Mechanical and Materials Engineering

Final Assessment Report &
Implementation Plan
February 2022

Faculty / Affiliated University College	Engineering	
Degrees Offered	MEng, MESc and PhD	
Date of Last Review	2012-2013	
Approved Fields	Automation Technologies and Systems Materials and Solid Mechanics Mechanical Engineering Thermofluids Micro and Nano Systems Biomechanics Composite Materials Heating, Ventilation and Air Conditioning (HVAC)	MEng, MESc, PhD MEng, MESc, PhD MEng, MESc, PhD MEng, MESc, PhD MESc, PhD MESc, PhD MEng MEng
External Reviewers	Dr. Cecile Devaud, Professor, Department of Mechanical and Mechatronics Engineering, University of Waterloo	Dr. Morris Flynn, Professor, Dept. of Mechanical Engineering University of Alberta
Internal Reviewers	Dr. Jisuo Jin Professor, Associate Dean, Graduate & Postdoctoral Studies, Faculty of Science	Jason Tzu Chieh Kai, Graduate Student Medical Biophysics
Date of Site Visit	November 2 & 3, 2021	
Date Review Report Received	November 22, 2021	
Date Program/Faculty Response Received	Program: December 15, 2021 Dean: December 17, 2021	
Evaluation	**Good Quality**	
Approval Dates	SUPR-G: February 28, 2022 SCAPA: March 9, 2022 Senate (for information only): March 18, 2022	
Year of Next Review	Year of next cyclical review 2028-2029	

Overview of Western's Cyclical Review Assessment Reporting Process

In accordance with Western's Institutional Quality Assurance Process (IQAP), adopted on May 11, 2011, and revised June 22, 2012, this Final Assessment Report provides a summary of the cyclical review, internal responses, and assessment and evaluation of the Mechanical and Materials Engineering Graduate program delivered by the Faculty of Engineering

This Final Assessment Report (FAR) report considers the following documents:

- the program's self-study,
- the external consultants' report,
- the response from the Mechanical and Materials Engineering Graduate Program Chair, and
- the response from the Dean's Office, 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 consultants, noting those recommendations that require attention.

The Implementation Plan details the recommendations from the Final Assessment Report 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 Final Assessment Report and Implementation Plan is sent for approval through SUPR-G and SCAPA, then for information to Senate and to the Ontario Universities' Council on Quality Assurance. It is publicly accessible on Western's IQAP website.

The FAR, including the Implementation Plan, is the only document from the Graduate cyclical review process that is made public; all other documents are confidential to Western's Faculty of Engineering, the Mechanical and Materials Engineering graduate program, the School of Graduate & Postdoctoral Studies, and SUPR-G.

Executive Summary

The graduate programs offered in the Department of Mechanical and Materials Engineering (MME) have two themes with distinct objectives: (i) a Professional theme that leads to the MEng degree, and (ii) a Research theme that leads to MESc and PhD degrees.

The MME MEng program 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. The MEng program is also a great preparation strategy for those planning to apply for registration with the Professional Engineers of Ontario. The goal of the MME research-based graduate degree programs is to train MESc and PhD students for independent research in today's changing technological world in either industry or academia. These research intensive, thesis-based programs provide leading-edge research using state-of-the-art experimental and computational facilities.

To inform the self-study, three graduate student surveys (1: MEng; 2: MESc & PhD; 3: alumni of MESc & PhD) were conducted in spring 2020. Current and past students were asked about: Research Facilities and Resources, Supervision, Courses, Program, Financial Support and the Graduate Academic Experience.

The external reviewers shared a particularly positive assessment of the MME graduate programs. They offer some considerations and a series of recommendations for further enhancement.

Strengths and Innovative Features Identified by the Program

- For the MEng program, specialized options focus on topics of current industrial interest, industrial projects, cooperation with Fraunhofer Project Centre and local HVAC companies.
- The MME department offers a 2+2 joint PhD program with Soochow University, China.
- Several opportunities to participate in Collaborative Specializations (e.g., Engineering in Medicine, Musculoskeletal Health Research, Environment and Sustainability, and Scientific Computing).
- Graduate students in the MME program (Research and Professional) have the opportunity to be involved in industry-oriented projects at the International Composite Research Centre (ICRC) and gain unique training through the NSERC-funded CREATE program.
- The MME department graduate seminar series is a weekly seminar taking place during the fall and winter terms, in which different speakers are featured weekly. This is a required milestone for both MESc and PhD students, aiming to provide an opportunity for students to develop presentation skills and enrich the academic experience.
- A Course Map for research students in the MESc and PhD programs has been developed to enrich their learning experience and ensure the current learning

outcomes are properly met. The Course Map divides graduate courses into three categories: Methodology, Fundamentals and Advanced.
- Opportunity for each graduate student (MESc and PhD) to self-assess his/her thesis work against the expected learning outcomes via a rubric developed as part of the thesis review package.

Concerns and Areas of Improvement Identified by the Program

- Some dissatisfaction is observed in the number and variety of courses available for students in both the professional and research streams.
- MEng students have shared that they feel less informed about career-related issues/opportunities, professional development, and departmental student social activities.

Upcoming Program Changes Proposed During this Cyclical Program Review
(to be submitted for approval at a future date as per Western's internal governance process)

- Addition of a new field of research to the MME graduate program titled "Biomechanics"

Review Process

As part of the external review, the review committee, comprising two external reviewers, one internal reviewer and a graduate student, were provided with Volume I and II in advance of the scheduled review and then met over two days with the:

- Vice Provost of the School of Graduate & Postdoctoral Studies
- Associate Vice-Provost of the School of Graduate & Postdoctoral Studies
- Vice Provost of Academic Planning, Policy and Faculty
- Dean of the Faculty of Engineering
- Associate Dean, Graduate and Postdoctoral Studies, Faculty of Engineering
- Acting Department Chair
- Associate Chair, Graduate Research Programs
- Associate Chair, Graduate Professional Programs
- Program Assistant and Administrative Officer
- Associate Chief Librarian
- Graduate Research Programs Committee
- Graduate Professional Programs Committee
- Program faculty members
- Graduate students

These formative documents, including Volumes I and II of the Self-Study, the External Report, the program response and the Dean's response, have formed the basis of this summative assessment report of the Mechanical and Materials Engineering Graduate

Programs, collated and submitted to SGPS and the Senate Graduate Program Review Committee (SUPR-G) by the Internal Reviewer with the support of the Office of Academic Quality and Enhancement.

Summative Assessment – External Reviewers' Report

Strengths of the Program

- Detailed program-level Learning Outcomes have been developed for each of the MEng, MESc and PhD programs.
- Over 95% of graduate courses are taught by the MME primary faculty members and approximately 50% of primary faculty members teach/have taught two courses or more/year.
- Course offerings, particularly those from the Advanced category, emphasize the current state-of-the-art in mechanical engineering.
- The thesis self-assessment form for research students.
- MESc and PhD students indicated very positive views about the quality of research supervision and interactions with their supervisor.
- About 50% of primary faculty members currently supervise research graduate students in other programs, like the biomed graduate program – a good indicator of multidisciplinary research engagement on the part of students and MME faculty members.
- Opportunities for an accelerated MESc and direct entry PhD, which are excellent vehicles to retain and attract top domestic students.
- Respecting the different needs of MEng vs. MESc and PhD students, course- and research-based programs are administered separately.
- A strong culture of equipment sharing/facilitation seems to exist within MME.
- MME/Faculty of Engineering/Western University provides notably more internal financial support than is available at select comparator institutions.
- There is a clear and positive sign of collaborative research projects between MME and other departments within Western University and outside.

Areas of Concern or Prospective Improvement

- The utility of the thesis examination rubrics were mixed. When evaluating the student performance relative to the learning outcomes, some examiners indicated that the evaluation scores did not significantly influence the discussion of a student's strengths and weaknesses.
- The MEng program has been tuned towards international MEng students. The department may want to think of ways to attract more domestic students into the MEng program. This effort may include, for example, an expansion of online course offerings to make it easier for working students to participate in the MEng program.
- The possible expansion of online course offerings in the MEng program and/or graduate diplomas provides a potentially attractive way of providing high-quality training opportunities to a broader audience of working professionals.

Summary of the Reviewers' Recommendations and Program/Faculty Responses

The following are the reviewers' recommendations in the order listed by the external reviewers.

Reviewers' Recommendation *Recommendations requiring implementation have been marked with an asterisk (*).*	**Program/Faculty Response**
1. We recommend that opportunities for temporary work placements be explored, particularly at the MEng level. Such opportunities would naturally align with the GDLEs Level of Application of Knowledge, Professional Capacity/Autonomy and Level of Communication Skills. Such opportunities would also satisfy the requests of select program participants.	**Program:** The Faculty of Engineering has initiated the process of adding the Co-op option to the MEng programs in all Engineering Departments, including the MEng Program in Mechanical and Materials Engineering (MME). The additional option will allow MEng students to complete one term of Co-op in an industrial organization in order to augment their experiential learning as well as engage in other learning activities of practical interest. The Co-op option will also provide students with an opportunity to gain practical experience that is relevant to their academic field and therefore will assist their future career advancements. The addition of the Co-op option will also enhance the learning outcomes for the MEng students, to become better aligned with the GDLEs level of Application of Knowledge, Professional Capacity/Autonomy and Level of Communications Skills. The students registered in the Co-op option will complete a one-term internship (though in exceptional cases the duration of the Co-op might be extended to two terms) in addition to the regular duration of their MEng program. This option will also allow international MEng students to apply for the Co-op work permit and complete a Co-op placement. **Faculty:** The Faculty has already started the process of major modification to add a "Co-op" option to the MEng program (in all Engineering Departments). This option will allow students to complete a co-op at an industrial organization that would enhance their experiential learning as well as professional skills. The proposed modification has been reviewed and approved by all participating Departments as well as the Engineering Faculty Council, and has been submitted for the review and approval by SUPR-G.
2. We recommend that the graduate seminars include EDI-training on par with training in professional ethics and career preparation.*	**Program:** To better train and educate graduate students on EDI topics, the program will include EDI training as a mandatory component of the professional ethics and career preparation that takes place during graduate seminar series. For this purpose, the program will coordinate with the Faculty EDI committee, the Office of the Associate Vice-President (EDI) and the Office of Indigenous Initiatives to invite guest speakers to deliver training seminars on various EDI topics in both Fall and Winter terms, starting with Winter 2022. **Faculty:** The Faculty of Engineering has established a Faculty-level EDI committee with the mandate to review current policies and practices, and to provide recommendations to integrate EDI considerations and support EDI-focused training initiatives, related to

	undergraduate and graduate education as well as inclusivity in the Faculty. The EDI Sub-Committee on Graduate and Research will work with the departmental graduate offices and other units on the campus to facilitate EDI training initiatives in graduate studies.
3. We recommend that the forms titled "Comprehensive Exam Assessment Form" and "Thesis Exam Assessment Form" be modified to include a brief set of instructions that explain (i) how the form may be used in evaluating student performance, and, (ii) whether the primary purpose of the form is evaluate the student or, more generally and in aggregate, the program.*	**Program:** The program will modify these forms by adding clear instructions on how the rubrics are being used to evaluate student performance and learning outcomes according to WDLOs/GDLEs principles starting from Summer 2022. While the primary purpose of the form is to evaluate the performance of the student and measure the learning outcomes, its secondary role is in fact to maintain and enhance the quality of the graduate research program.
4. We recommend an examination of the "minimum path" associated with the MEng degree to verify that the desired level of specialization is realized to the extent implied by the above Learning Outcome.	**Program:** The External Consultants' recommendation to examine the "minimum path" associated with each specialization interest is well received. For this purpose, the program carried out a review with the help of a "course map table" that contains various "Learning Outcome" measures related to all courses offered to the MEng students (all graduate courses in MME include a table that outlines which of the six graduate attributes tied to GDLEs are covered in a given course). Careful examination of these courses revealed that the required "learning outcomes" aligned with the program-level GDLEs are successfully met, regardless of the course combinations chosen by students within each course category. The program will continue to monitor the total attributes of the GDLEs associated with the current courses that are offered as well as the future courses that will be offered for MEng program. Hence, the current structured approach of the MEng program (two mandatory core courses, two professional courses, and six technical elective courses or four technical elective courses with a project) sets requirements equivalent to a "minimum path" in the MEng program.
5. We recommend that, if sufficient funds are available, a fund be established (by MME and/or the Faculty of Engineering) that may provide to faculty members short-term "bridge" funding for PhD students in the event of non-overlapping grants of brief duration. Such a support mechanism may incentivize the recruitment of PhD students but should obviously be implemented with due care so as to discourage applications from professors	**Program:** Without having a formal funding mechanism in place, MME Department currently provides short-term "bridge" funding support for faculty members who have non-overlapping grants (such is the case of a temporary loss of NSERC Discovery Grant, for instance). Furthermore, formal "Bridge" funds/grants are provided by the university and administrated within the faculty by the Associate Dean, Research. Prior to the pandemic, MME leadership has initiated discussions to establish a fund to incentivize the recruitment of PhD students by allocating $5,000 to each faculty member who hires a doctoral student. Nonetheless, the plan was temporarily halted due to the reduced graduate enrollment caused by the pandemic. It is anticipated that the incentive plan will resume once the graduate enrollment will approach or exceed the pre-pandemic level. Similar plans are presently under

without sincere intentions for securing follow-on funding.	consideration at faculty level in an overall effort to elevate the number of doctoral students enrolled in Western Engineering. **Faculty:** The Associate Deans of Graduate Studies and Research in the Faculty have already started to explore initiatives to incentivize the recruitment of PhD students (particularly for junior faculty) and also to use such initiatives to motivate faculty members to secure more external funding.
6. A) Creation of a database of past MEng students with their application GPA, previous degree and university, failed courses in the MEng program, and graduate GPA. This would help make informed decisions and keep the knowledge through the rollover of administrative staff and Associate Chairs.* B) GRE scores may help give another indicator of student background knowledge for applicants from outside North America.	**Program:** A) The program agrees that creating its own database would be extremely beneficial, particularly if the program will attempt to establish retrospective correlations between the undergraduate programs completed by the incoming students and their performance in the MEng program. As such, the program will work towards the generation of this database. B) At this time, standardized tests, such as GRE, are not a compulsory component of graduate student admission at Western Engineering or Western SGPS in general. For consistency reasons, the program believes that it would be better that such initiatives will be led and set by the Faculty of Engineering, rather than individual departments. Furthermore, the program believes that the inclusion of GRE on the list of admission criteria for the professional programs will become a strong disincentive for any Canadian engineering professionals looking to upgrade their personal skills by means of the MEng program.
7. We recommend that MEng students be permitted to credit only two MME 9500- level courses. Exceptions to this rule (e.g. for reasons of scheduling or specialization) should be at the discretion of the Associate Chair, Graduate Professional Programs.*	**Program:** The MME Graduate Professional Programs Committee plans to meet soon to discuss the rules around course selection for MEng students. To address this concern, the program plans to limit the number of 9500-level of courses to two with case-by-case exceptions to be granted by the MME Associate Chair, Graduate Professional Programs. The current plan is to ensure that this change will be in effect for all students starting their MEng program in Fall 2022.
8. We recommend reminding students of the self-assessment form and process at each annual supervisory meeting.*	**Program:** Presently, these reminders are mandatory component of the new student orientation coordinated by the MME Associate Chair, Graduate Research Programs. Nonetheless, additional reminders about the self-assessment form and process will be integrated in the Progress Report (a component of Western's Pathfinder system), that is required for completion and approval after each supervisory committee meeting. The program expects that this additional mechanism will continue to provide student guidance and support towards thesis writing throughout the entire duration of the graduate program.
9. We recommend that MME adjust the balance between required mandatory attendance and the number of presentations/topics. For instance, the department could let research	**Program:** To address this recommendation, the program plans to actively consult with MME Graduate Student Society on ways to improve the delivery of the graduate seminar. In this regard, the program remains hopeful that a superior seminar delivery structure will be in place for the next academic year.

students choose the seminars that they want to attend and reduce the mandatory attendance to once a month.*	
10. We recommend that, where possible, better tracking of graduate student alumni be performed. Of particular interest would be to determine whether the individuals in question pursue technical employment, non-technical employment or further educational opportunities upon leaving Western Univ. Also relevant would be to ascertain whether graduate students remain in Canada after graduation. Data collected from former MEng, MESc and PhD students could also be used to inform strengths and weaknesses of the different programs.*	**Program:** To address this concern, the program is presently investigating ways to establish a better and closer contact with the alumni of the graduate research-focused and professional programs. In this regard, Western Engineering plans to create alumni groups via social and professional networking portals (Facebook, LinkedIn, etc.) since this will allow us to obtain more accurate and up-to-date information about the postgraduation career trajectory of MME graduates. These types of connections will also enable current graduate students to establish more connections for their future career development. Finally, the program plans to invite some MME alumni to speak to current graduate students about their post-graduation professional experience. **Faculty:** The Faculty Graduate Office in collaboration with the Communications Team in the Faculty have already started some preliminary discussions to explore the appropriate tools and platforms (e.g. LinkedIn) to track graduate alumni, which will be shared with departmental graduate programs.
11. We recommend that exit interviews be conducted for PhD students who leave the program prematurely. Doing so should inform the combination of factors that led each individual to withdrawal from the PhD program. With these data to hand, broader trends may become apparent that help to reduce the rate of withdrawal in future. In a similar vein, and consistent with the last recommendation, we further recommend that an exit survey be distributed to graduate students who successfully complete their program of study. Such a survey may probe strengths and weaknesses of the program in question.*	**Program:** According to experience with these cases, the program has identified two major factors that contribute to PhD student withdrawals: failure to pass the comprehensive examination and personal reasons (family-related, professional opportunities, relocation, etc.). Evidently, the investigation and monitoring of the personal reasons is outside of the program's area of responsibility and/or control. On the other hand, the continuous collection/monitoring of doctoral comprehensive exam assessment data will allow us to better understand the knowledge gaps for some of the doctoral students such that they will be better prepared for their comprehensive examinations. To directly address the concern, the program will introduce the suggested exit surveys collecting data from all MME graduates. Such exit surveys are presently being sent out to the graduates of Western Engineering undergraduate programs such that the MME graduate programs will build on that experience to design and deploy their own surveys targeting the graduates of the MESc, MEng and PhD programs.

Implementation Plan

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

The number of recommendations prioritized for implementation has been reduced given that several are already underway or completed as explained in the program and faculty responses.

Recommendation	Proposed Action and Follow-up	Responsibility	Timeline
Recommendation #2: We recommend that the graduate seminars include EDI-training on par with training in professional ethics and career preparation.	Iinclude EDI training as a mandatory component of the professional ethics and career preparation that takes place during graduate seminar series. Invite guest speakers to deliver training seminars on various EDI topics in both Fall and Winter terms.	Associate Chair, Graduate Research Programs (MME) to coordinate with: - Faculty EDI committee - Office of the Associate Vice-President (EDI) - Office of Indigenous Initiatives	By April 2022
Recommendation #3: We recommend that the forms titled “Comprehensive Exam Assessment Form” and “Thesis Exam Assessment Form” be modified to include a brief set of instructions.	Modify the forms by adding clear instructions on how the rubrics are being used to evaluate student performance and learning outcomes according to WDLOs/GDLEs principles.	Associate Chair, Graduate Research Programs (MME) (Consult Associate Dean, Graduate and Postdoctoral Studies, if needed)	By June 2022
Recommendation #6: Creation of a database of past MEng students with their application GPA, previous degree and university, failed courses in the MEng program, and graduate GPA.	Develop a database of past MEng students and consider how that may inform holistic admission processes to support EDID.	Associate Chair, Graduate Research Programs (MME)	By June 2022

Recommendation #7: We recommend that MEng students be permitted to credit only two MME 9500-level courses.	Discuss the rules around course selection for MEng students. Limit the number of 9500-level of courses to two with case-by-case exceptions to be granted by the MME Associate Chair, Graduate Professional Programs. The current plan is to ensure that this change will be in effect for all students starting their MEng program in Fall 2022.	Associate Chair, Graduate Research Programs (MME) MME Graduate Professional Programs Committee	By August 2022
Recommendation #8: We recommend reminding students of the self-assessment form and process at each annual supervisory meeting.	Additional reminders about the self-assessment form and process will be integrated in the Progress Report (a component of Western's Pathfinder system).	Associate Chair, Graduate Research Programs (MME)	By June 2022
Recommendation #9: We recommend that MME adjust the balance between required mandatory attendance and the number of presentations/topics for the graduate seminars.	Consult with MME Graduate Student Society on ways to improve the delivery of the graduate seminar.	Associate Chair, Graduate Research Programs (MME) MME Graduate Student Society	By June 2022
Recommendation #10: We recommend that, where possible, better tracking of graduate student alumni be performed.	Create alumni groups via social and professional networking portals (Facebook, LinkedIn, etc.). Invite some program alumni to speak to current graduate students about their post-graduation professional experience.	Associate Chair, Graduate Research Programs (MME) AD (Graduate) and Office and Communications Team	By December 2022
Recommendation #11: We recommend that an exit survey be distributed to graduate students who successfully complete their program of study.	Design and deploy exit surveys targeting the graduates of the MESc, MEng and PhD programs.	Associate Chair, Graduate Research Programs (MME) Survey form should be approved by AD (Graduate) to meet Western policies	By December 2022

Other Opportunities for Program Improvement and Enhancement

- Neither the graduate program committee for professional or research-based students includes a student member. The committees may find it informative to include such representation.
- We were left with the impression that MEng students enjoy less departmental engagement overall as compared to their research-based counterparts. While there may be good reasons for this (e.g. many MEng students must work off-campus to support themselves financially), MME may find it helpful arrange a series of educational or social events specifically for the benefit of this group of students.