Chemical and Biochemical Engineering

Final Assessment Report & Implementation Plan
June 2023

Faculty / Affiliated University College	Engineering	
Degrees Offered	MEng, MESc and PhD	
Date of Last Review	2013-2014	
Approved Fields	Biomaterials & Biochemical Engineering Environmental & Green Engineering Macromolecular & Materials Engineering Particle Technology and Fluidization Reaction & Process Systems Engineering Water and Energy Food Processing Process Control and Safety	MEng, MESc, PhD MEng, MESc, PhD MESc, PhD MEng, MESc, PhD MEng, MESc, PhD MESc, PhD MEng Meng
External Reviewers	Dr. Nasser M Abukhdeir, Chemical Engineering University of Waterloo	Dr. João B. P. Soares, Chemical & Materials Engineering University of Alberta
Internal Reviewers	Dr. Tom Drysdale Associate Dean Schulich School of Medicine and Dentistry	Natasha Knier Ph.D. Candidate, Medical Biophysics
Date of Site Visit	November 9 & 10, 2022	
Date Review Report Received	March 5, 2023	
Date Program/Faculty Response Received	Program – May 14, 2023 Faculty – May 18, 2023	
Evaluation	Good Quality	
Approval Dates	SUPR-G: June 26, 2023 ACA: September 6, 2023 Senate (for information): September 15, 2023	
Year of Next Review	Year of next cyclical review: 2029-2030	
Progress Report	June 2026	

Overview of Western's Cyclical Review Assessment Reporting Process

In accordance with Western's Institutional Quality Assurance Process (IQAP), the Final Assessment Report (FAR) provides a summary of the cyclical review, internal responses, and assessment and evaluation of the Chemical and Biochemical Engineering Program delivered by the Faculty of Engineering.

This FAR considers the following documents:
- the program's self-study brief;
- the external reviewers' report;
- the response from the Program; and
- the response from the Dean, Faculty of Engineering.

This FAR identifies the strengths of the program and opportunities for program enhancement and improvement, and details the recommendations of the external reviewers – noting those recommendations to be prioritized for implementation.

The Implementation Plan details the recommendations from the FAR that have been selected for implementation, identifies who is responsible for approving and acting on the recommendations, specifies any action or follow-up that is required, and defines the timeline for completion.

The FAR (including Implementation Plan) is sent for approval through the Senate Graduate Program Review Committee (SUPR-G) and ACA, then for information to Senate and to the Ontario Universities' Council on Quality Assurance. Subsequently, it is publicly accessible on Western's IQAP website. The FAR is the only document from the graduate cyclical review process that is made public; all other documents are confidential to the Faculty of Engineering, the School of Graduate & Postdoctoral Studies (SGPS), and SUPR-G.

Executive Summary

Receiving approval in 2008 for the current version of graduate programming, Chemical & Biochemical Engineering offers programs that lead to the following degrees 1) Course-based Master of Engineering (M.Eng.); 2) Course and Project-based Master of Engineering (M.Eng.); 3) Thesis-based Master of Engineering Science (M.E.Sc.); and 4) Doctor of philosophy (Ph.D.).

The M.Eng. is structured to assist qualified engineers in the advancement of their professional careers and to provide students with the skills necessary to address key technological challenges. In 2019-2020, total enrolment was at 64 students. The goal of the CBE research-based graduate degree programs is to train M.E.Sc. and Ph.D. students for independent research in today's changing technological world in either industry or academia. In 2019-2020, total enrolment in the M.E.Sc. was at 39, with 70 students in the Ph.D. program.

To inform the self-study, an online survey of current graduate students was conducted and completed by 61 students. Additionally, a survey of faculty members was conducted regarding the graduate program with a particular focus on issues raised during the previous self-study.

The external reviewers shared a positive assessment of the Graduate Programs in Chemical & Biochemical Engineering. They offer seven recommendations for further enhancement.

Strengths and Innovative Features Identified by the Program

- Fields added to the MEng program to meet evolving market needs are:
    - Food Processing in collaboration with Food and Nutrition Department at the Brescia University College.
    - Process Control and Safety has been introduced following a need to bolster this expertise, as indicated by industrial partners.
- Faculty members and graduate students in the department are currently involved in an initiative led by Minerva Canada, Exxon Mobile and the National Safety Council to develop professional development programs focusing on process safety.
- The MEng program has seen strong growth over the past six years and is expected to reach a steady level in the coming years.
- The Soochow-Western 2+2 joint PhD program provides students with interdisciplinary expertise to undertake a graduate project incorporating synchrotron radiation.
- WesternWater Centre concentrates on research leading to innovative solutions addressing all aspects related to clean water supply and water-environment

issues including the protection and management of water resources, resource recovery, and treatment technologies.
- The CBE graduate seminar series is a weekly seminar taking place during the fall and winter terms, in which different speakers are featured weekly.

Concerns and Areas of Improvement Identified and Discussed by the Program

- Budget constraints that affect teaching assistantships.
- Encourage collaboration among faculty members through team-building exercises and retreats to continue enhancing the climate within the department.
- The program faces the same recruitment challenges as many similar programs:
    - Increased competition from other universities in Canada
    - Lack of scholarship opportunities for international students
    - Increased cost in supporting research graduate students (tuition and living expenses)
- The most frequent area of concern identified in the student survey was that program information on the website was often outdated or very difficult to find.

Review Process

As part of the external review, the review committee, comprising two external reviewers, one internal reviewer and a graduate student reviewer, were provided with Volume I and II of the self-study brief in advance of the scheduled review and then met virtually (due to pandemic restrictions) over two days with the:

- Associate Vice-Provost of the School of Graduate & Postdoctoral Studies
- Associate Vice-Provost, Academic Planning, Policy and Faculty Relations
- Director, Academic Quality & Enhancement
- Associate Dean, Graduate and Postdoctoral Studies
- Department Chair
- Graduate Program Chair
- M.Eng. Program Director
- Graduate and M.Eng. Committee Members
- Associate University Librarian
- Graduate Program and Department Staff
- Program Faculty Members
- Graduate Students

Following the virtual site visit, the external reviewers submitted a comprehensive report of their findings which was sent to the Program and Dean for review and response. Formative documents, including Volumes I and II of the Self-Study, the External Report, and the Program and Decanal responses form the basis of this Final Assessment

Report (FAR) of the Chemical and Biochemical Engineering Program. The FAR is collated and submitted to SUPR-G by the Internal Reviewer with the support of the Office of Academic Quality and Enhancement.

Summative Assessment – External Reviewers' Report

External reviewers shared that "*Overall, the graduate program was found to be of high quality and organized in a way to equitably accommodate the significant breadth of research occurring in a chemical and biochemical engineering department*."

Strengths of the Program

- With a breadth and "critical mass" of expertise across research areas, the department's research environment is conducive to the advancement and dissemination of knowledge.
- Allocation of two associate chair positions for the graduate program is both unique and a significant commitment; this enhances students' access to a dedicated advisor.
- Outstanding aspects of the MEng include:
    - specializations are exactly in line with faculty member expertise;
    - students are provided with clear and coherent curriculum options;
    - cross-disciplinary strengths at Western can be seen in the Engineering in Medicine specialization; and
    - low withdrawal rate and excellent time-to-completion.
- The project option in the coursework-based Master's program is unique and innovative in enhancing students' interaction with faculty members and providing opportunity for students to apply knowledge to practical or research problems.
- Transitional undergraduate-level courses in the MESc program support students with non-CBE and non-engineering backgrounds.
- The plan to carefully monitor the research performance of PhD students exceeding 12 terms of study is a positive indicator for improved graduation outcomes.
- Graduate students appear to be publishing good quality work in high quantities.

Areas of Concern or Prospective Improvement

- All degree programs could benefit from changes to degree requirements with clear course requirements for foundational concepts in chemical and biochemical areas.
- Curriculum related to research/scholarship and professional capacity/autonomy could be strengthened through the addition of courses focused on research methods, research ethics, professional engineering, and engineering ethics.

- Coursework requirements for the course-based MEng program are higher than many other competing MEng programs which can impose a significant load on students during their first term, which can be the most difficult one, especially for international students.
- Consider prescribing a representative set of foundational (Group A) courses that must be taken to prepare students for professional practice in CBE-related industries; these traditionally include engineering thermodynamics, transport phenomena, and chemical (or biochemical) reactor engineering.
- Consider allocating two staff members to the graduate program, given its size, or cross-train two staff members in the department so that secondments and leaves do not negatively affect faculty and students.
- The development and implementation of a space policy would ensure the adequate provision of lab space for all new faculty.
- The current practice of reducing graduate student stipends from those who voluntarily complete teaching assistantships is highly unusual.

Summary of the Reviewers' Recommendations and Program/Faculty Responses

The following are the reviewers' recommendations in the order listed by the external reviewers. Recommendations requiring implementation have been marked with an asterisk (*).

Reviewers' Recommendation	Program/Faculty Response
Recommendation #1* Clarify course requirements, the fundamental course list (group A) should be reduced to the three foundational areas of chemical engineering: engineering thermodynamics, transport phenomena, and chemical reaction engineering.	**Program:** Information on the website will be revised to clearly communicate course requirements. The program aims to provide a balance of fundamental and specialized courses. The courses listed in the 'fundamental' group are frequently reviewed in order to reflect the department's core research areas. Flexibility in the course selection is necessary for research-based students; too many constraints will not do justice to the diverse student body and research areas. Course selection is done in consultation with the students' advisors and advisory committee and requires Graduate Chair approval. The current process ensures broad and rigorous training and the department prefers not to add additional constraints. However, the graduate committee will review the course groups and clarify the requirements. **Faculty:** The Dean's Office supports program's proposed plan.
Recommendation #2 Consider offering courses focused on research methods and ethics (for MESc and PhD students) and professional engineering/ethics (for MEng students).	**Program:** Though no formal stand-alone course currently exists in the present repertoire, the program believes that these areas are sufficiently covered in a variety of existing courses, for instance: • CBE 9100 Advanced Engineering Communications covers grant and proposal writing. • CBE 9190B Statistical Process Analysis covers research methods and experimental design. • CBE 9180A Instrumental Methods of Analysis covers the practical implementation. Through the John M. Thompson Centre for Engineering Leadership and Innovation, three optional non-credit professional courses are offered to research students: • PhD/MESc students can take ENGSCI 9701 Business Acumen, ENGSCI 9701 Technology Commercialization for Research Students and ENGSCI 9703 Project Management. • MEng students are offered seven professional courses and students have to complete two professional courses as part of the program requirement. The Faculty has also developed an online non-credit course titled *Fundamentals of Communication* that has four modules - Ethical Communication, Effective Technical Writing, Communicating Orally and Professional Conversations – that is open to all graduate students in Engineering. In addition, the School of Graduate and Postdoctoral Studies offers a series of online, graduate-level qualitative research methods modules and professional development workshops. The program will improve communication with current students to make them aware of these additional learning resources.

	Faculty: As mentioned in the program's response, graduate students have access to a range of courses (for credit or non-credit) offered through the department, the faculty and the SGPS to develop competencies in research methods, communication, professionalism and ethics.
Recommendation #3 Past postdoctoral fellowships completed compared to MESc/PhD graduates is close to a 5:1 ratio of graduate student to postdoctoral fellows. Given the relatively high costs of postdocs versus graduate students, combined with the currently low graduate student numbers, promote graduate student supervision using merit, cost recovery, and other means.	**Program:** The ratio of active post-docs to graduate students cited by the program reviewers, 5:1, is not reflective of the program. In this discipline, the duration of a post-doctoral position is typically rather short (compared to +4 years residency of a PhD student), and varies on a case-by-case basis, as frequently PhD students will take on a post-doctoral role for a few months while securing external employment. The current ratio of active graduate students to postdoctoral scholars is 12:1. **Faculty:** The Dean's Office agrees with the program's response that a simple headcount in each category may not accurately reflect the steady graduate students to postdoc ratio. Regarding the increase in graduate enrollment, the Dean's Office supports Engineering Departments, in graduate recruitment initiatives and efforts. In particular, to increase PhD and MEng enrollments.
Recommendation #4* Coursework requirements for the course-based MEng program should be reduced to 8 courses to be competitive with other MEng programs in Canada.	**Program:** The program recognizes that the course load,10 half courses or 8 half courses and a project, is higher than the course loads of other universities. Reduction in the number of courses would have to be carefully reviewed against the overall learning outcomes of the MEng program. The Graduate Chair will consult with the Associate Dean (Graduate) in the Faculty to further assess the pros and cons of this recommendation. **Faculty:** The Dean's Office agrees with the program's response.
Recommendation #5* Reconsider the inclusion of CHE 9100 in the required set of courses for the MESc program.	**Program:** CHE 9100 is open to MESc students but is not mandatory; as the program would like to keep flexibility in the curriculum. Students and their advisors will decide whether this course would be beneficial to them. **Faculty:** The Dean's Office agrees with the program's response.

Recommendation #6* The departmental practice of reducing stipend amounts proportional to teaching assistantship earnings should be discontinued OR clearly communicated in offer letters to potential graduate students.	**Program:** Graduate funding is being addressed given the current increases to the cost of living. Western has recently increased the minimum funding levels for doctoral students to tuition + $17,000. In addition, the Faculty has increased: 1) minimum funding to tuition + $18,000 for doctoral students who have successfully completed the comprehensive exam; and 2) minimum funding for MESc students to tuition + $14,200. The perceived reduction is an unfortunate misunderstanding by some graduate students. It is clearly mentioned in the admission offer letters that the graduate funding package may include graduate teaching assistantship (GTA). The Faculty of Engineering has partially decoupled the GTA stipend from the guaranteed funding package where no more than 50% of the GTA stipend could be counted towards the guaranteed graduate funding package for PhD students and no more than 73% of the GTA stipend for MESc students. This policy shows that the Faculty values Teaching Assistantships as part of student learning. The actual funding received by students including the breakdown of funding resources is communicated through the Mercury funding portal. The program plans to further improve communication with students regarding the funding package and accessing the relevant information. **Faculty:** As mentioned in the Program's response, the funding sources are communicated to students in the offer letters and through the Mercury portal. The Dean's Office agrees that improved communication on funding matters is important. The Faculty is progressing towards de-coupling GTA stipend from the guaranteed graduate funding and will continue as financial constraints permit.
Recommendation #7 The department should consider allocating/cross-training two staff members to the graduate program to negate the impact of secondments/leaves.	**Program:** The department's administrative staff consists of an Admin Officer, an Undergraduate Coordinator and a Graduate Coordinator. There has been considerable turnover with the Graduate Coordinator role over the past 6 years which has led to cross-training of the UG-coordinator and Admin Officer who can support the graduate program during leaves or vacation of the Graduate Coordinator. With current enrolment numbers, the graduate program in CBE is suitably staffed and will not need additional human resources. The topic will be discussed with the Faculty should the average annual enrolment during a three-year period increase by more than 30% over the average annual enrolment of last three years. **Faculty:** The program is currently appropriately resourced with staff to support the graduate program. Should there be a need for additional staff support in future due to the expansion of the graduate program in CBE, the Faculty Graduate Office would take over some admissions related activities to balance the workload of the CBE Graduate Coordinator.

Implementation Plan

The Implementation Plan provides a summary of the recommendations that require action and/or follow-up. In each case, the Graduate Program Chair, in consultation with the SGPS and the Dean of the Faculty is responsible for enacting and monitoring the actions noted in Implementation Plan.

The number of recommendations prioritized for implementation has been reduced as some are already being actioned (#2, #3 & #7), as described in the program and faculty responses above. As a result, the recommendations appearing in the implementation table are #1, #4, #5 & #6.

Recommendation	Proposed Action and Follow-up	Responsibility	Timeline
Recommendation #1: Clarify course requirements, the fundamental course list (group A) should be reduced to the three foundational areas of chemical engineering: engineering thermodynamics, transport phenomena, and chemical reaction engineering	• Revise Information on the website to clarify course requirements. • Review the course requirements to ensure common fundamental knowledge for graduates while maintaining some flexibility in course selection.	Graduate Chair Graduate Committee	By December 2023
Recommendation #4: Coursework requirements for the course-based MEng program should be reduced to 8 courses to be competitive with other MEng programs in Canada.	Assess the implications of reduced coursework for MEng students and the impact on the learning outcomes of the MEng program.	Graduate Chair Associate Dean (Graduate)	By September 2024
Recommendation #5: Reconsider the inclusion of CHE 9100 in the required set of courses for the MESc program.	Ensure that decisions regarding the benefits of enrolling in this course are made by the students' advisory committee using a dedicated set of criteria.	Graduate Chair	By September 2024
Recommendation #6: Clearly communicate funding packages in offer letters to potential graduate students.	Improve communication with students regarding the breakdown of the funding package and how to access this information through the Mercury funding portal.	Graduate Chair Associate Dean (Graduate)	By January 2024