UNSW SYDNEY

UNSW Engineering

Education Specification

1. Program Overview

Program Title: Bachelor of Engineering (Honours)

Award Title: Bachelor of Engineering (Honours) (Bioinformatics Engineering)

Engineering Discipline: Bioinformatics Engineering

Bioinformatics Engineering is both a scientific and an engineering discipline. Engineering in that graduates design and implement computer systems for managing and analysing biological information, and scientific in that graduates then use these systems to analyse data towards making scientific discoveries. Bioinformatics Engineering is a relatively new discipline that shares many of the engineering challenges of software engineering.

2. Career Alignment

Graduates can take three general career pathways after completing their bioinformatics degree, including further postgraduate studies. One of the program design goals is to offer graduates enough versatility that they are broadly employable in the ICT and engineering industries in addition to bioinformatics, given that bioinformatics careers can be limited without doing a PhD that many graduates don't want to do. Some graduates choose careers in software or biomedical engineering, in IT, or even in finance and consulting.

Academic/research in bioinformatics (Computational biologists):

A typical career path is continuing in computational biology or bioinformatics. This requires a good understanding of both the computational sciences and of biology problems. For careers within this field, typically individuals will need to continue postgraduate studies (PhD). Graduates will be developing new algorithms and new ways of looking at biological data and applying developments in computer science and mathematics to biological problems. The program prepares students for these careers by providing both computing and science core courses. The honours project provided research capabilities.

e.g., Bioinformatics researcher, University lecturer, Scientific Data Analyst

Biological or medical science roles (Biologists who use computers):

This career path is adjacent to that of a bioinformatician/computational biologist, but it is leaning more on the biological side of their degree. A postgraduate degree is also a pathway through this, but here they would be using existing software and databases and applying established methods. In this case, individuals will be working as a biologist or medical researcher or research assistant. But instead of developing software, they are those that can use it properly, ad understand the limitations and assumptions of the software. These can be in the pharmaceutical or health industries. The program prepares students for these careers by science core courses and multiple science electives. Furthermore, students that take a double degree can choose a Bachelor of Science and affords further alignment with their desired biological or molecular life science career (e.g., genetics). The honours project provides research capabilities and skills.

e.g., Biobank lead, Biocurator, Discovery biologist, Molecular life sciences educator

Computational developers or support roles (Software developers/engineers):

In this pathway, graduates will work more as software engineers and developers, or use some of their other computational skills. Here, graduates will choose and implement algorithms in an efficient manner (suitable for high-throughput analysis), design and implement databases to store and retrieve biological data, and design and implement user interfaces for biologists to be able to use the software. The roles are different to the research side – here they address issues such as performance, diverse resource integration, inter-operability, scalability, data access, security, networks, costs etc. Graduates will use their software engineering skills, and their understanding of biological data to help with a biologists needs (or a bioinformatics adjacent researcher). Alternatively, non-biological engineering roles can also be undertaken, such as those in financial institutions and software companies. The program prepares students for these careers by providing core computing courses and software engineering electives. Students can choose to take more computing than science based courses to enhance their skills. Students can also choose to take their Industrial Training in a software based company.

e.g., Bioinformatics software developer, Core facility scientist, Research infrastructure bioinformatician, Scientific Database Administrator/Data Manager, Consultant

UNSW and affiliated research centres and institutes that our graduates work for

- Kirby Institute
- NeuRA
- Lowy Cancer Research Centre
- UNSW AI Institute
- UNSW Data Science Hub
- UNSW Centre for Big Data Research in Health
- UNSW Cellular Genomics Institute
- UNSW Ageing Futures Institute
- Ramaciotti Centre for Genomics
- Children’s Cancer Institute Australia
- Garvan Institute of Medical Research
- Victor Chang Cardiac Research Institute

3. Specialisation Framework

The BINFAH specialisation learning outcomes were developed by the BINFAH Director of Studies in conjunction with CSE’s Deputy Head of School (education) and considered/refined by both the CSE Education Committee and the Industry Advisory Board. The suggestions from both the Committee and Board were incorporated into the final statement of the outcomes.

Please refer to the **Curriculum Mapping** section to gain an overview of how the Bioinformatics Engineering specialisation learning outcomes (SLOs) map to the program level outcomes (PLOs), which correspond to the EA Stage 1 Competencies. The curriculum mapping further details how individual courses contribute to the achievement of the specialisation learning outcomes (SLOs) and in turn the PLOs.

Briefly, the core computing and mathematics courses give students a solid foundation on which to build subsequent study in the more advanced aspects of designing and implementing software systems. Alongside their computing studies, Bioinformatics Engineering students study a substantial number of biology courses; such knowledge is clearly required in dealing with biological data.

The two strands (computing and biology) coexist well, with the curriculum map showing a progression of engineering competencies and scientific knowledge. Each strand has a progression of courses, from foundational to more advanced. The Ethics and Professional Issues course (COMP4921) in fourth year is particularly important, given the kind of data that graduates will deal with.

After completing their core computing courses, Bioinformatics Engineering students undertake a series of practical/project courses (DESN2000, BINF3010, BINF3020) which strengthen their skills in software development and managing projects as a team. They also complete computing courses (COMP2041, COMP3121 and COMP3311) which further extend their skills in three areas critical to bioinformatics projects (scripting, databases and algorithms).

The 4th-year thesis allows students to explore the application of computing to solving biology problems in more depth or on heavily engineering focused projects that involves the design and development of broader computational methods, software and systems. As some students are enrolled in dual degrees, their projects also come from the Graduate School of Biomedical Engineering (GSBME), School of Biotechnology and Biomolecular Sciences (BABS), and School of Biomedical Sciences (SBMS), which gives them very useful exposure to real problems at the intersection of biology and computing. All these projects are co-supervised by faculty within the School.

4. Continuous Improvement

The Bioinformatics Engineering specialisation is one of very few such programs in Australia. It spans a breadth of knowledge (both biological and computing) that is unique among engineering programs. Graduates have a wide variety of job prospects, from working at the discovery end of biological research to working as IT professionals.

The industrial relevance of the program was tested during the design of the program and subsequent reviews in consultation with representatives from industries and medical research centres with a stake in bioinformatics including biotechnology companies, scientific software companies and hardware vendors who service the biotechnology and pharmaceutical industries at the time (IBM, CSIRO Bioinformatics, Garvan Institute for Medical Research, Victor Chang Cardiac Research Institute).

Industry and other employers were also consulted through relevant professional organisations and peak bodies – including the International Society for Computational Biology (ISCB), and the Australian Bioinformatics and Computational Biology Society (ABACBS). Academic stakeholders including the School of Biotechnology and Biomolecular Sciences, the School of Physics, the School of Mathematics and Statistics, and the Centre for Health Informatics at UNSW who contribute to the program were also consulted as part of the revision processes, as were current students through student representatives on the Teaching Committee and several former students.

5. Review Process

UNSW's Academic Offering Review and Monitoring Procedure outlines a structured approach to maintaining the quality and relevance of academic programs and courses. It includes both program-level and course-level review processes, with defined responsibilities and timelines.

Program Monitoring is conducted annually for all programs and specialisations. A comprehensive program review must occur at least once every five years for accredited programs, and every seven years for others. These reviews include a self-evaluation report (SER), review panel, review event, and a formal response with an implementation plan. Oversight is provided by the Academic Board and University Academic Quality Committee (UAQC), with input from Faculty Education Committees and Deans.

Course Review within UNSW Engineering is managed through a two-tiered process: Routine Course Review and Comprehensive Course Review. Routine reviews are conducted at the end of each term by Schools, using data such as enrolment, assessment outcomes, academic integrity issues, WAM differences, and student feedback (myExperience). Courses flagged through this process are added to the Comprehensive Course Review roster.

Comprehensive Course Reviews are detailed evaluations led by the Course Convenor in collaboration with a Faculty Educational Developer, Nexus Fellow, or Senior Academic. These reviews assess course design, pedagogy, alignment with learning outcomes, and feedback mechanisms. Outcomes are documented in a Course Development Plan and an Evaluation Report following the next course delivery. Schools must review at least 10% of their courses annually.

Stakeholder involvement spans multiple levels, including the Academic Board, UAQC, Faculty and School committees, Course Convenors, and external contributors such as students and professional bodies.

Frequency of updates includes termly course reviews, annual program monitoring, and five-yearly comprehensive reviews for accredited programs.

6. Curriculum Mapping

As in all the Engineering Specialisations at CSE, the specialisation learning outcomes (SLOs) are set by the Director of Studies along with the teaching cluster responsible for providing the specialized core Bioinformatics Engineering courses and approved by the CSE Education Committee (EdCom).

SLOs are mapped to the individual courses comprising the specialisation, each of which has a set of specified course learning outcomes (CLOs). These course learning outcomes are set during the course proposal and are reviewed by course convenors and the Director of Studies as necessary and further approved by the EdCom. All course and specialisation adjustments are recorded in ECLIPS, where their approval at Faculty and University level is managed.

Verification of attainment is up to course convenors, who determine the number, type, and style of assessments that best suit the specific course learning outcomes. In doing so, convenors are constrained by university rules on the weighting and distribution of marks for assessments within a course.

On subsequent pages we map the Bioinformatics Engineering SLOs to the Engineering (Hons) program level outcomes; show how the Bioinformatics Engineering courses develop each of the SLOs; and list the assessments currently undertaken in each of the Bioinformatics Engineering courses and how these verify the attainment of individual CLOs.

The bioinformatics program does not include any core courses that are unique to the program. With the exception of the BINF courses, all the core courses of the program are also core courses in several other programs taught either from the Faculty of Engineering or the Faculty of Science, and staff development planning for these courses are part of overall staff planning at school and faculty level. The bioinformatics courses (BINF2010, BINF3010, and BINF3020) are open to students from other programs, but they are core courses only in the bioinformatics program.

The specialisation learning outcomes are provided to give a bioinformatics specific leaning to the outcomes of the program, and map in part to the ISCB framework, described further in the appendix. In addition, the SLOs map to the PLOs which reflect the Engineering Australia competencies. A delicate balance between the two ensures students are provided with key engineering skills, and specific bioinformatics skills.

Table 2 shows that Bioinformatics Engineering students are encouraged from early on to work in interdisciplinary scenarios (SLO1). Their critical statistical knowledge (SLO2) is acquired via multiple Maths courses and data science techniques via bioinformatics and computing courses. The skills to build bioinformatics applications (SLO4-SLO7) are covered mainly in computing and bioinformatics courses. Students give presentations throughout their degree to acquire effective communication skills (SLO9).

The achievement of all course learning outcomes is the basis for the verification of attainment of the SLOs and PLOs. The former is up to course convenors, who determine the number, type, and style of assessments that best suit the specific course learning outcomes. In doing so, convenors are constrained by university rules on the weighting and distribution of marks for assessments within a course.

Table 1. Mapping of the specialisation learning outcomes to the Engineers Australia Stage 1 Competencies

SLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	PLO13	PLO14	PLO15	PLO16
1. Work with multi-disciplinary colleagues to formulate research questions and design life-science experiments that will generate data suitable for subsequent bioinformatics analysis	X		X	X	X							X				X
2. Apply statistics/data science methods suitable for the size and complexity of the data		X	X			X	X	X	X							
3. Manage own and others' data according to community standards and principles					X	X	X	X	X							
4. Make appropriate use of bioinformatics tools and resources			X	X	X	X	X	X								
5. Design and develop user-centric bioinformatics tools and resources			X	X			X	X	X							
6. Make appropriate and efficient use of scripting and programming languages			X	X		X	X	X								
7. Construct, manage and maintain bioinformatics computing infrastructure of varying complexity		X	X	X	X	X	X									
8. Comply with professional, ethical, legal and social standards and codes of conduct relevant to computational biology					X						X			X	X	
9. Communicate meaningfully with a range of audiences - within and beyond the profession										X		X	X			X

Table 2. Mapping of courses to the specialisation learning outcomes

	1. Work with multi-disciplinary colleagues to formulate research questions and design life-science experiments that will generate data suitable for subsequent bioinformatics analysis	2. Apply statistics/data science methods suitable for the size and complexity of the data	3. Manage own and others' data according to community standards and principles	4. Make appropriate use of bioinformatics tools and resources	5. Design and develop user-centric bioinformatics tools and resources	6. Make appropriate and efficient use of scripting and programming languages	7. Construct, manage and maintain bioinformatics computing infrastructure of varying complexity	8. Comply with professional, ethical, legal and social standards and codes of conduct relevant to computational biology	9. Communicate meaningfully with a range of audiences - within and beyond the profession
Level 1 Core Courses									
BABS1201	Introduced								
CHEM1011	Introduced								
CHEM1031	Introduced								
COMP1511		Introduced	Introduced			Introduced	Introduced		

COMP1521						Introduced	Introduced		
COMP1531	Introduced		Introduced	Introduced	Introduced	Introduced	Introduced		Introduced
DESN1000	Introduced				Introduced		Introduced		Introduced
MATH1081		Introduced							Introduced
MATH1131		Introduced							
MATH1141		Introduced							
MATH1231		Introduced							
MATH1241		Introduced							
PHYS1111	Introduced								
PHYS1121	Introduced								
PHYS1131	Introduced								
Level 2 Core Courses									
BABS2202	Developed								Developed
BABS2204	Introduced	Introduced		Introduced					Developed
BABS2264	Introduced	Introduced		Introduced					Developed
BINF2010		Introduced	Introduced	Introduced		Introduced	Introduced	Introduced	
BIOC2101	Developed	Developed		Introduced					Developed
BIOC2201	Developed	Developed		Introduced					Developed
COMP2041				Developed	Introduced	Developed	Introduced		Developed
COMP2521					Developed	Developed	Developed		
DESN2000	Developed	Developed	Developed	Developed	Developed	Developed		Developed	Developed
MATH2801		Developed				Developed			
MATH2901		Developed							
MICR2011			Developed	Developed					Developed
COMP2511					Developed		Developed		Developed
Level 3 Core Courses									
BABS3121	Proficient	Proficient							Proficient
BINF3010		Proficient	Proficient	Proficient	Developed	Developed			Proficient
BINF3020		Proficient	Developed	Proficient	Proficient	Proficient		Proficient	Proficient
COMP3121		Proficient			Proficient	Proficient		Proficient	Proficient
COMP3311			Proficient	Proficient	Proficient	Proficient	Proficient		
Level 4 Core Courses									

COMP4920								Proficient	Developed
COMP4951	Developed	Developed	Developed	Developed	Developed	Developed	Developed	Developed	Developed
COMP4952	Developed	Developed	Developed	Developed	Developed	Developed	Developed	Developed	Developed
COMP4953	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient
Discipline Electives									
ENGG2600	Introduced								Proficient
ENGG3060	Developed								Proficient
ENGG3600	Developed								Proficient
ENGG4600	Proficient								Proficient

7. Assessments

Throughout the program, students take on courses with a range of activities and assessments that cater to different learning outcomes, skills, and capabilities.

As can be seen in the following charts, there is heavy emphasis on summative assessments with quizzes and exams the two largest fractions of the overall types (**Figure 1**). This is to ensure that students have developed solid foundations. However, they still only form close to 50% of the assessments, with the remaining formative assessments allowing students to engage in a mix of practical work (laboratories) and reflective aspects (reports, essays, and assignments) in their learning experience. This is similar for core courses (**Figure 2**).

For computing courses, coding and problem solving are key activities, and this is assessed across practical work in the labs. Students take the theoretical information from their lectures and extend this in tutorials and practicals. Harder versions of these problems or critical code components are assessed in assignments. In the science/biological courses, students are also provided with key theories, and then work on experiments that reinforce these ideas, with a report to assess their understanding and critical thinking around the outcomes. In the bioinformatics courses, a mix of both these practices allows students to engage with both the software side of practical bioinformatics (e.g., BINF3020) and the downstream analysis in applied bioinformatics (BINF3010).

In multiple courses throughout the program are peer/group activity with a peer evaluation component. This promotes collaborative learning, engagement with the work of others, and critical management and feedback skills. In the DESN2000 course for example, students form a group and assign roles that reflect a working group, with a team leader, designer, coder, etc. While the 4th-year thesis is usually an individual project, it requires close interaction with the supervisor as a mentor, and presentations to the supervisor and their peers.

Students are introduced to the responsible use of AI, but each course has its own set of policies and frameworks that are specified in the course outlines. The categories for permissible use range from no use permitted, to variations of permissions based on planning/design, or AI-based. Most courses currently allow only some simple editing help, or no AI use.

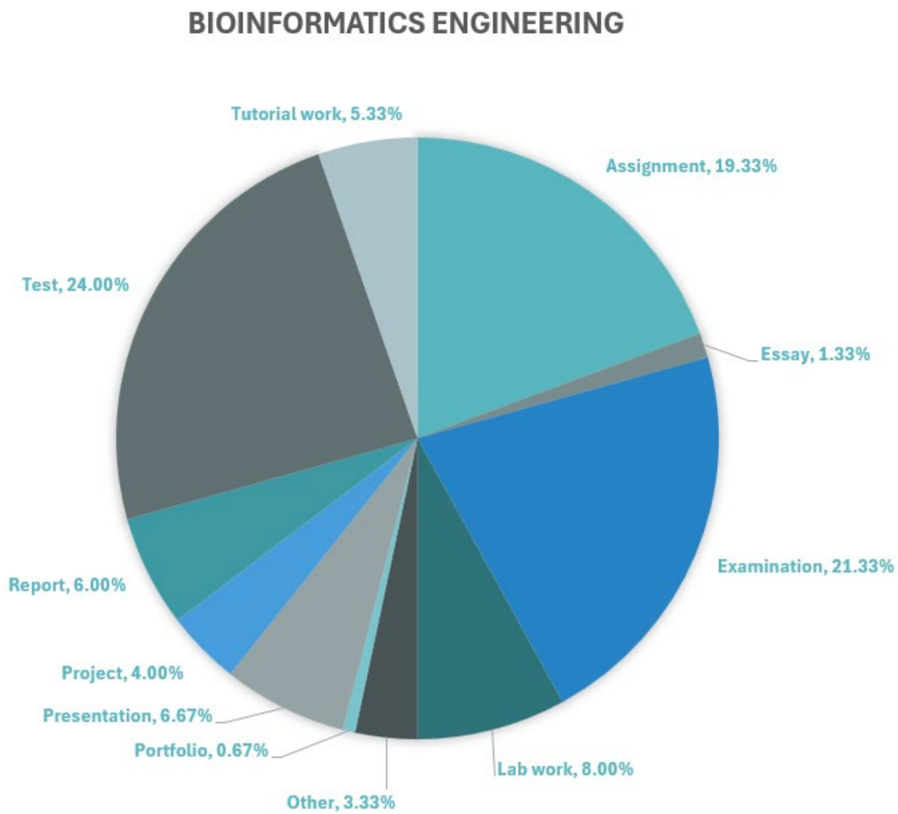

Figure 1. Percentage of assessment types used within the specialisation

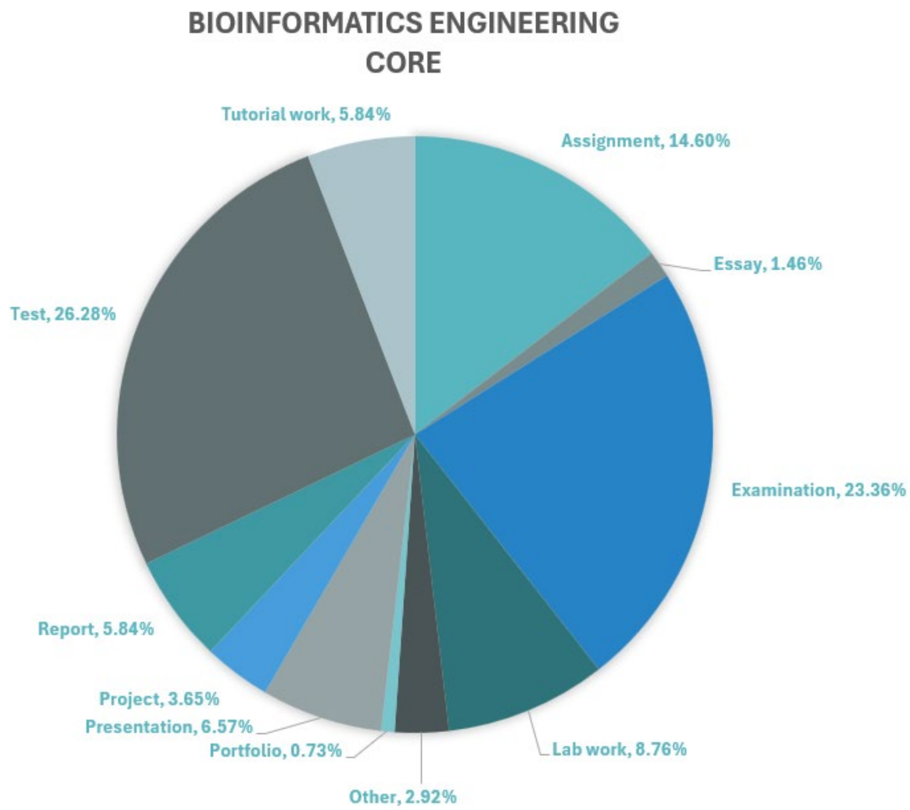

Figure 2. Percentage of assessment types used within the core of the specialisation

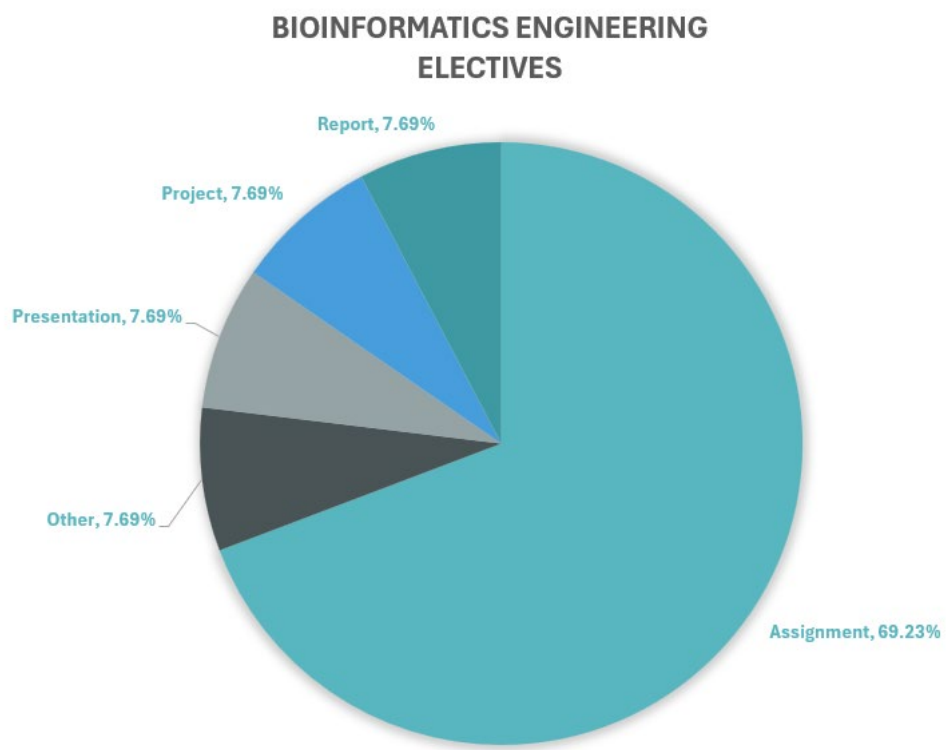

Figure 3. Percentage of assessment types used within the electives of the specialisation

8. Specialisation Progression Plan

The BINFAH specialisation has the following requirements across the four years of the program.

- 54 UoC Introductory knowledge core courses
  - at least 18 UoC of introductory Mathematics courses: MATH1081, MATH1131 or MATH1141, MATH1231 or MATH1241
  - at least 18 UOC Physics, Chemistry, Materials Science, Biology and/or Engineering foundations: BABS1201, CHEM1011 or CHEM1031, PHYS1111 or PHYS1121 or PHYS1131
  - at least 18 UoC of Programming courses: COMP1511, COMP1521, COMP1531
- At least 72 UoC Discipline-specific core courses: BINF2010, BIOC2201, COMP2041, COMP2511, COMP2521, MATH2801 or, MATH2901, BABS2202 or BABS2204 or BABS2264 or BIOC2101 or MICR2011, BABS3121, BINF3010, BINF3020, COMP3121, COMP3311
- At least 6 UoC of Engineering and Technical Management core: COMP4920
- At least 12 UoC Engineering Design: DESN 1000, DESN2000
- At least 12 UoC enquiry-based courses (research and/or design project) including

- at least 12 UoC of thesis courses: COMP4951, COMP4952, COMP4953

- At least 12 UOC of Discipline-specific elective courses: ENGG2600, ENGG3060, ENGG3600, ENGG4600, or any non-introductory COMP*, BABS*, BIOC*, MICR* courses

<table>
<tr><td>Year 4</td><td>Engineering & technical Management
6 UOC</td><td colspan="3">Thesis Project
12 UOC</td><td rowspan="2">General Education
12 UOC</td><td rowspan="2">Free Electives
12 UOC</td><td rowspan="4">60 days of Industrial Training</td></tr>
<tr><td>Year 3</td><td>Discipline-specific elective courses
12 UOC</td><td colspan="3">Discipline-specific core courses
30 UOC</td></tr>
<tr><td>Year 2</td><td>Maths 6 UOC</td><td>L2 Engineering Design
6 UOC</td><td colspan="4">Discipline-specific core courses
42 UOC</td></tr>
<tr><td>Year 1</td><td>Maths 18 UOC</td><td>L1 Engineering Design
6 UOC</td><td>Programming
18 UOC</td><td colspan="3">Physics, Chemistry, Materials Science, Biology and/or Engineering foundations
18 UOC</td></tr>
</table>

Students can track their progression through the “myPlan” checker tool.

[myPlan | Current Students - UNSW Sydney]

A progression checklist and/or study plan is also available for students for the single degree and the double degree offerings.

[Progression checksheets & study plans | Engineering - UNSW Sydney]