

Chemical Product Engineering Stream (CEICDH)

School of Chemical Engineering

Introduction

The CEICDH Chemical Product Engineering stream in the 3707 Bachelor of Engineering (Honours) program at UNSW trains graduate engineers with specialist discipline knowledge and who have developed the Engineers Australia Stage 1 Competencies.

In this integrated graduate specification, we describe the aims of the stream, what sets chemical product engineering apart from other engineering streams, the stream learning outcomes, and the overall curriculum. Detailed mappings between courses, stream learning outcomes and EA Stage 1 Competencies are included.

Aims of the stream

Chemical Product Engineering involves researching, developing and improving the properties of the products that we use every day through the selection and design of the materials that are used. Product engineers work on the fluids that you use in your everyday life, including chemicals (cosmetics, pharmaceuticals, shampoos, paints, glues), foods, and drinks. Product engineers take consumer needs and turn them into technical requirements, finding the right combinations of chemicals to deliver those properties and then developing the product and strategies for commercialisation and manufacture. At UNSW, Chemical Product Engineers learn how to apply knowledge of engineering and chemistry to design complex chemical products for the pharmaceutical, consumer products and food industries. Chemical Product Engineers master the entire development process, testing out ideas for products and extrapolating small scale, laboratory chemistry into large, industrial scale production. In the final year Product Design Project, students work with industry partners to develop new consumer products up to the point where they could be patented and commercialised. To get work ready, graduates apply these skills through 60 days of approved industry training.

Our Chemical Product Engineering alumni work in a broad range of industries, covering everything from the food manufacture to cosmetics and industrial chemical manufacture. The defining characteristic of a successful chemical product engineering graduate is the ability to apply knowledge from a broad foundational of chemistry, mathematics, physics and computing to this wide range of contexts with an innovative and commercially oriented spirit; moreover, the chemical product engineer much include safety, the environment, people, and economics within their work.

The Chemical Product Engineering stream in the BE(Hons) aims to ensure a rigorous foundation of chemistry and chemical engineering theory is developed and that graduates are able to apply this theory to a range of design and operation scenarios. As an Honours level stream (AQF level 8), the curriculum contains advanced disciplinary knowledge, enquiry based learning, and an introduction to research. Graduates are able to use their advanced skills to analyse critically, evaluate and transform knowledge into product designs and solutions. Moreover, they are able to develop and communicate solutions to complex problems with autonomy and professional judgement.

The stream is composed of individual courses that are articulated into four thematic areas: product design, manufacturability, 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.

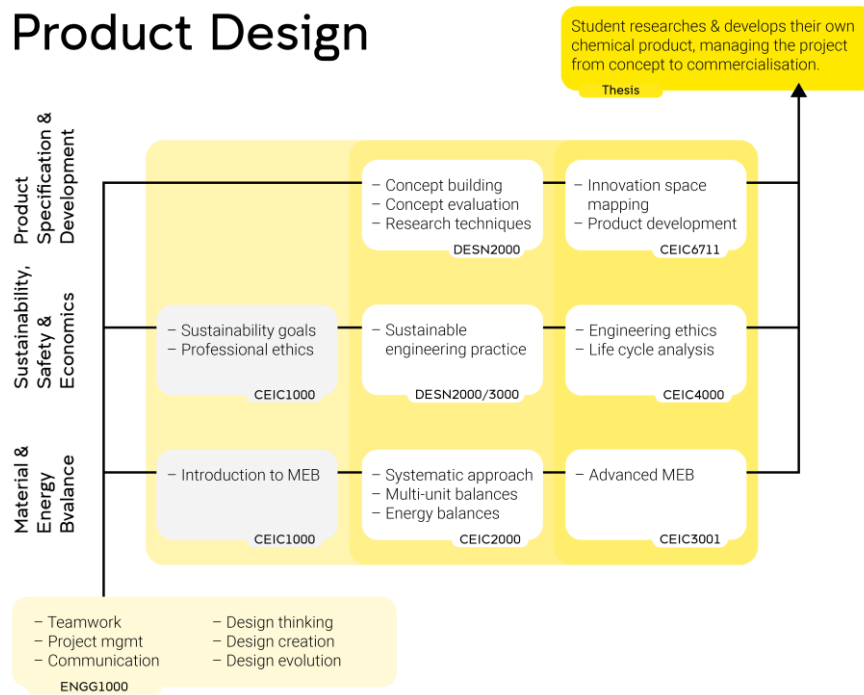


Figure 1: Chemical Product Engineering specification for the Product Design Theme

Manufacturability

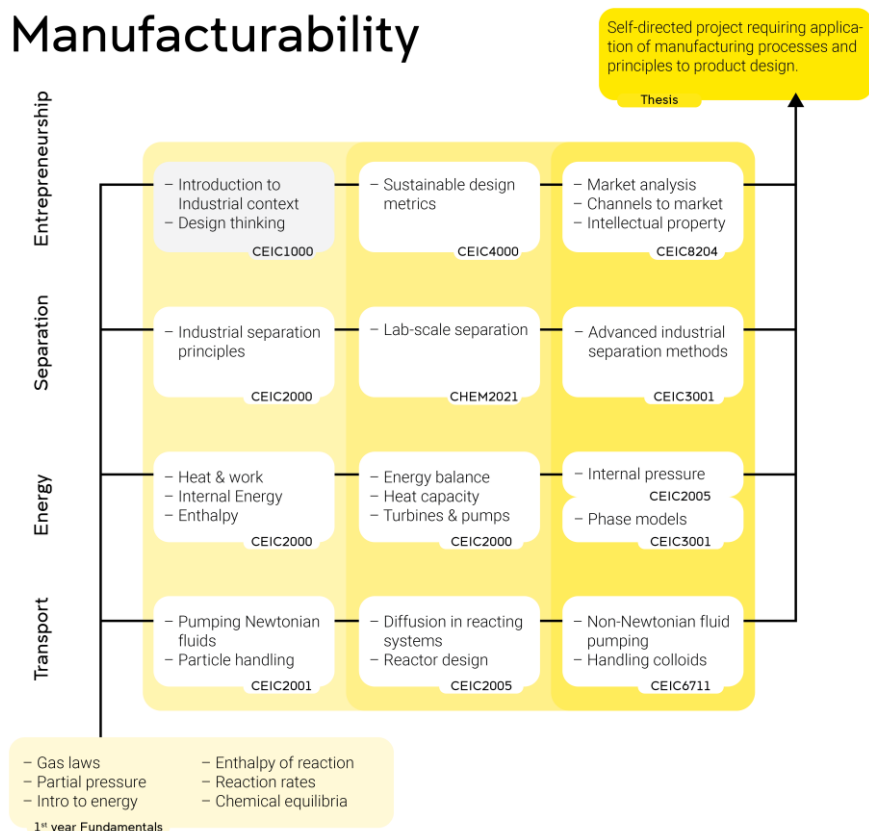


Figure 2: Chemical Product Engineering specification for the Manufacturability theme

Fluids & Materials

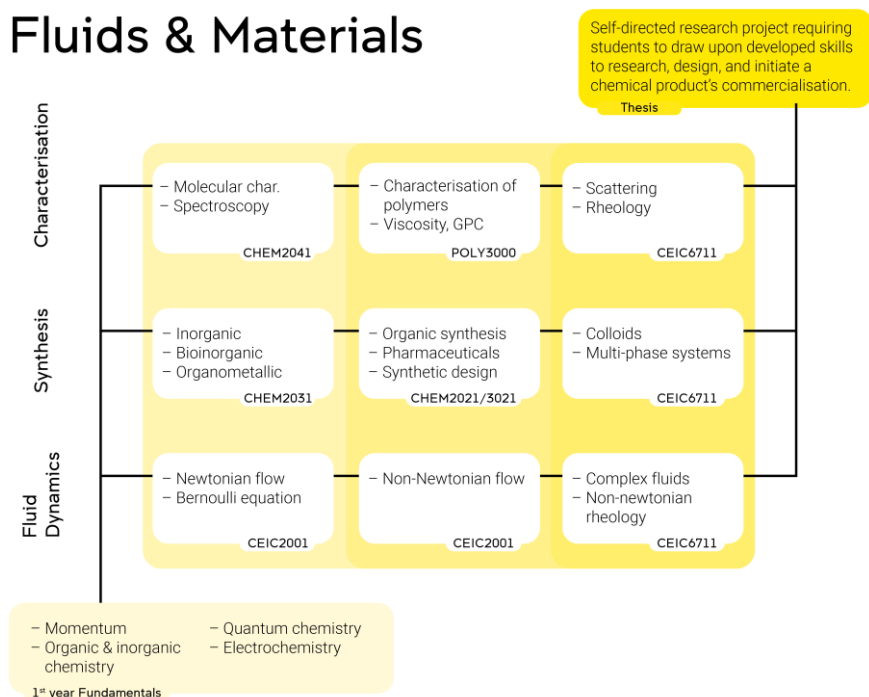


Figure 3: Chemical Product Engineering specification for the Fluids & Materials theme

Lifelong Learning

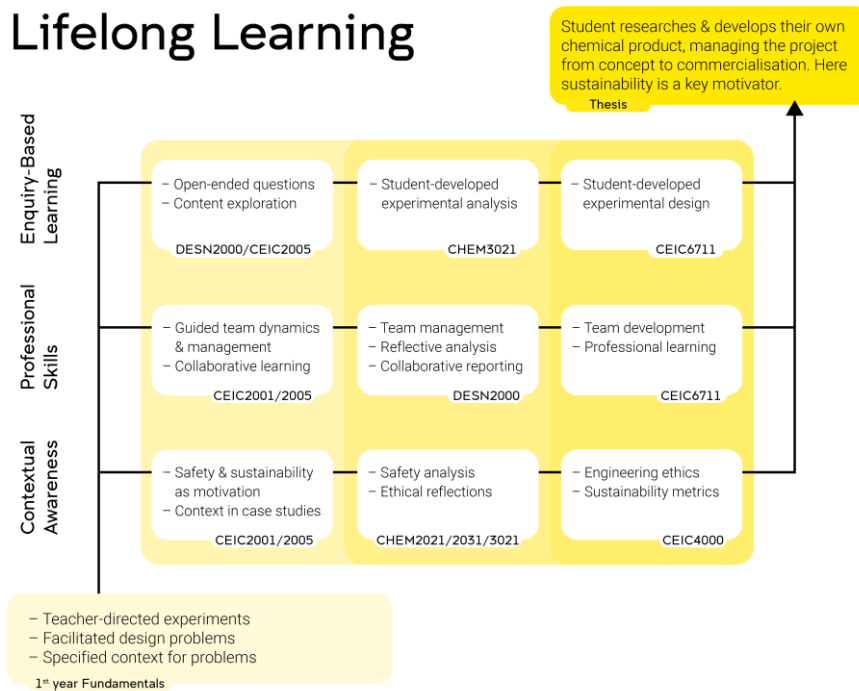


Figure 4: Chemical Product Engineering specification for the Lifelong Learning theme

Stream Plan

The standard plan is shown below for the Chemical Product 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.

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

Table 1: Normal enrolment sequence for the Chemical Product Engineering stream

Year 1		
Term 1	DESN1000	Introduction to engineering design and innovation
	CHEM1811	Engineering Chemistry 1A
	MATH1131	Mathematics 1A
Term 2	ENGG1811	Computing for Engineers
	CHEM1821	Engineering Chemistry 1B
	MATH1231	Mathematics 1B
Term 3	CEIC1000	Sustainable product engineering and design
	PHYS1121	Physics 1A
	CHEM2041	Analytical chemistry: essential methods
Year 2		
Term 1	CEIC2000	Materials and energy systems
	CEIC2001	Fluid and particle mechanics
	MATH2089	Numerical methods and statistics
Term 2	CEIC2002	Heat and mass transfer
	CEIC2005	Chemical reaction engineering
	CHEM2021	Organic chemistry: mechanisms and biomolecules
Term 3	CHEM2031	Inorganic chemistry: the elements
	DESN2000	Engineering design and professional practice
	CEIC3001	Advanced thermodynamics and separation
Year 3		
Term 1	MATH2018	Engineering mathematics 2D
	CHEM3021	Organic chemistry: modern synthesis strategies
	Gen Ed	General education elective
Term 2	POLY3000	Polymer science
	CEIC4000	Environment and sustainability
	Elective	Discipline elective
Term 3	ENGG4999	Industrial training
Year 4		
Term 1	CEIC4007	Product design project thesis A
	CEIC6711	Complex fluids microstructure and rheology
	Elective	Discipline elective
Term 2	CEIC4008	Product design project thesis B
	CEIC8204	Entrepreneurship and the innovation cycle
	Elective	Discipline elective
Term 3	Gen Ed	General education elective
	Elective	Discipline elective

Stream Learning Outcomes

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 product engineering.
2. Solve chemical product engineering problems in formulated materials by competent application of technical knowledge in synthetic chemistry, analytical chemistry, polymer chemistry, colloids, complex fluids, material and energy balances, thermodynamics, fluid

mechanics, particulate flow, chemical reaction engineering, transport phenomena, economic analysis, and safety analysis.

3. Demonstrate engineering design expertise to create socially aware chemical product concepts and prototypes for solutions, enabling technically and economically viable products that are sustainable, safe, appropriate, and standards-compliant.
4. Use systems thinking to guide engineering practice, including articulating financial and technical constraints on product design, analysing competitive intellectual property to identify opportunities in markets and technologies, providing a basis for formulated product scale-up and manufacturing, and liaising with process engineers to judge when optimal to develop manufacturing capability or use contract manufacturers.
5. Use appropriate resources, including research data, to analyse microstructured product performance characteristics, create quantifiable product benchmarks, develop sustainable, holistic approaches while dealing with uncertainty and solving complex product engineering problems with actual social and environmental contexts.
6. Effectively manage product, material, and equipment development projects, with multidisciplinary teams of scientists, engineers and marketers 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 product engineering, including describing project outputs, pitching product concepts to management, technologists, and marketing, effectively incorporating, and being responsive to, feedback.
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 product engineers.

Development of Stream Learning Outcomes

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.

Curriculum Mapping

The following data shows the mapping from:

- stream learning outcomes (SLOs) to Engineers Australia Stage 1 Competencies
- courses to SLOs
- courses to Engineers Australia Stage 1 Competencies (derived from the above two mappings)

The weightings displayed in the latter two mappings are derived from a cognitive scale that takes each assessment weighting and the assessment to CLO mapping for each course to derive an overall contribution to the course and stream.

The recommended first year elective of CEIC1000 Sustainable Product Engineering and Design is included in the mappings. A representative set of four 3rd/4th year discipline electives are also included; these courses were chosen as they represent a popular cross-section of the courses taken by recent cohorts: CEIC6712 Pharmaceutical Design and Engineering, CEIC6789 Data Driven Decision Making for Chemical Engineering and Food Science, CEIC8105 Advanced Polymer Science and Research, CHEN6703 Advanced Particle Systems Engineering.

Table 2: Mapping of the stream learning outcomes to the Engineers Australia Stage 1 Competencies

SLO → GC Mapping	Engineers Australia Stage 1 Competencies																
	1.1	1.2	1.3	1.4	1.5	1.6	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	3.5	3.6	
SLO1 Demonstrate knowledge ...	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SLO2 Solve chemical enginee...	-	-	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	-	-	-
SLO3 Demonstrate expertise ...	-	-	-	✓	-	-	✓	✓	✓	✓	-	-	-	-	-	-	-
SLO4 Use systems thinking t...	-	-	-	-	-	-	✓	✓	✓	✓	-	-	-	-	-	-	-
SLO5 Use appropriate resour...	-	-	-	-	-	-	-	-	✓	✓	-	✓	-	✓	-	-	-
SLO6 Effectively manage pro...	-	-	-	-	-	-	-	-	-	-	✓	-	-	✓	✓	✓	✓
SLO7 Communicate complex id...	-	-	-	-	-	-	-	-	-	-	-	✓	-	✓	-	✓	✓
SLO8 Conduct themselves pro...	-	-	-	-	-	✓	-	-	-	-	-	-	✓	-	✓	-	-

Table 3: mapping of courses to the stream learning outcomes

Courses (CO)	Stream Learning Outcomes (SLOs)							
	SLO1	SLO2	SLO3	SLO4	SLO5	SLO6	SLO7	SLO8
CEIC1000	12.5	20.2	9.2	0.0	16.0	13.0	16.0	13.0
CHEM1811	70.0	30.0	0.0	0.0	0.0	0.0	0.0	0.0
CHEM1821	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0
DESN1000	0.0	18.3	16.9	8.5	0.0	30.6	17.1	8.5
ENGG1811	91.2	8.8	0.0	0.0	0.0	0.0	0.0	0.0
MATH1131	89.2	0.0	0.0	0.0	0.0	10.8	0.0	0.0
MATH1231	89.2	0.0	0.0	0.0	0.0	0.0	10.8	0.0
PHYS1121	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CEIC2000	24.0	61.3	13.3	1.3	0.0	0.0	0.0	0.0
CEIC2001	0.0	37.5	37.5	0.0	25.0	0.0	0.0	0.0
CEIC2002	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0
CEIC2005	7.9	44.2	20.8	27.1	0.0	0.0	0.0	0.0
CHEM2021	26.2	30.7	13.1	0.0	0.0	0.0	0.0	0.0
CHEM2031	46.8	34.2	15.2	0.0	0.0	0.0	3.8	0.0
CHEM2041	25.5	51.0	0.0	0.0	0.0	0.0	8.5	0.0
DESN2000	0.0	5.0	17.7	12.7	7.7	27.0	20.0	10.0
MATH2018	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0
MATH2089	16.8	71.2	0.0	0.0	0.0	0.0	12.0	0.0
CEIC3001	0.0	37.5	25.0	12.5	25.0	0.0	0.0	0.0
CHEM3021	0.0	21.7	41.5	31.1	5.7	0.0	0.0	0.0
POLY3000	7.8	48.9	25.6	7.8	10.0	0.0	0.0	0.0
CEIC4000	0.0	0.0	10.8	5.3	16.1	0.0	35.8	31.9
CEIC4007	0.0	4.2	9.6	7.5	28.3	11.7	29.2	9.6
CEIC4008	0.0	0.0	9.8	4.8	32.0	17.7	25.9	9.8
CEIC6711	0.0	16.7	22.2	22.2	11.1	0.0	27.8	0.0
CEIC6712	0.0	0.0	35.0	25.0	35.0	0.0	5.0	0.0
CEIC6789	0.0	30.6	21.1	12.2	18.3	0.0	8.9	8.9
CHEN6703	0.0	16.7	37.1	20.4	25.8	0.0	0.0	0.0
CEIC8105	0.0	6.9	35.6	28.8	28.8	0.0	0.0	0.0
CEIC8204	0.0	8.1	5.6	44.3	15.8	0.0	0.0	10.0

Table 4: mapping of courses to Engineers Australia Stage 1 Competencies

Curriculum Mapping	Engineers Australia Stage 1 Competencies																
	1.1	1.2	1.3	1.4	1.5	1.6	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	3.5	3.6	
Courses (CO)																	
CEIC1000	6.2	6.2	4.0	5.9	4.0	8.4	5.9	1.9	5.8	5.8	3.2	9.3	4.3	12.6	7.6	8.6	
CHEM1811	35.0	35.0	6.0	6.0	6.0	6.0	6.0	-	-	-	-	-	-	-	-	-	
CHEM1821	25.0	25.0	10.0	10.0	10.0	10.0	10.0	-	-	-	-	-	-	-	-	-	
DESN1000	-	-	3.7	7.0	3.7	6.5	9.2	5.5	5.5	5.5	7.7	5.7	2.8	13.4	10.5	13.4	
ENGG1811	45.6	45.6	1.8	1.8	1.8	1.8	1.8	-	-	-	-	-	-	-	-	-	
MATH1131	44.6	44.6	-	-	-	-	-	-	-	-	2.7	-	-	2.7	2.7	2.7	
MATH1231	44.6	44.6	-	-	-	-	-	-	-	-	-	3.6	-	3.6	-	3.6	
PHYS1121	50.0	50.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CEIC2000	12.0	12.0	12.3	14.9	12.3	12.3	15.3	3.0	3.0	3.0	-	-	-	-	-	-	
CEIC2001	-	-	7.5	15.0	7.5	7.5	15.0	7.5	13.8	13.8	-	6.2	-	6.2	-	-	
CEIC2002	-	-	10.0	20.0	10.0	10.0	20.0	10.0	10.0	10.0	-	-	-	-	-	-	
CEIC2005	4.0	4.0	8.8	13.0	8.8	8.8	19.8	10.9	10.9	10.9	-	-	-	-	-	-	
CHEM2021	13.1	13.1	6.1	8.8	6.1	6.1	8.8	2.6	2.6	2.6	-	-	-	-	-	-	
CHEM2031	23.4	23.4	6.8	9.9	6.8	6.8	9.9	3.0	3.0	3.0	-	1.2	-	1.2	-	1.2	
CHEM2041	12.8	12.8	10.2	10.2	10.2	10.2	10.2	-	-	-	-	2.8	-	2.8	-	2.8	
DESN2000	-	-	1.0	4.5	1.0	4.3	7.7	6.7	8.6	8.6	6.8	8.6	3.3	15.3	10.1	13.4	
MATH2018	25.0	25.0	10.0	10.0	10.0	10.0	10.0	-	-	-	-	-	-	-	-	-	
MATH2089	8.4	8.4	14.2	14.2	14.2	14.2	14.2	-	-	-	-	4.0	-	4.0	-	4.0	
CEIC3001	-	-	7.5	12.5	7.5	7.5	15.6	8.1	14.4	14.4	-	6.2	-	6.2	-	-	
CHEM3021	-	-	4.3	12.6	4.3	4.3	20.4	16.1	17.5	17.5	-	1.4	-	1.4	-	-	
POLY3000	3.9	3.9	9.8	14.9	9.8	9.8	16.8	7.1	9.6	9.6	-	2.5	-	2.5	-	-	
CEIC4000	-	-	-	2.2	-	10.6	3.5	3.5	7.5	7.5	-	16.0	10.6	16.0	10.6	11.9	
CEIC4007	-	-	0.8	2.7	0.8	4.0	4.6	3.8	10.9	10.9	2.9	16.8	3.2	19.7	6.1	12.6	
CEIC4008	-	-	-	2.0	-	3.3	3.2	3.2	11.1	11.1	4.4	16.6	3.3	21.1	7.7	13.1	
CEIC6711	-	-	3.3	7.8	3.3	3.3	13.3	10.0	12.8	12.8	-	12.0	-	12.0	-	9.3	
CEIC6712	-	-	-	7.0	-	-	13.2	13.2	22.0	22.0	-	10.4	-	10.4	-	1.7	
CEIC6789	-	-	6.1	10.3	6.1	9.1	13.4	7.3	11.9	11.9	-	7.5	3.0	7.5	3.0	3.0	
CHEN6703	-	-	3.3	10.7	3.3	3.3	15.9	12.5	19.0	19.0	-	6.5	-	6.5	-	-	
CEIC8105	-	-	1.4	8.5	1.4	1.4	15.7	14.3	21.5	21.5	-	7.2	-	7.2	-	-	
CEIC8204	-	-	1.6	2.7	1.6	5.0	13.8	12.2	16.1	16.1	-	3.9	3.3	3.9	3.3	-	
Cognitive Scale	15.1	15.1	4.0	5.8	4.0	4.5	7.4	4.9	7.2	7.2	2.9	4.7	2.7	5.4	4.3	4.6	

Reflection on Strengths, Weaknesses, and Future Action

Reflection on curriculum strengths

The curriculum map shows a structured development of knowledge within the stream: foundational knowledge is developed in Year 1, engineering discipline knowledge is built in Year 2, applications of this knowledge in design developed through Years 2 and 3, culminating in advanced disciplinary learning and design in Year 4. This structure builds applications on top of separately assessed foundational learning to ensure that all graduates have sufficient discipline knowledge.

The curriculum map also demonstrates the close integration that we maintain between theory and practice. Our courses bring together engineering knowledge with applications to chemical engineering problems and design; this is expressed in the curriculum map by the inclusion of many PLOs within each course.

Reflection on curriculum weaknesses

The nature of undertaking the mapping via the Cognitive Scale based around Course Learning Outcomes is that competencies that are assessed but not explicitly listed in a CLO might appear to be missing from a course. It might be tempting to use the above heatmap to conclude that there was insufficient treatment of some competencies, while the reality is that simply writing an additional CLO for a selected 2nd and 3rd year course and mapping an assessment to that CLO would smooth out the heatmap further.

Reflection on 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.

Table 5: map of assessment types used within the stream.

CO → AT Mapping	Assessment Types (AT)												
	Courses (CO)	Assi	Essa	Exam	Lab	Othe	Perf	Port	Pres	Proj	Repo	Test	Tut
CEIC1000	-	-	-	-	-	-	15	-	-	55	-	15	-
CHEM1811	-	-	40	20	-	-	-	-	-	-	-	40	-
CHEM1821	-	-	40	20	-	-	-	-	-	-	-	40	-
DESN1000	-	5	-	-	20	-	15	15	-	-	45	-	-
ENGG1811	20	-	70	10	-	-	-	-	-	-	-	-	-
MATH1131	10	-	50	-	40	-	-	-	-	-	-	-	-
MATH1231	10	-	50	-	40	-	-	-	-	-	-	-	-
PHYS1121	-	-	50	20	30	-	-	-	-	-	-	-	-
CEIC2000	-	-	60	-	20	-	-	-	-	-	-	20	-
CEIC2001	-	-	100	-	-	-	-	-	-	-	-	-	-
CEIC2002	-	-	80	-	-	-	-	-	-	-	-	20	-
CEIC2005	20	-	50	-	-	-	-	-	20	-	-	10	-
CHEM2021	9	-	44	30	-	-	-	-	-	-	-	17	-
CHEM2031	9	-	61	30	-	-	-	-	-	-	-	-	-
CHEM2041	-	-	40	45	15	-	-	-	-	-	-	-	-
DESN2000	25	-	-	-	60	-	-	15	-	-	-	-	-
MATH2018	-	-	60	-	10	-	-	-	-	-	-	30	-
MATH2089	-	-	60	-	20	-	-	-	-	-	-	20	-
CEIC3001	-	-	25	-	-	-	-	-	-	-	50	25	-
CHEM3021	15	-	60	25	-	-	-	-	-	-	-	-	-
POLY3000	30	-	40	30	-	-	-	-	-	-	-	-	-
CEIC4000	60	-	-	-	40	-	-	-	-	-	-	-	-
CEIC4007	-	-	-	-	-	-	-	50	-	-	50	-	-
CEIC4008	-	-	-	-	-	-	-	60	-	-	40	-	-
CEIC6711	-	-	-	-	-	-	-	55	-	-	-	45	-
CEIC6712	-	-	-	-	30	-	-	30	-	-	-	40	-
CEIC6789	-	-	-	-	-	-	-	-	80	-	-	20	-
CHEN6703	35	-	-	-	45	-	-	20	-	-	-	-	-
CEIC8105	-	-	55	-	-	-	-	45	-	-	-	-	-
CEIC8204	65	-	-	-	-	-	-	-	35	-	-	-	-

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.

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.
- Worked solutions with detailed marking guides or marking rubrics are created for all 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.

As exams have moved online due to COVID-19, the following standard practices have been adopted as part of the exam setting and marking procedures:

- Fixed times for the start and end of the examination are maintained to prevent groups working in sequence.
- Long duration exams (for example 24 h exams) are discouraged as it makes it too easy for groups to work together; short duration examinations remain normal (2 h).
- Randomisation of questions is undertaken either using technologies like STACK (with random numbers included in the questions for each student) or by creating multiple variants of questions.
- Web searches are conducted before and after the exam is held, initially to see if there are sites that would give the answers to the students easily, and then after the exam to see if students have received assistance on “homework help” sites.
- The combination of question randomisation, question watermarking, and answer similarity checking permits many forms of exam misconduct to be trivially identified.

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.

Summary

The Chemical Product Engineering stream in the BE(Hons) has strengths in its staged development of discipline knowledge across the 4 years, and the integration of content learning with application of knowledge. Chemical product engineering as a profession is in a growth phase as the roles of the specialist formulator and product developer become better established in industry; the School will need to continue to track industry trends such as the greater emphasis on sustainability, circular economy, and digitalisation. Industry consultation the scope of product engineering within the stream is also feasible – the current focus on carbon-based materials via the organic and polymer chemistry courses could be broadened to permit inorganic materials or food materials, for instance. Revision of CLOs to more explicitly highlight the professional skills learning that is already within those courses will be undertaken. Changes to assessment types to ensure that both team work and individual competence are thoroughly captured by the assessment scheme are likely.