

FINAL ASSESSMENT REPORT

Evaluation of Undergraduate and Graduate Programs

Chemical Engineering

Faculty of Engineering

Cyclical Review Period: 2020-2021

Date: November 10, 2022

I. Evaluated Programs

- BAsC in Chemical Engineering
- BAsC in Chemical Engineering, Engineering Management and Entrepreneurship Option
- BAsC in Chemical Engineering and BSc in Computing Technology
- Honours BSc in Biochemistry and BAsC in Chemical Engineering (Biotechnology)

II. Evaluation Process (outline of the visit)

- This final assessment report on the above programs was prepared from the following documents: (a) the self-study report produced by the academic unit, (b) the report of the external evaluation following the virtual visit, and (c) the comments outlined in the action plan by the Dean of the Faculty of Engineering, Jacques Beauvais, and by Program Leadership, Xudong Cao and Arturo Macchi.
- The virtual visit took place on February 3-4, 2022, and was conducted by Christine Moresoli, University of Waterloo, and Michel Couturier, University of New Brunswick.
- Evaluators met with Aline Germain-Rutherford, Vice-Provost Academic affairs, Xudong Cao and Arturo Macchi, Program Leadership, various undergraduate office staff, a selection of 1st-4th course year professors, teaching assistants, 2-4th year students, administrative and technology support staff, and also with Jacques Beauvais, Dean, Faculty of Engineering, and Michel Labrosse, Vice-Dean of Undergraduate Studies, Faculty of Engineering.

III. Summary of Reports on the Quality of Programs

This section aims to inform the unit on the strengths and weaknesses observed during the evaluation process to improve its programs.

EMPHASIZING THE STRENGTHS AND IDENTIFYING CHALLENGES

STRENGTHS

- The program offers partial bilingual, English-French, course offerings.
- Students have the option to participate in a co-op program.
- There is a dual degree option available in Biochemistry and Chemical Engineering.
- The faculty members are highly motivated and engaged.
- The Chemical Engineering program has a primary laboratory equipped with state-of-the-art equipment, which is diligently maintained by a competent team of technical support staff.

CHALLENGES

- The rate of student retention and time to completion is relatively low, as indicated in the self-study brief (Self-study brief, Volume 1, Section 6.4, page 39), potentially due to the high workload.
- Advising for students in the dual degree program in Biochemistry and Chemical Engineering is not as effective as desired, leading to concerns raised by students when scheduling conflicts arise.
- Francophone students express their disappointment regarding the inability to complete their program entirely in French.

IV. Program Improvements

The programs under evaluation are in conformity with the standards of the discipline. The following recommendations aim at maintaining or increasing the level of quality already achieved by the programs.

Recommendation 1: Develop a fully bilingual Chemical Engineering program (University strategic plan: Strengthen our Francophone heritage and bilingual character).

Recommendation 2: Improve the retention rate and increase the percentage of students who can complete the Chemical Engineering program in four years (University strategic plan: Improve the ability of students to complete degree programs in a timely way).

Recommendation 3: Offer a capstone design experience which more closely resembles what students will encounter in the workplace after graduation (University strategic plan: Strengthen and expand experiential learning for every student & Connect with local, national and global partners for research and knowledge mobilization).

Recommendation 4: Offer guidance for the preparation of effective technical oral presentations (University strategic plan: Optimize our program offerings and training opportunities to make them more attractive and responsive to the needs of tomorrow's generation of students).

Recommendation 5: Review the programming/coding languages taught in the Chemical Engineering program (University Strategic plan: Optimize our program offerings and training opportunities to make them more attractive and responsive to the needs of tomorrow's generation of students).

Recommendation 6: Improve the support provided to the students in the dual degree Biochemistry/Chemical Engineering programs when they have conflicts between the two programs.

V. Action Plan

The six recommendations made by the external evaluators have been considered in the action plan. For each action, the level of priority has been clearly indicated, in line with the recommendations made, a list of actions to be undertaken has been drawn up, a person responsible for each action has been designated and a timetable has been set.

VI. Conclusion

The Chemical Engineering program at the University of Ottawa offers a comprehensive range of fundamental and specialized courses, preparing graduates for diverse employment opportunities. The program is delivered by dedicated and skilled faculty members, with well-maintained equipment in the main laboratory. Unique aspects of the program include its partial bilingual course offerings, co-op option, and dual degree programs in Biochemistry/Chemical Engineering. Areas for improvement include enhancing student retention, fostering external partnerships, providing guidance for technical oral presentations, and reviewing programming languages taught. Feedback from students highlighted the need for improved support for those in the dual degree programs and expressed disappointment among native Francophone students regarding the program's lack of complete bilingualism.

Given this favourable evaluation, the committee members would like to thank all participants for their contributions to the program evaluation. They commend the unit on the rigour of the work completed as well as the quality of the self-study report and the report produced by the external reviewers.

Schedule and Timelines

A progress report that outlines the completed actions and subsequent results will be submitted to the evaluation committee by December 15, 2024.

The next cyclical review will take place in no more than eight years, in 2027-2028. The self-study brief must be submitted no later than June 15, 2027.

Unit Response and Action Plan

Faculty:

- Faculty of Engineering

Programs evaluated:

- BAsC in Chemical Engineering
- BAsC in Chemical Engineering and BSc in Computing Technology
- BAsC in Chemical Engineering, Engineering Management and Entrepreneurship Option
- Honours BSc in Biochemistry / BAsC in Chemical Engineering (Biotechnology)

Cyclical review period:

- 2020-2021

Date:

- January 26, 2024 (final version)

General comments:

On 22 March 2022, the Chemical Engineering program was made aware of the External Review Report produced in the context of the cyclical program evaluation. We were pleased with the positive evaluation of our undergraduate program. Given that the Chemical Engineering undergraduate program has committed to providing an outstanding training and research experience, we were gratified to see that the external reviewers found that our BAsC programs were “delivered by competent, motivated, and dedicated faculty members, and the equipment in the main laboratory is maintained by an experienced team of technical support staff” and that “students were generally satisfied with their program”. No major issues with the program, the learning objectives, courses or management of the programs were identified. The report makes six recommendations, of which three are considered high priority (urgent). We take all the recommendations seriously and feel confident that by addressing them, our undergraduate program will be even stronger. The recommendations and our response, produced jointly by the unit and the Faculty, are included below.

Recommendation 1: Develop a fully bilingual Chemical Engineering program (University strategic plan: Strengthen our Francophone heritage and bilingual character). Identified degree of priority: important.

Unit response: A greater number of faculty members is required to develop a fully bilingual Chemical Engineering program at uOttawa. In the short- and medium-term, active recruitment of faculty members who can deliver courses in both French and English is being implemented. In the long-term, a Faculty level plan including both personnel and required resources needs to be in place in order to develop a fully bilingual Chemical Engineering program.

Decanal response: The action proposed by the Chair corresponds well to the internal procedure for applying for new faculty positions.

Priority Level*	Actions to be undertaken	Assigned to	Timeline	Curriculum change?
2	The Chair will build a case to request new positions, using arguments provided by the external evaluation report, to be submitted to the Dean.	Department Chair	F2022 (on-going)	No
2	The Chair has initiated a program to translate teaching material to French for all compulsory CHG courses.	Department Chair	S2024	No

* PRIORITY LEVEL: 1. URGENT-IMMEDIATE ACTION REQUIRED 2. IMPORTANT-ACTION REQUIRED WITHIN 18 MONTHS (MAXIMUM) 3. ADVISED: DEVELOPMENT AND STRATEGY-ACTION TO BE DISCUSSED AND MUST BE IN PLACE BY MID-CYCLE (WITHIN 4 YEARS)

Recommendation 2: Improve the retention rate and increase the percentage of students who can complete the Chemical Engineering program in four years (University strategic plan: Improve ability of students to complete degree programs in a timely way). Identified degree of priority: urgent.

Unit response: The Department of Chemical and Biological Engineering and the Faculty of Engineering have been examining the retention rate challenge for many years. The problem occurs in all engineering disciplines and is not specific to the University of Ottawa. The American Society for Engineering Education (ASEE) found that between 40% to 50% of engineering students drop out or change their majors¹. ASEE attributes the high drop out rate to three main factors: poor advising and teaching, innate difficulty of engineering curriculum, and feeling that one does not “belong” in engineering.

The Faculty of Engineering has taken many initiatives to remedy the low retention rate: <https://www2.uottawa.ca/faculty-engineering/student-experience>

- a. A strong outreach program where teenagers experience the diversity of careers available in STEM. This program helps students’ motivation and orient students in their career choice.
- b. The retention program, in collaboration with the Office of the Registrar, where a questionnaire is submitted to all new incoming students at the Faculty of Engineering, and statistically processed to determine socioeconomic, academic and/or other factors that may put these students at risk of academic failure. The initial data are completed with the academic performance in the first assessments in the first year courses, such that, by the end of October, the students (whether Canadian or International) who are at the highest risk of failure are invited for a mandatory meeting with an academic advisor at the Undergraduate Studies Office to ensure that they know about the support services available to them, and to put together an action plan to improve their performance. Developed, implemented and ramped up in the last four years, the retention plan has brought significant improvements in retention after the first year.
- c. The creation in 2016 of a Student Experience Officer position who overviews, amongst other, a mentorship program (The Workshop) with over a dozen student-mentors to help undergraduate students in their academic success.
- d. The creation of the Centre for Entrepreneurship and Engineering Design (CEED), which has the goal to develop the entrepreneurial and engineering design skills of our students.

With respect to the percentage of students who complete the Chemical Engineering program in four years, the data needs to be further analyzed to determine the reasons for this apparent problem. Some known reasons for late graduation include:

- a. STEM courses are challenging. While that statement is obvious, it also means that students are likely to drop a class and must eventually retake it. Otherwise, they stand the chance of negatively affecting several grades by the amount of time that class requires.
 - b. There are many prerequisite courses. Unfortunately, students may have to wait a semester or a year for that missing prerequisite course. If a prerequisite course is dropped, this can cascade into a whole semester or year delay on graduation. Nevertheless, the Department of Chemical and Biological Engineering very often accommodates students to take a course by granting a waiver for those who have taken but failed the prerequisite course.
 - c. Some students elect to work part-time during their entire program and register to fewer courses per year, which inevitably delays the timely graduation.
 - d. Based on an informal survey with many students, the level of distraction is constantly increasing, which removes a portion of student attention away from their studies. Some of these distractions are the instant and omnipresent access to the internet and student texting, which require high-level discipline to abstain from.
1. <https://www.allaboutcircuits.com/news/what-prevents-many-ee-students-from-making-it-to-professional-careers/>

Considering above, the Department Curriculum Committee continuously reviews its program for curriculum improvement and will take actions to reduce imbalances in workload, specifically in the number and timing of assessments. The entire program was already re-arranged with workload in mind for students entering in Fall 2019; impact via analysis of CEAB graduate attributes and student program exit surveys are forthcoming.

Decanal response: I agree with the actions proposed by the unit. In addition, the Undergraduate Office monitors student academic performance and takes steps to meet and advise those who are in difficulty. Also, as described below, the CHG Department has developed a pilot program in the faculty in the form of an academic advisement program (CHG Advisory Hub) where students are met at regular intervals by professors, which is a key step often requested by students according to our surveys. This is an important step and should have a strong impact on retention.

Priority Level*	Actions to be undertaken	Assigned to	Timeline	Curriculum change?
1	<p>Reduce and better distribute student workload</p> <ul style="list-style-type: none"> - Keeping CEAB graduate attribute assessment in mind, encourage teaching staff to reduce quantity of summative evaluations. Extra assessments can be formative if need be. Recommendations to be voiced during Department Council meetings. - Log major summative assessments in CHG courses for better workload coordination. Calendar is available at MSTeams/CHG Department/General/Student Workload. - Ask students to voice time conflicts of major assessments from out-of-faculty courses. This will be done within the information session to newly admitted students and every semester via the CHG Advisory Hub on MSTeams. 	Associate Chair – Undergraduate Studies; Department Curriculum Committee.	S2022 (ongoing)	Not anticipated for now as we evaluate impact of CHG curriculum re-arrangement in 2019.
1	Investigate how to offer students failing first year CHG courses (CHG1125/1525 and CHG1371/1771) an opportunity to pass the course without having to wait a full year and avoid de-stabilizing the course sequence and increasing workload in second year.	Associate Chair – Undergraduate Studies; Department Curriculum Committee.	F2022 (on-going)	No
1	Lower passing grade from D+ (55%) to a D (50%) for 2000-level and higher undergraduate engineering courses, while keeping required CGPA for graduation at 5.0 (C+).	Vice-Dean, Student affairs	S2022	No

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Recommendation 3: Offer a capstone design experience which more closely resembles what students will encounter in the workplace after graduation (University strategic plan: Strengthen and expand experiential learning for every student & Connect with local, national and global partners for research and knowledge mobilization). Identified degree of priority: important.

Unit response: The current version of the capstone design course is the culmination of the undergraduate student experience where students produce an engineering design project (e.g., process design and economic evaluation of a complete industrial plant) that resembles most of the work an engineer performs in an engineering consulting firm for an entirely new project. In some universities, students perform their capstone projects in collaboration with external stakeholders. However, it is challenging to assure that all these projects offer scopes with the desired degree of comprehensiveness.

Given the high degree of satisfaction of our student cohorts and their performance in Canadian engineering design competitions, the curriculum committee feels that the current structure of the plant design capstone course, although still improvable as per actions proposed below, provides an excellent training environment to our students.

Decanal response I agree with the actions identified by the unit.

Priority Level*	Actions to be undertaken	Assigned to	Timeline	Curriculum change?
2	Over the last few years, some design projects have expanded to “outside of the classroom” via the design of a micro-brewery and micro-distillery. These projects have garnered collaboration and financing from both small and large companies, and thus we anticipate more in-depth comprehensive design projects to be industry-based as this initiative evolves to construction, commissioning, and operation for ultimately an experiential learning environment.	Professor(s) of CHG4250 Plant Design Project.	W2023	No
2	We will form a review panel of PEng from local government and private institutions to provide recommendations at the design project mid-point and final presentation. As these panelists become familiar with the CHG4250 course and its objectives and procedures, then external projects from their (and their peers via networking) institutions can occur.	Professor(s) of CHG4250 Plant Design Project.	W2024	No

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Recommendation 4: Offer guidance for the preparation of effective technical oral presentations (University strategic plan: Optimize our program offerings and training opportunities to make them more attractive and responsive to the needs of tomorrow’s generation of students). Identified degree of priority: urgent.

Unit response: It is believed that our students effectively orally communicate. In many CHG courses (2312/2712, 2317/2717, 3112, 3122, 3127, 4116, 4250, 4307, 4381, 4900), clear instructions are given to the structure of oral communication via class presentations or team meetings with the teaching assistants to update design project progress. The inability to effectively communicate orally has also not been observed in the review of CEAB graduate attribute 7 - Communication skills. Nevertheless, the Department will continue on-going efforts in preparing students for scientific communications and, if possible, offer additional opportunities for oral presentations in the curriculum.

Decanal response I agree with the action identified by the unit.

Priority Level*	Actions to be undertaken	Assigned to	Timeline	Curriculum change?
1	Ask instructors to continue improving oral communication guidelines as well as assessment rubrics for feedback. Assess if additional oral presentations need to be performed in other courses.	Associate Chair – Undergraduate Studies; Department Curriculum Committee.	S2022 (on-going)	None

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Recommendation 5: Review the programming/coding languages taught in the Chemical Engineering program (University Strategic plan: Optimize our program offerings and training opportunities to make them more attractive and responsive to the needs of tomorrow’s generation of students). Identified degree of priority: important.

Unit response: Currently, chemical engineering students develop expertise in two programming languages: VBA (to support spreadsheet development) and Java (to provide exposure to a modern, object-oriented language).

Given the ubiquitous application of spreadsheets in engineering computation within industry, our students leave the program well prepared to provide advanced spreadsheet computational work through their training in VBA. Meanwhile, Java remains one of the most popular languages in current use and lies very close to Python in this regard according to recent articles in Techspot (October 10, 2021) and RedMonk (March 28, 2022). Further, since both languages are object-oriented and because Python is arguably somewhat simpler syntactically, it can reasonably be expected that students will find no difficulty migrating from Java to Python, should the need arise. Key instead is that students are well grounded in object-oriented programming principles, which Java provides.

Finally, it is noted that within the Computer Science curriculum, students begin their programming studies in Python (IT11120) but then migrate to Java in the follow-up course (IT11121); in other words, both Python and Java are viewed as valuable object-oriented languages in that program.

Decanal response I agree with the action proposed by the unit.

Priority Level*	Actions to be undertaken	Assigned to	Timeline	Curriculum change?
2	Monitor industry preferences in Python versus Java and consider a transition from Java to Python, should the latter strongly dominate the industry as an object-oriented programming language.	Associate Chair – Undergraduate Studies; Department Curriculum Committee.	S2022 (on-going)	None

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Recommendation 6: Improve the support provided to the students in the dual degree Biochemistry/Chemical Engineering programs when they have conflicts between the two programs. Identified degree of priority: urgent.

Unit response: We asked both the students (those interviewed during the IQAP visit and others) and Faculty of Engineering administration about this challenge. The Biotechnology program is administered by the Faculty of Science, and they are the primary service providers towards the requirements of the BSc in Biochemistry whereas the Faculty of Engineering provides services (and ensure compliances) for the BASc in Chemical Engineering. There is thus naturally some back and forth pending the problem and where a student first visits. This balancing of responsibilities was heightened because of major CHG curriculum changes in 2019; student progress through the program will now be less impacted from evolving course sequencing.

Nonetheless, better communication to entering students of the roles and responsibilities of each Faculty will be done as well as internally identifying a contact person from each Faculty to help with the relay of information between both faculties.

Decanal response I agree with the actions proposed by the unit.

Priority Level*	Actions to be undertaken	Assigned to	Timeline	Curriculum change?
1	Communicate to entering Biotechnology students the roles and responsibilities of each Faculty. This will be done within the information session to newly admitted students and every semester via the CHG Advisory Hub on MSTeams.	Associate Chair – Undergraduate Studies	S2022 (on-going)	None
1	Internally identify a contact person from each Faculty to help with the relay of information between both Faculties. (Chantale Morasse, Manager, office of undergraduate programs)	Vice-Dean, Student affairs	S2022 (done)	None

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