allows prediction of outcomes. | Weekly online quizzes; validation tests; final exam |
| CLO 5 | Upon completion of a bachelor degree with a major in chemistry, graduates will be able to apply recognised methods and appropriate practical techniques and tools, and be able to adapt these techniques when necessary:  
• Weighing and measuring  
• Use of appropriate glassware  
• Preparation and handling of solutions  
• Preparation – the ability to handle/manipulate chemical substances to make a desired product that is different from starting materials  
• Isolation - the ability to separate and/or purify (by distillation, crystallisation, chromatography etc.) the desired product(s)  
• Characterisation – the ability to use qualitative and/or quantitative instrumental and/or chemical methods to confirm product identity and/or purity | Laboratory assessment |
- Consideration of the sample & and an understanding of the process of sampling
- Understanding of the analyte/sample/matrix under investigation
- Understanding and application of separation methods (e.g. chromatography, electrophoresis)
- Understanding and application of instrumental methods (e.g. spectroscopic, spectrometric & diffraction methods; electrochemical & potentiometric methods) including: instrument setup (operation and calibration; including preparation and use of standards); data collection, handling and analysis (including statistical analysis, estimation of uncertainty/error)
- Understanding and application of appropriate chemical methods

Upon completion of a bachelor degree with a major in chemistry, graduates will be able to:
- appropriately document the essential details of procedures undertaken, key observations, results and conclusions.
- demonstrate a capacity for working responsibly and safely.

<table>
<thead>
<tr>
<th>CLO 6</th>
<th>Upon completion of a bachelor degree with a major in chemistry, graduates will be able to:</th>
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<tbody>
<tr>
<td></td>
<td>- recognise that chemistry plays an essential role in society and underpins many industrial, technological and medical advances.</td>
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<tr>
<td></td>
<td>- recognise that chemistry is a broad discipline that impacts on, and is influenced by, other scientific fields.</td>
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Final exam
3. Strategies and approaches to learning

3.1 Learning and teaching activities

During this course, you’ll earn a series of microcredentials covering both theory knowledge and practical skills. Some of these microcredentials are essential requirements for passing the course.

In the theory part of the course, the microcredentials are called “threshold” and “mastery” concepts. The “threshold” concepts are taught online, and continuously assessed. You must demonstrate complete possession of ALL threshold knowledge in order to be eligible to pass the course. The “mastery” concepts are taught in traditional face-to-face lectures, and assessed in the final exam.

In the laboratory part of the course, the microcredentials are called “core” and “non-core” skills. You must obtain ALL of the “core” skills in order to be eligible to pass the course.

Each week, you will do the following activities:

- **Online lesson.** This lesson will teach you the “threshold” concepts for the week. You’re expected to complete this online lesson, and attempt the associated online quiz, BEFORE the first face-to-face lecture of the week. If you find the online lesson and quiz easy, you probably don’t need to attend the first lecture of the week (see below).

- **“Threshold” lecture.** The first lecture of each week is typically a workshop-style session in which the “threshold” concepts are reinforced. This session won’t make sense unless you’ve already completed the online lesson and have made an attempt at the quiz.

- **“Mastery” lectures.** The remaining two lectures each week will typically cover “mastery” topics, in a traditional lecture format. You will need to take your own notes.

- **Tutorial.** Each week you’ll attend a small-group tutorial in which you will delve more deeply into certain “mastery” topics. You’ll also learn a variety of skills related to problem-solving, teamwork and communication. The tutorials will give you an idea of what to expect in the final exam.

- **Laboratory class.** Most weeks during the term, you’ll participate in a laboratory class. You will be continuously assessed by your demonstrator on both your “core” and “non-core” laboratory skills. In addition, you must complete some online pre-lab work before each laboratory class.

3.2 Expectations of students

A major difference between high school and university is that you are now expected to take responsibility for your own learning. This means that no-one will chase you up if you start falling behind in your attendance or assessments, let alone your independent study.

As a general rule, you should plan to do about one hour of independent study (e.g. completing assignments, readings and exam preparation) for every face-to-face hour of the course. In addition, you should manage your time so that you can complete your online lessons and weekly quizzes progressively throughout the term rather than leaving them all to the last minute.

If you find yourself struggling or falling behind, several avenues of support are available to you (see Section 9 of this outline); but you must seek this support yourself.

In this course, attendance is recorded in both tutorials and laboratory classes. An 80% attendance record in the laboratory is an essential requirement for passing the course.
4. Course schedule and structure

This course consists of 63 face-to-face contact hours, and ~9 hours of self-paced online lessons. In addition, you should plan to spend an equivalent total amount of time on independent study (see Section 3.2).

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Learning opportunities</th>
<th>Related CLO</th>
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</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Atomic structure</td>
<td>Online lesson (1h); lectures (3h); tutorial (1h); laboratory class (3h)</td>
<td>1, 5</td>
</tr>
<tr>
<td>Week 2</td>
<td>Electronic configurations</td>
<td>Online lesson (1h); lectures (3h); tutorial (1h); laboratory class (3h)</td>
<td>1, 5</td>
</tr>
<tr>
<td>Week 3</td>
<td>Lewis structures and VSEPR</td>
<td>Online lesson (1h); lectures (3h); tutorial (1h); laboratory class (3h)</td>
<td>1, 5</td>
</tr>
<tr>
<td>Week 4</td>
<td>States and properties of matter</td>
<td>Online lesson (1h); lectures (3h); tutorial (1h); laboratory class (3h)</td>
<td>1, 5</td>
</tr>
<tr>
<td>Week 5</td>
<td>Chemical equilibrium</td>
<td>Online lesson (1h); lectures (3h); tutorial (1h); laboratory class (3h)</td>
<td>2, 5</td>
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<tr>
<td>Week 6</td>
<td>Acids &amp; bases</td>
<td>Online lesson (1h); lectures (3h); tutorial (1h); laboratory class (3h)</td>
<td>2, 5</td>
</tr>
<tr>
<td>Week 7</td>
<td>Thermodynamics</td>
<td>Online lesson (1h); lectures (3h); tutorial (1h); laboratory class (3h)</td>
<td>3, 5</td>
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<tr>
<td>Week 8</td>
<td>Electrochemistry</td>
<td>Online lesson (1h); lectures (3h); tutorial (1h); laboratory class (3h)</td>
<td>4, 5</td>
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<tr>
<td>Week 9</td>
<td>Energy storage</td>
<td>Lectures (3h); tutorial (1h); laboratory class (3h)</td>
<td>5, 6</td>
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<td>Week 10</td>
<td>Public holiday catch-up (if required)</td>
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5. Assessment

5.1 Assessment tasks

<table>
<thead>
<tr>
<th>Assessment task</th>
<th>Weight</th>
<th>Details</th>
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<tbody>
<tr>
<td><strong>Assessment 1: Laboratory work</strong></td>
<td>20%</td>
<td>The definitive source of information about laboratory assessment is the Laboratory Manual (available on Moodle). A few key points are repeated here:</td>
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<td>• Assessment in the laboratory is done on a &quot;skills&quot; basis. You must demonstrate that you’ve acquired all of the “core skills” in order to be eligible to pass the course. The “core skills” will give you 10/20 in one lump sum; the remaining “non-core (graded) skills” will take you from 10/20 up to 20/20 for the laboratory component of the course.</td>
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<td>• If you fail to earn any core skills during the regular lab weeks, you should attend a make-up lab to get a last chance to be awarded your missing core skills.</td>
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<td>• You must attend at least 80% of the scheduled laboratory classes in the semester in order to be eligible to pass the course. Medical certificates or other documentation do not compensate for absences. If you miss a laboratory class for any reason, you will be permitted to do a make-up lab which will compensate for an absence from any one lab class. You can attend a maximum of two make-up labs throughout term; see the Laboratory Manual for definitive details.</td>
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<td>• All experiments require pre-lab work to be completed before your lab class.</td>
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<td>• You must attend the laboratory class shown on your official timetable. If you arrive more than 20 minutes late to a laboratory class you will be refused entry and marked absent.</td>
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<td>• Safety eyewear, a laboratory coat and fully enclosed footwear must be worn in the laboratory. You will not be permitted to work in thongs or open-top shoes or sandals or without a laboratory coat and safety eyewear.</td>
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<td>• Repeat students must apply to the first year laboratory coordinator if they want exemption from laboratory classes. Exemption is not automatic and is decided on a case-by-case basis.</td>
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<tr>
<td><strong>Assessment 2: Weekly online quizzes</strong></td>
<td>No marks awarded for these quizzes,</td>
<td>There are online quizzes for you to complete, most weeks during the term. These quizzes cover the “threshold” content of the syllabus (only). The quizzes are primarily designed to be a learning process, not an assessment process: they’ll ensure that you learn in a consistent fashion, rather than cramming at the end of term.</td>
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but you must complete them before you can sit the validation tests (see below).

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<thead>
<tr>
<th>Assessment 3: Validation tests</th>
<th>40%</th>
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<tbody>
<tr>
<td>Each quiz consists of 10 questions. You must get ALL of the questions correct, in order to successfully complete the quiz.</td>
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<tr>
<td>You may use any form of help that you wish. You can make multiple attempts at each quiz (see Moodle), but you'll most likely get different versions of the questions on each attempt.</td>
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<tr>
<td>You must complete all of the relevant quizzes, as indicated on Moodle, before each validation test (see below). If you sit a validation test without having completed all of the relevant quizzes, your validation test score will not be recorded.</td>
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<tr>
<td>To confirm your knowledge of the “threshold” content of the syllabus, three validation tests are held throughout the term. The validation tests are tentatively scheduled to take place during one of your timetabled classes in each of weeks 3, 6 and 9. But these details are subject to change, depending e.g. on public holidays and room suitability. See Moodle for the definitive information.</td>
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<tr>
<td>The validation tests are conducted under exam conditions. Each test is of 45 minutes' duration. Each test contains 20 questions; most of these questions will be drawn from the same question bank as the preceding weekly online quizzes, but there will also be some new questions of similar style.</td>
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<tr>
<td>The pass mark for each validation test is 90%.</td>
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<tr>
<td>If you fail a validation test, or miss it for any reason, you may sit a make-up test for equivalent credit. Make-up tests are tentatively offered in the same timeslot in weeks 4, 5, 7, 8 and 10. One extra sitting will also be offered in week 10 (see Moodle for details). You may use any of these times to repeat any of the validation tests. But you may only do one make-up test per timeslot. If you miss a make-up test for any reason (including illness), no offer to sit an alternative time is guaranteed. Furthermore, no guarantee is made that you will have access to the maximum number of make-up opportunities.</td>
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<tr>
<td>When you’ve passed all three validation tests, you’ll be awarded 40% of the total marks for the course. If you fail to pass even one validation test, you’ll receive zero overall for this assessment category and you’ll be ineligible to pass the course.</td>
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<thead>
<tr>
<th>Assessment 4: Final exam</th>
<th>40%</th>
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<tr>
<td>The final exam is of 2 hours’ duration. It will consist of written-answer questions (only). It will focus on the “mastery” content of the syllabus, but it will also require you to remember the “threshold” concepts as a foundation for answering the mastery questions.</td>
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<tr>
<td>Attendance at the exam is not an essential requirement for passing the course. There is no minimum mark required.</td>
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<tr>
<td>Remember, if you haven’t passed all of the validation tests (see above), you can’t pass the course no matter how well you perform in the final exam. If you find yourself in this unfortunate situation before the academic withdrawal date (i.e. Friday of Week 10), you should consider withdrawing from this course and prioritising your other courses during the study period.</td>
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</tbody>
</table>
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
The Laboratory Manual contains detailed criteria for the awarding of each laboratory skill.
The weekly online quizzes and the validation tests are primarily composed of multi-choice questions. For such questions, you must select the one best answer.
The final exam is different from what you might have encountered previously. It will focus only on the “mastery” topics, and it is designed to be more difficult than a traditional exam. Most questions will demand problem-solving ability, and the questions will offer little or no scaffolding to help you towards the answer. Part marks will sometimes be awarded for working, but a heavier than usual weighting will be assigned to getting the answer completely correct. See Moodle for an example of a past paper, and an associated marking rubric.

5.3 Submission of assessment tasks
See the Laboratory Manual for details on how to submit reports.
Weekly online quizzes are accessed and submitted through Moodle.

5.4. Feedback on assessment
You will receive near-real-time feedback on your laboratory performance, including details of which skills you have and haven’t yet earned. This information is available through Moodle.
You will receive instantaneous feedback on your weekly online quizzes. This feedback will include information on your overall score for each quiz, plus details of which questions you got right and wrong. You will also be directed back to the appropriate online lesson if your knowledge in a certain topic area is weak.
The validation tests will be conducted using paper-based generalised answer sheets. It typically takes several days for the results to be processed and communicated via Moodle.
The results of the final exam will not be communicated to you explicitly. Instead, you will receive an overall mark for the course once the results have been finalised.
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/presentation

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.

7. Readings and resources

Textbooks:


- Aylward and Findlay, “SI Chemical Data,” 6th Ed. or later.

Course Pack:

- A printed copy of the CHEM1011 Course Pack (Term 1, 2019), which includes the laboratory manual and tutorial notes, is required. This can be purchased from the UNSW bookstore; electronic version available on Moodle.

8. Administrative matters

If you have any administrative questions, try the following sources of information (in order):

- This course outline
- The Moodle site for this course (including the Important Announcements and FAQ sections)
- Chemistry Student Services (firstyearchem@unsw.edu.au; +61 (2) 9385 4651; Dalton 104)
- The Science Student Centre (+61 (2) 9385 6125; Robert Webster Building 128; http://www.science.unsw.edu.au/current-students/science-student-centre)
9. Additional support for students

The School of Chemistry provides a free duty tutor service. This service offers one-on-one tuition, by a chemistry professional, on any aspect of chemistry theory that you need help with. The duty tutor service operates most days during the term, on a drop-in basis (see Moodle for times and venues). Please take advantage of this service early during the term, because it typically becomes oversubscribed just before major assessments.

- Other avenues of support include:
  - The Current Students Gateway: [https://student.unsw.edu.au/](https://student.unsw.edu.au/)
  - Academic Skills and Support: [https://student.unsw.edu.au/skills](https://student.unsw.edu.au/skills)
  - Student Wellbeing, Health and Safety: [https://student.unsw.edu.au/wellbeing](https://student.unsw.edu.au/wellbeing)
  - UNSW IT Service Centre: [https://www.it.unsw.edu.au/students/index.html](https://www.it.unsw.edu.au/students/index.html)