UNSW Engineering

Education Specification

1. Program Overview

Program Title: Bachelor of Engineering (Honours)

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

Engineering Discipline: Chemical Engineering

The discipline of chemical engineering has evolved over time and continues to evolve around the world, though it contains common elements that are nearly universal and neatly summarised in accreditation requirements for the specialisation (such as those of the Institution of Chemical Engineers – the IChemE). The Chemical Engineering specialisation within the Bachelor of Engineering (Honours) at UNSW is named to be consistent with what the discipline is generally known as globally.

Chemical Engineering involves researching, developing and improving properties of products we use every day through the selection of raw materials, the design of chemical processes, and improving the conditions for production. It's about taking projects from inception as a research proposal, through product development and on to commercialisation and manufacture. At UNSW, Chemical Engineers learn how to apply advanced knowledge in chemical engineering and chemistry to optimise complex chemical processes in environmental management, general industry and services like water delivery. Chemical Engineers master the entire process, extrapolating small-scale, laboratory chemistry into large, industrial-scale production. These skills are critical for the Australian economy now and into the future.

The Engineers Australia Stage 1 Competency Standard forms the high-level Engineering (Honours) program learning outcomes at UNSW, which form the design specification for the specialisation.

The specialisation learning outcomes (SLOs) are mapped to the program learning outcomes (EA Stage 1 Competency Standard) to ensure those outcomes are achieved.

Course-level intended learning outcomes are, in turn, mapped to the specialisation learning outcomes to ensure that those are also achieved.

The specialisation and (and if necessary, course) learning outcomes are mapped to various external benchmarks. The balance of outcomes achieved across the specialisation is considered by expert groups, including the School's teaching committee and Industry Advisory Board, with reference to external groups, including TEQSA, Engineers Australia, and the IChemE.

These diverse and evolving requirements together create a rather narrow feasible program design space, which we endeavour to stay within.

Where adjustments to the balance of outcomes are required as identified in periodic review, these are implemented through revisions to the stream (to adjust included courses) or courses (to adjust the balance of content, skills, or assessment).

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2. Career Alignment

Chemical Engineering involves researching, developing and improving properties of products we use every day through the selection of raw materials, the design of chemical processes, and improving the conditions for production. It's about taking projects from inception as a research proposal, through product development and on to commercialisation and manufacture. At UNSW, Chemical Engineers learn how to apply advanced knowledge in chemical engineering and chemistry to optimise complex chemical processes in environmental management, general industry and services like water delivery. Chemical Engineers master the entire process, extrapolating small scale, laboratory chemistry into large, industrial scale products.

Our Chemical Engineering alumni work in a broad range of industries, covering everything from the traditional petrochemical industry through to the emerging hydrogen economy, and from food manufacture to mineral processing. The defining characteristic of a successful chemical engineering graduate is the ability to apply knowledge from a broad foundational of chemistry, mathematics, physics and computing to this wide range of contexts; moreover, the chemical engineer much include safety, the environment, people, and economics within their work.

3. Specialisation Framework

The specialisation learning outcomes (SLOs) for chemical engineering encapsulate all the discipline-specific technical knowledge and application skills that are generally expected capabilities for chemical engineering graduates, as detailed in the IChemE's accreditation guidelines.

The SLOs for chemical engineering (and their sub-SLOs when more granularity is required) are mapped to the Program Learning Outcomes (Engineers Australia Stage 1 Competency standard). Mapping of individual course learning outcomes to the SLOs (and thence to the program learning outcomes) measures the specialisation design's attainment of the Stage 1 competencies. Where deficiencies are identified these are addressed through course and / or stream revisions overseen by the School's teaching committee.

Herewith the stream learning outcomes for chemical engineering.

On successful completion of this stream, graduates will be able to:

1. Demonstrate knowledge and expertise in the use of the methods, tools and ideas from chemistry, mathematics, physics, and computing that underpin chemical engineering.
2. Solve chemical engineering problems by competent application of technical knowledge in material and energy balances, thermodynamics, fluid mechanics, particulate flow, chemical reaction engineering, transport phenomena, separation technologies, process equipment selection, process modelling, process simulation, process control, economic analysis, and safety analysis.
3. Demonstrate expertise in the design of chemical engineering systems, using established methods to create and document solutions that are technically feasible, appropriate, safe, sustainable, economically viable, socially acceptable, and standards-compliant.
4. Use systems thinking to guide engineering practice, including articulating financial and technical constraints on process design, analysing competitor processes to identify opportunities in market and technologies, developing process improvement plans, and liaising with product engineers to select appropriate process designs.

5. Make responsible engineering decisions in the face of uncertainty, complexity, and incomplete information in consultation with stakeholders, via critical reflection, and through the planning, collection, and analysis of data from research, experimentation and simulations.
6. Effectively manage process engineering projects and multidisciplinary teams with robust project planning and project management approaches that are adaptable, responsive, and appropriate in benefiting from the capabilities of diverse teams.
7. Communicate complex ideas effectively and professionally through a range of media to diverse audiences within and outside of chemical engineering, effectively incorporating feedback and being responsive to others.
8. Conduct themselves professionally, ethically, respectfully and with integrity, being accountable as an individual, as members of teams, and as a leader of teams, while recognising the social and environmental obligations of chemical engineers.

The SLOs are developed through individual courses that are articulated into four thematic areas: process design, thermodynamics, fluids & materials, lifelong learning. It is important that both staff and students understand the connections between the courses that together produce a graduate engineer. As part of our curriculum development and review cycle, these thematic areas have been summarised in the following diagrams, that help explain to our students and staff how the individual courses are designed to fit with each other, developing a graduate engineer at the successful conclusion of the studies.

4. Continuous Improvement

Program design is primarily informed by formal and informal professional networks in which the School's academic staff participate. From engagement with the academic literature and conferences, industry-based research and professional networks, through to formal channels such as our Industry Advisory Board and accreditation processes, the School collectively stays in touch with developments that affect the way our graduates might fulfill changing industry and societal needs.

These insights make their way to the School's teaching committee, where they are discussed and result in adjustments to the specialisation design as necessary.

A good example of this is the recently more widespread use of generative AI in the student body, in industry and in the wider community. The University has developed policy relating to the use of generative AI in assessment, but at the School level we are dealing with the implications for course and program design – not just for assessment but for instructional and learning activity design. Being able to evaluate and use these tools competently will be a very important capability of our future graduates.

The shape of future demands are difficult to know for certain. It's becoming increasingly clear that the world is changing rapidly, and not just because of the advent of widespread access to AI. The sustainability imperative is becoming increasingly urgent, at the same time as international relationships and supply chains are becoming increasingly fraught. Australia is having to consider its position carefully. With a rich resource base including critical minerals, limited local manufacturing capability and security heavily dependent on the actions of larger players, it may be wise for Australia to build (and rebuild) sovereign capability in critical areas including chemical manufacturing (as we recently saw with the narrowly averted urea crisis) and liquid fuels. The School is alert to the possibility that this will entail an increased demand for chemical engineering graduates who are able to deploy both traditional and emerging skills and expertise in chemical engineering.

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

To develop an initial draft of the SLOs, a working group was formed that included members of the school with relevant industry experience, specialists in education and curriculum design, and the stream coordinators of each stream. The group was selected to ensure diversity in professional background, industry experience, cultural background, and gender, gathering a representative set of views. Over the course of six weeks, the group progressed through a sequence of divergent then convergent phases of identifying important topics to be included in the SLOs, finding suitable wording for the SLOs, combining the work, and the refining the draft.

The draft SLOs were widely circulated for comment, critique, and suggestions around the entire academic staff of the School, the Faculty Accreditation Working Group, and the School's Industry Advisory Board. The final versions of the SLOs were endorsed by the School's Education Committee, and the industry and student members of the School's Industry Advisory Board.

The SLOs are reviewed as part of the comprehensive program review conducted at least every five years.

Verification of achievement of learning outcomes is a multi-step chain from the program learning outcomes (stage 1 competencies) mapped to specialisation learning outcomes, mapped to course learning outcomes, to assessment design and finally review of individual student work for each assessment. Each step is conducted through periodic course and program review as outlined earlier, except for the final step verifying student work. That is conducted at all course levels during the IChemE accreditation process (every 5 years), and verified for the capstone thesis and design courses each time they are offered

Table 1. Mapping of the stream 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. Demonstrate knowledge and expertise in the use of the methods, tools and ideas from chemistry, mathematics, physics, and computing that underpin chemical engineering.	x	x														
2. Solve chemical engineering problems by competent application of technical knowledge in material and energy balances, thermodynamics, fluid mechanics, particulate flow, chemical reaction engineering, transport phenomena, separation technologies, process equipment selection, process modelling, process simulation, process control, economic analysis, and safety analysis.			x				x	x								
3. Demonstrate expertise in the design of chemical engineering systems, using established methods to create and document solutions that are technically feasible, appropriate, safe, sustainable, economically viable, socially acceptable, and standards-compliant.					x	x	x		x							
4. Use systems thinking to guide engineering practice, including articulating financial and technical constraints on process design, analysing competitor processes to identify opportunities in market and technologies, developing process improvement plans, and liaising with product engineers to select appropriate process designs.				x	x	x	x	x	x							
5. Make responsible engineering decisions in the face of uncertainty, complexity, and incomplete information in consultation with stakeholders, via critical reflection, and through the planning, collection, and analysis of data from research, experimentation and simulations.				x		x		x	x		x			x		
6. Effectively manage process engineering projects and multidisciplinary teams with robust project planning and project management approaches that are adaptable, responsive, and appropriate in benefiting from the capabilities of diverse teams.							x			x						x
7. Communicate complex ideas effectively and professionally through a range of media to diverse audiences within and outside of chemical engineering, effectively incorporating feedback and being responsive to others.												x				
8. Conduct themselves professionally, ethically, respectfully and with integrity, being accountable as an individual, as members of teams, and as a leader of teams, while recognising the social and environmental obligations of chemical engineers.											x		x	x	x	x

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Table 2. Mapping of courses to the stream learning outcomes

CLO	1. Demonstrate knowledge and expertise in the use of the methods, tools and ideas from chemistry, mathematics , physics, and computing that underpin chemical engineering.	2. Solve chemical engineering problems by competent application of technical knowledge in material and energy balances, thermodynamics, fluid mechanics, particulate flow, chemical reaction engineering, transport phenomena, separation technologies, process	3. Demonstrate expertise in the design of chemical engineering systems, using established methods to create and document solutions that are technically feasible, appropriate, safe, sustainable, economically viable, socially acceptable, and standards-compl	4. Use systems thinking to guide engineering practice, including articulating financial and technical constraints on process design, analysing competitor processes to identify opportunities in market and technologies, developing process improvement plans,	5. Make responsible engineering decisions in the face of uncertainty, complexity, and incomplete information in consultation with stakeholders, via critical reflection, and through the planning, collection, and analysis of data from research, experimentat	6. Effectively manage process engineering projects and multidisciplinary teams with robust project planning and project management approaches that are adaptable, responsive, and appropriate in benefiting from the capabilities of diverse teams.	7. Communicate complex ideas effectively and professionally through a range of media to diverse audiences within and outside of chemical engineering, effectively incorporating feedback and being responsive to others.	8. Conduct themselves professionally, ethically, respectfully and with integrity, being accountable as an individual, as members of teams, and as a leader of teams, while recognising the social and environmental obligations of chemical engineers.
Level 1 Core Courses								
CHEM1811 Engineering Chemistry 1A	Introduced				Introduced		Introduced	Introduced
CHEM1821 Engineering Chemistry 1B	Introduced	Introduced			Introduced			Introduced
DESN1000 Introduction to Engineering Design and Innovation		Introduced	Introduced		Introduced	Introduced	Introduced	Introduced
ENGG1811 Computing for Engineers	Introduced							
MATH1131 Mathematics 1A	Introduced						Introduced	
MATH1141 Higher Mathematics 1A	Introduced						Introduced	
MATH1231 Mathematics 1B	Developed						Introduced	
MATH1241 Higher Mathematics 1B	Developed						Introduced	
PHYS1121 Physics 1A	Introduced				Introduced		Introduced	Introduced
PHYS1131 Higher Physics 1A	Introduced				Introduced		Introduced	Introduced
Level 2 Core Courses								

CEIC2000 Material and Energy Systems	Developed	Introduced	Developed					
CEIC2001 Fluid and Particle Mechanics	Developed	Introduced	Developed					
CEIC2002 Heat and Mass Transfer	Developed	Developed						
CEIC2005 Chemical Reaction Engineering	Developed	Developed	Developed					
CEIC2007 Chemical Engineering Lab A	Developed	Developed	Developed		Introduced	Developed	Introduced	Introduced
DESN2000 Engineering Design and Professional Practice		Developed	Developed	Introduced	Introduced	Developed	Introduced	Introduced
MATH2018 Engineering Mathematics 2D	Developed	Developed						
MATH2019 Engineering Mathematics 2E	Developed	Developed						
MATH2089 Numerical Methods and Statistics	Developed	Developed					Developed	
Level 3 Core Courses								
CEIC3000 Process Modelling and Analysis	Proficient	Developed	Developed					
CEIC3001 Advanced Thermodynamics and Separation	Proficient	Developed	Developed		Introduced			
CEIC3004 Process Equipment Design		Developed	Developed	Developed	Developed	Developed		Developed
CEIC3005 Process Plant Design		Developed	Developed	Developed	Developed		Developed	Developed
CEIC3006 Process Dynamics and Control	Proficient	Developed	Developed					
CEIC3007 Chemical Engineering Lab B		Proficient	Developed		Developed	Developed	Developed	Developed
Level 4 Core Courses								
CEIC4000 Environment and Sustainability				Developed	Proficient		Developed	
CEIC4001 Process Design Project		Proficient	Proficient	Proficient	Proficient		Proficient	Proficient
CEIC4951 Research Thesis A	Proficient	Proficient	Proficient	Proficient	Proficient		Proficient	
CEIC4952 Research Thesis B	Proficient	Proficient	Proficient	Proficient	Proficient		Proficient	

CEIC4953 Research Thesis C	Proficient	Proficient	Proficient	Proficient	Proficient		Proficient	
Recommended First-Year Elective								
CEIC1000 Sustainable Product Engineering and Design			Introduced	Introduced	Introduced	Introduced	Introduced	
Discipline (Depth) Electives								
CEIC6711 Complex Fluids Microstructure and Rheology	Proficient	Proficient	Proficient	Developed	Proficient			
CEIC8102 Advanced Process Control	Proficient	Proficient	Proficient	Proficient	Proficient			
CEIC8105 Advanced Polymer Science and Research	Proficient	Proficient	Proficient	Proficient	Proficient		Proficient	Proficient
CHEN6701 Advanced Reaction Engineering	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient
CHEN6703 Advanced Particle Systems Engineering	Proficient	Proficient	Proficient	Proficient	Proficient	Developed	Proficient	Proficient
CHEN6706 Advanced Transport Phenomena	Proficient	Proficient	Proficient	Proficient	Developed			
Breadth Electives								
CEIC6712 Pharmaceutical Design and Engineering	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient
CEIC6714 Hydrogen Systems Engineering and Economics	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient
CEIC8104 Topics in Polymer Technology	Proficient	Proficient	Proficient	Proficient	Developed		Proficient	Proficient
CEIC8204 Entrepreneurship and the Innovation Cycle			Proficient	Proficient	Proficient	Proficient	Proficient	Proficient
CEIC8341 Membrane Processes	Proficient	Proficient	Proficient	Proficient	Proficient			Proficient
CHEM2041 Analytical Chemistry: Essential Methods	Proficient	Proficient	Proficient		Proficient	Developed	Proficient	Proficient
ELEC4445 Entrepreneurial Engineering	Proficient		Proficient	Proficient	Proficient	Proficient	Proficient	Proficient
ENGG3001 Fundamentals of Humanitarian Engineering	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient

ENGG3741 Introduction to Nuclear Engineering	Developed	Developed	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient
ENGG4111 Energy Storage	Proficient	Proficient	Proficient	Proficient	Proficient			Proficient
FOOD3010 Food Products and Ingredients Technology	Proficient	Proficient	Proficient	Proficient	Proficient		Proficient	Proficient
FOOD4450 Industry Applications of Food Processing Unit Operations	Proficient	Proficient	Proficient	Proficient	Proficient			
MECH4770 Fundamentals and Design of Electrochemical Energy Storage Systems	Proficient	Proficient	Proficient	Proficient	Proficient			Proficient
MINE2820 Minerals Processing	Proficient	Proficient	Proficient	Proficient	Proficient			Proficient
Practice Electives								
CEIC4954 Research Thesis Extension	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient
ENGG2600 Engineering Vertically Integrated Project	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient
ENGG3060 Rehabilitation and Assistive Technology	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient
ENGG3600 Engineering Vertically Integrated Project	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient
ENGG4060 Student Initiated Project		Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient
ENGG4102 Humanitarian Engineering Project	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient
ENGG4103 International Humanitarian Response	Proficient			Proficient	Proficient	Proficient	Proficient	Proficient
ENGG4600 Engineering Vertically Integrated Project	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient	Proficient

7. Assessments

The mixture of assessment types used within the stream is shown below.

As is typical of many streams, early courses are content-driven and the assessments reflect a desire to see demonstration of individual learning in tests or examinations. Students commonly have opportunities for longer form formative or summative assignment activities. In later years, the assessment mix tends to pivot towards project work, often in teams.

It is noted that Assignment, Essay, Report, and Project are used quite interchangeably in many courses, as are Exam vs Test, and Presentation vs Performance; a presentation that is about a project might be classified as a project or as a presentation. Laboratory work (which might include wet labs or computer labs) may also be assessed via reports, interviews, or presentations, and so not appear with a "Laboratory" designation.

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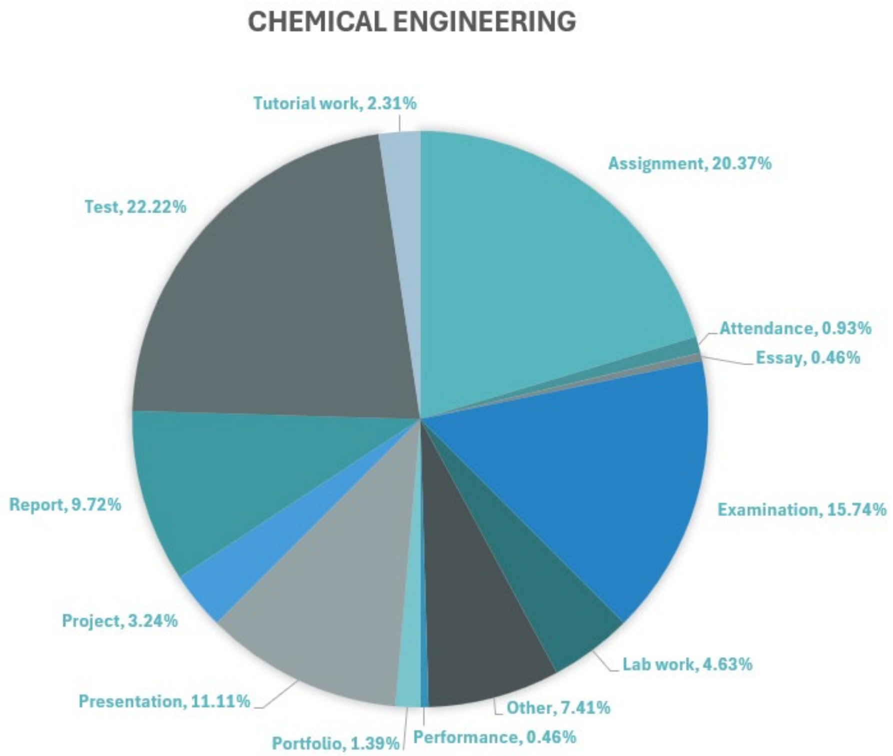

Figure 1. Percentage of assessment types used within the specialisation.

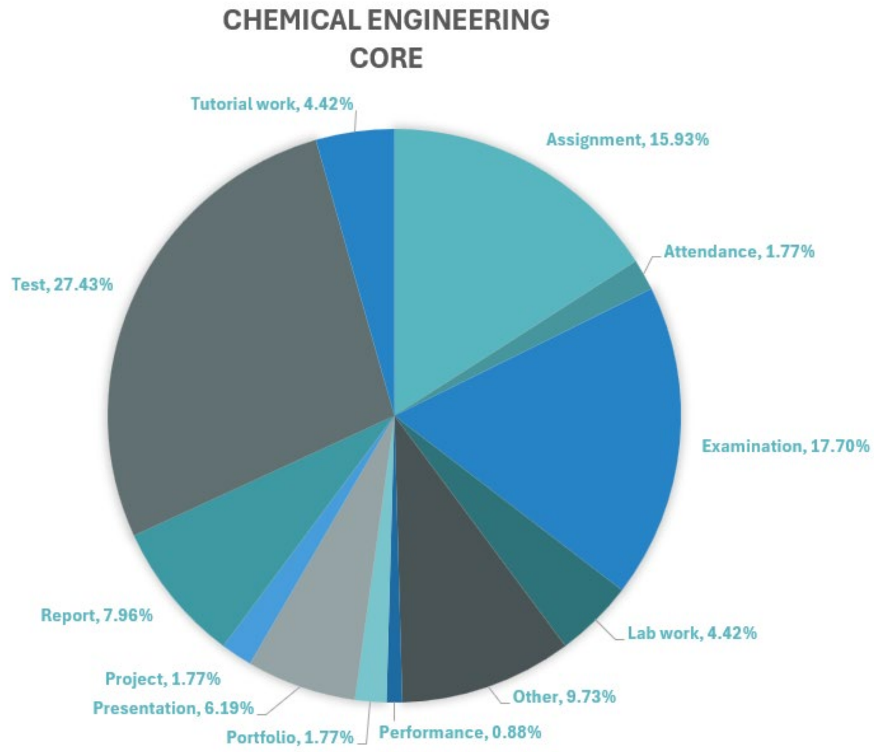

Figure 2. Percentage of assessment types used within the core of the specialisation.

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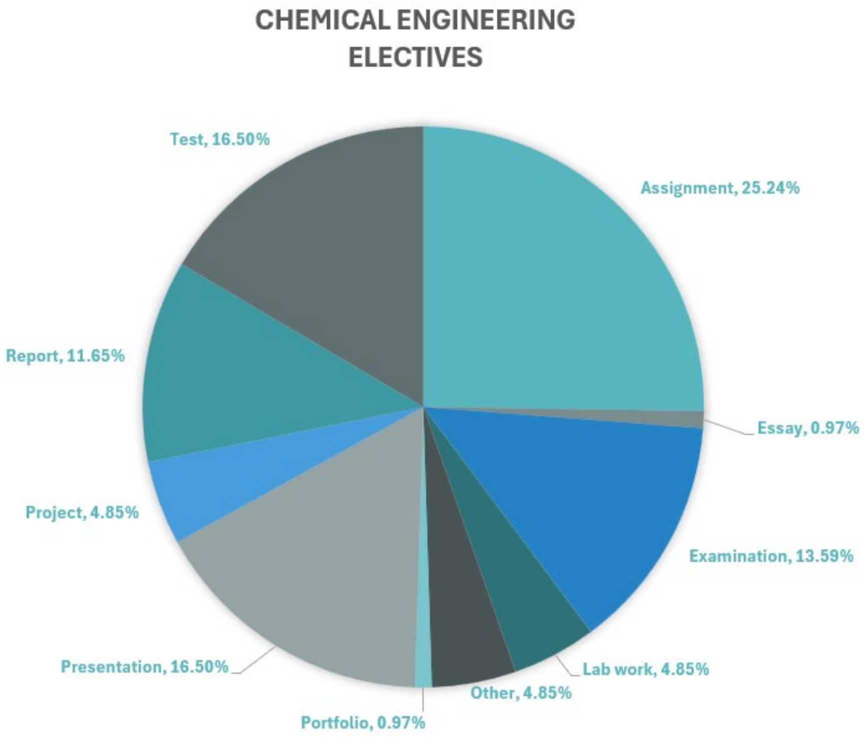

Figure 3. Percentage of assessment types used within the electives of the specialisation.

Even with the limitations of classification, it is seen that a broad range of assessment types are employed in the stream, offering many opportunities for students to demonstrate their learning, and different formats used to develop a variety of communications skills.

Reflective practice, critical review, peer and self assessment skills are developed under SLO 7 and 8, across a number of courses in the stream, especially the professional practice and design oriented courses.

Assessment design is consistent with achieving stated course learning outcomes, as assured by the governance process for course proposal and revision. Grading rubrics are developed by course coordinators consistent with the learning outcomes targeted and are monitored as part of the course review process.

The School has a range of measures in place for assessment quality and academic integrity:

- All final exam papers are peer reviewed by the School Exam Review meeting. At this meeting, papers are checked for their academic level, correctness, and clarity. Marking rubrics are also reviewed along with the measures proposed by the exam setter to check for academic integrity.
- Reports are normally submitted via Turn-It-In where appropriate. Final year theses may also be checked via Turn-It-In if there are any concerns from either marker. This is generally effective in detecting garden-variety plagiarism and indicative in terms of flagging AI generated content.
- The University operates a multi-level AI permission setting which is determined at the level of individual assessment items and specified in each Course Outline. Where appropriate, assessment is designed to make attempted inappropriate AI use unhelpful, for instance by

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requiring students to reflect upon their own personal beliefs or experience. There is generally some level of discussion around the appropriate use of AI for each assessment in the classroom. Inappropriate use is generally picked up through a combination of suggestive matching in Turnitin, unlikely or unusual language choice, or academic subject matter expertise. Allegations of AI misuse are handled within the University's plagiarism management procedure or complaints management and investigations policy and procedure, depending on severity.

- Worked solutions with detailed marking guides or marking rubrics reflective of the course's intended learning outcomes are created for all closed-ended assessment items and used by markers.
- Final year theses are double marked to ensure consistency; if the markers are not in reasonable agreement on the final mark, a third marker is appointed.

It is reasonable to assume that assessment practices will continue to evolve, with arguments unresolved about the best approaches to assess student learning, the impact of high stakes assessments on student welfare, and the efficacy of various assessment practices in maintaining academic integrity including effectively adapting teaching and assessment practice to the era of generative AI.

8. Specialisation Progression Plan

The standard plan is shown below for the Chemical Engineering stream. It is noted that students may approach the stream in different sequences for a range of reasons, including Co-op Scholarship placements, international exchange, enrolment in a double degree, part-time study, commencing the degree in Term 2 or Term 3, or failing an individual course. To complement the study plan shown below, the School has developed recommended study plans for other common eventualities and these are published on the Faculty website; our Academic Advisors also work with individual students to develop study plans tailored to their circumstances.

The university has developed the online myPlan tool to assist students with developing their own custom enrolment sequence depending on personal circumstances.

https://www.unsw.edu.au/engineering/student-life/student-resources/enrolment-sequences

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