UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Report No. 3679

MEMORANDUM

To: Executive Committee of Faculty Council (February 2, 2021)
Faculty Council (February 24, 2021)

From: Professor Julie Audet
Chair, Engineering Graduate Education Committee (EGEC)

Date: January 25, 2021

Re: **Addition of an Extended Full-time Option to the MEng in Biomedical Engineering**

REPORT CLASSIFICATION

This is a major policy matter that will be considered by the Executive Committee for endorsing and forwarding to Faculty Council for vote as a regular motion (requiring a simple majority of members present and voting to carry).

PROPOSED

See the attached major modification proposal to add an Extended Full-Time option to the MEng in Biomedical Engineering program.

RECOMMENDATION FOR FACULTY COUNCIL

THAT an Extended Full-Time option be added to the Master of Engineering (MEng) in Biomedical Engineering, as described in Report 3679.

University of Toronto
Major Modification Proposal

Significant Modifications to Existing Graduate and Undergraduate Programs

Program being modified:	Master of Engineering (MEng) in Biomedical Engineering
Proposed major modification:	Addition of an Extended Full-Time option Reduction in credits earned for BME1899/1898Y from 1.5 FCEs to 1.0 FCE and addition of 0.5 FCE elective course (no change in the total FCE requirement for the program)
Department/unit:	Institute of Biomedical Engineering (BME)
Faculty/academic division:	Faculty of Applied Science and Engineering
Dean's Office contact:	Dr. Julie Audet, Vice-Dean, Graduate Studies
Proponent:	Dr. Warren Chan, Director, IBME
Version date:	February 4, 2021

1 Summary

We propose adding an Extended Full-Time (EFT) option to the MEng program at the Institute of Biomedical Engineering (BME). Students currently complete the MEng program in one year; the addition of an EFT option will allow them to complete the same course requirements over a period of two years, or six sessions.

We further propose to decrease the FCE requirement for the practicum component (BME1899/8Y) from 1.5 FCEs to 1.0 FCE. MEng students will be required to take an additional 0.5 FCE over the course of their program, as the total number of required credits will remain unchanged at 5.0 FCEs total. This 0.5 FCE can be either biomedical engineering, commercialization and entrepreneurship, or any graduate-level course of interest to the student.

2 Effective Date

Extended Full Time Option: September 2021.
Credit Reduction for BME1899/8Y: September 2021.

3 Academic Rationale

Extended Full Time Option (EFT): We have received feedback from many of our MEng students that an EFT option would be beneficial. This option will enable them to divide course work between a maximum of 6 sessions, providing greater flexibility for course scheduling. The work integrated learning component of the program is typically taken during the summer term of the third session, and the EFT option will allow students additional time to seek out and secure industry internships. An EFT option will also give many of our international students more time to complete the MEng program requirements as well as additional time to settle into a new country, and in some cases, a different academic environment.

We are seeing increased interest in the MEng program from mature students and industry professionals who wish to pursue their studies and upgrade their skills while continuing their employment. Greater scheduling flexibility will be particularly beneficial to them. Historically, mature students who pursue an MEng after a period of industry employment do well in the program and BME would like to continue to attract these entrepreneurs and engineering professionals as the program grows.

This change will also align BME with other Faculty of Applied Science and Engineering (FASE) institutes and departments (ChemEng, CIV/MIN, ECE, UTIAS, MIE and MSE) that offer EFT options for their MEng students, including the EFT fee structure and maximum course loads per session and per year (as mandated by SGS), as well as restrictions relevant to transfers between FT and EFT options.

Credit Reduction for BME1899/8Y: BME1899/BME1898Y, Practical Experience in Applied Research, is a required work-integrated learning component of the BME MEng program. BME1899Y is taken in one session by students completing a full-time practicum, while BME1898Y can be taken by students over three sessions while completing a part-time practicum. A sister work-integrated learning course, BME4444Y, Practical Experience in Clinical Engineering, is a required work-integrated learning component of the BME Master of Health Science (MHSc) program. In both BME1899/8Y and BME4444Y, students complete 12 to 16 weeks in an industrial, hospital or academic setting to gain practical experience. Students currently earn 1.5 FCEs for BME1899/8Y and 1.0 FCE for BME4444Y. Lowering BME1899Y to 1.0 FCE will align these courses, and will align BME1899/8Y with CEM1000Y, the summer practicum course in Civil and Mineral Engineering's MEng CEM program which is also weighed 1.0 FCE. Both courses require similar time commitments, have the same learning objectives, and have similar assignments. Currently, BME MEng students complete seven 0.5 FCE half courses plus BME1899Y. Under the proposed structure, students will take eight 0.5 FCE half courses and BME1899Y. The program requirements will remain 5.0 FCEs total, so students will have to take one additional half course to meet these requirements. To be flexible, we will allow students to take a course from any of our current categories since the learning objectives of the internship straddle technical, device design, development and commercialization aspects.

4 Description of the Proposed Major Modification(s)

Extended Full Time (EFT) Option: Students will have the option of registering in the EFT and completing their program requirements over six sessions. They will adhere to the current SGS guidelines for EFT programs, including the current fee structure, maximum course limits per session and per year, and the current SGS regulations that prohibit students from switching between Full Time and EFT options once an option has been selected. See Section 3.

Sample Student Pathway for EFT Option:

YEAR	FALL	WINTER	SUMMER
Year 1	1.0 BME credits	BME1801 One of: BME1439, BME1802	0.5 APS course credit
Year 2 option 1	1.0 BME credits	0.5 elective	BME1899Y

Year 2 option 2	BME1898Y 0.5 BME credit	BME1898Y 0.5 BME credits	BME1898Y 0.5 APS course credit

Credit Reduction of BME1899/8Y: The weight of BME1899/8Y, Practical Experience in Applied Research, will be lowered from 1.5 FCEs to 1.0 FCE. Students will be required to take an additional 0.5 FCE half course to meet program requirements. See Section 3.

The proposed modifications will not change what students will know (i.e., no change to program learning outcomes) or the opportunities available to them upon graduation. The addition of an EFT option will change program delivery but will not affect the program's learning outcomes. The addition of an EFT option will positively impact student mental health as several of our international students have shared their disappointment that BME is the only FASE academic unit without the EFT option, and that this option would have reduced stress and allowed them more flexibility in transitioning to the Canadian post-graduate education system generally, and life at the University of Toronto, specifically. Similarly, this option will positively impact mature students returning to post-graduate studies by allowing them more flexibility as they re-adjust to academia. The proposed changes may further benefit students in adapting to post-COVID 19 learning environments.

Table 1, below, outlines the projected enrollment numbers for the part-time, full-time and extended full-time options. Domestic full-time student enrollment is expected to grow by around 10% over the next several years. Currently, we accept up to 5 MD students from the Temerty Faculty of Medicine into the MEng program on a part-time basis and will continue to accept up to 5 concurrent program students each Winter. As a result of a rigid schedule in their medicine program, these students typically complete the program in two years, therefore the domestic part-time student numbers will remain steady. We don't expect a large uptake in the EFT option among domestic students and will limit the number of domestic students in the EFT program option through the admission process. In terms of international students, we expect a 50% uptake for the EFT option. In previous years we have enrolled up to 10 international MEng students and will maintain this number of newly admitted international MEng students year over year. With the EFT option, the program will retain a group of second year MEng students, but in total we expect no more than 15 international students registered in any given year. As outlined in Table 1, the MEng program will reach maximum capacity in Fall 2025.

Table 1. Master of Engineering in Biomedical Engineering Enrolment Projections (headcount)

		Year of study	Fall 2020	Winter 2020	Fall 2021	Winter 2021	Fall 2022	Winter 2022	Fall 2023	Winter 2023	Fall 2024	Winter 2024	Fall 2025	Winter 2025
Domestic	**FT**	1	48	48	55	55	55	55	60	60	60	60	60	60
		Total FT	**48**	**48**	**55**	**55**	**55**	**55**	**60**	**60**	**60**	**60**	**60**	**60**
	PT (MD)	1		5	5	5	5	5	5	5	5	5	5	5
		2	2			5	5	5	5	5	5	5	5	5
		3												
		Total PT	**2**	**5**	**5**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
	EFT	1	X	X	5	5	5	5	5	5	10	10	10	10
		2	X	X	X	X	5	5	5	5	5	5	10	10
		Total EFT	**X**	**X**	**5**	**5**	**10**	**10**	**10**	**10**	**15**	**15**	**20**	**20**
INTL	**FT**	1	8	8	5	5	5	5	5	5	5	5	5	5
		Total FT	**8**	**8**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
	EFT	1	X	X	5	5	5	5	5	5	5	5	5	5
		2	X	X	X	X	5	5	10	10	5	5	5	5
	FT	**Total EFT**	**X**	**X**	**5**	**5**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
		Total Meng	**58**	**61**	**75**	**80**	**90**	**90**	**95**	**95**	**100**	**100**	**105**	**105**

5 Impact of the Change on Students

Current BME MEng students will not be impacted by the proposed modifications other than having more options in terms of timing to select courses and complete their program. The modifications will also give students more opportunities to pursue graduate emphases, as they will have an additional 0.5 FCE course as an elective.

The program is typically completed in one year, over three consecutive sessions: Fall, Winter, and Summer. The 2020-2021 cohort of MEng students are expected to complete the program prior to the modifications becoming effective in September 2021.

Previous MEng cohort student have been consulted regarding the EFT option. See Section 3.

6 Consultation

Broad consultation has been held with the Director of BME (Dr. Warren Chan), the Associate Director, Professional Programs (Dr. Paul Yoo), the Associate Professor and former Associate Director, Professional Programs (Dr. Jan Andrysek), the Vice-Dean, Graduate Studies, FASE (Dr. Julie Audet), and current and previous BME MEng students.

7 Resources

Students in the proposed EFT option will take courses along side their peers in the full-time program option. Allowing a percentage of students to complete the MEng program requirements over six sessions is expected to reduce the burden on BME's resources. While current course enrollment limits prevent some students from enrolling in certain elective courses, EFT students will now have the option of spreading out their course requirements.

Reducing the weight of BME1899/8Y to 1.0 FCE will require students to take another 0.5 FCE half course, which could impact BME course enrolment numbers and potentially impact faculty teaching commitments; however, when balanced with the creation of the EFT option and the resulting reduction in course load per session for EFT students, it is expected that the overall impact on BME's resources will balance out and essentially remain unchanged.

8 UTQAP Process

Steps	Approvals
Development/consultation within unit	May 2020
Consultation with Dean's Office (and VPAP)	June to November 2020 (sign-off VP-AP/SGS Jan 12, 2021)
Unit-level approval as appropriate	November 2020
Faculty/divisional Council	February 2021
Submission to Provost's Office	February 2021
Reported to the Provost and included in annual report to AP&P	June 2021
Ontario Quality Council —reported annually	June 2021

9 Appendix A: Current Learning Outcomes and Degree Level Expectations

Master of Engineering Degree Level Expectations (Approved by FASE Council in March 2011)	**Program Learning Outcomes**	**How the Program Design/Structure Supports the Attainment of the Degree Level Expectations and Program Learning Outcomes**
Expectations: The Master of Engineering in Biomedical Engineering is awarded to students who have demonstrated:		
1. Depth and Breadth of Knowledge A systematic understanding of engineering and applied science knowledge including, where appropriate, relevant knowledge outside the field and engineering discipline, and a critical awareness of current problems and/or new insights, much of which is at, or informed by, the forefront of their engineering or applied science discipline.	Depth and breadth of knowledge is defined in the MEng in BME program as expertise in at least one field of biomedical engineering and an understanding of the challenges of moving technology forward in a regulated environment. This is reflected in students who are able to: • Apply mathematics, life sciences, physical sciences, and engineering to biomedical device development (e.g., to develop a concept for a device and a design a prototype). • Appreciate potentially conflicting interests or points of view (patients, physicians and businesspersons).	The program design and requirement elements that ensure these student outcomes for depth and breadth of knowledge are: • Coursework in engineering, biomedical sciences, and entrepreneurship. • A core entrepreneurship course which will be a survey course that will cover a variety of technologies and applications. Captured in the internship where students will cover four important aspects of biomedical device development (need assessment, concept development, design and prototype, business models).

Master of Engineering Degree Level Expectations (Approved by FASE Council in March 2011)	Program Learning Outcomes	How the Program Design/Structure Supports the Attainment of the Degree Level Expectations and Program Learning Outcomes
2. Knowledge of Methodologies A conceptual understanding and methodological competence that: a. Enables a working comprehension of how established techniques of inquiry are used to interpret knowledge in the discipline. b. Enables a critical evaluation of current developments in the discipline. c. Enables a treatment of technical issues and judgments based on established principles and techniques.	Knowledge of methodologies is defined in the MEng in BME program as a conceptual understanding and methodological competence that: • Enables a working comprehension of how experimental methods and data analysis methods can be used to assist the design of biomedical devices and optimize them. • Enables a critical evaluation of current developments in the at least one field of study at BME and familiarity with viewpoints of experts in other disciplines (e.g., medicine and business). • Enables a treatment of technical issues and judgments based on principles of engineering designs and method of data analysis. This is reflected in students who are able to:	The program design and requirements that ensure these student outcomes for knowledge of methodologies are: • Outstanding instructors whose expertise will bring both theory and practice to the classroom. • Course papers and case studies for the Engineering; Commercialization and Entrepreneurship; and Biomedical Sciences, where students will have the opportunity to explore in-depth topics. • Captured in the internship where students will cover four important aspects of biomedical device development (need assessment, concept development, design and prototype, business models).

Master of Engineering Degree Level Expectations (Approved by FASE Council in March 2011)	Program Learning Outcomes	How the Program Design/Structure Supports the Attainment of the Degree Level Expectations and Program Learning Outcomes
	• Develop a concept for a medical device based on literature and patent searches, input from experts. • Consider and evaluate the validity of the assumptions on which the device concept is based. • Critically and comprehensively assess a complex problem from the viewpoints of stakeholders. • Distinguish between what is known and what is unknown and subsequently elaborate a research plan that will shed light on the unknown. • Evaluate a biomedical device design strategy and identify areas where alternative or better approaches could be used, to consider and evaluate cost-effectiveness.	
3. Level of Application of Knowledge Competence in the application of an existing body of data in the critical analysis of advanced problems or issues. Here,	Level of application of knowledge is defined in the MEng in BME program as the ability to identify areas where engineering can be used to innovate and solve problems in	The program design and requirements that ensure these student outcomes for level and application of knowledge are:

Master of Engineering Degree Level Expectations (Approved by FASE Council in March 2011)	Program Learning Outcomes	How the Program Design/Structure Supports the Attainment of the Degree Level Expectations and Program Learning Outcomes
advanced indicates a difficulty level beyond that encountered at the undergraduate level.	medicine and develop a plan to achieve this goal. This is reflected in students who are able to: • Proficiently identify, formulate and solve advanced biomedical engineering problems. • Use advance techniques, skills and modern engineering tools necessary for to develop a design and prototype for a new biomedical device. • Distinguish between what is known and what is unknown and elaborate a research plan that will shed light on the unknown. • Proficiently design and validate experiments, systems, components or processes to meet desired needs. • Develop a concept for a biomedical device based on literature and patent searches, input from experts.	• Exams and projects in the Biomedical Engineering Technology; Commercialization and Entrepreneurship; and Biomedical Sciences pillar courses. • Captured in the internship where students will cover four important aspects of biomedical device development (need assessment, concept development, design and prototype, business models). • Captured in the internship where students are expected to achieve significant advances in biomedical device prototyping.

Master of Engineering Degree Level Expectations (Approved by FASE Council in March 2011)	Program Learning Outcomes	How the Program Design/Structure Supports the Attainment of the Degree Level Expectations and Program Learning Outcomes
	• Critically assess a complex problem with opposite and conflicting perspectives.	
4. Professional Capacity/Autonomy a. The qualities and transferable skills necessary for employment requiring: i. The exercise of initiative and of personal responsibility and accountability. ii. Decision-making in complex situations. b. The intellectual independence required for continuing professional development. c. The ethical behaviour consistent with academic integrity and the use of appropriate guidelines and procedures for responsible conduct in a professional context. d. The ability to participate meaningfully as leaders in society.	Professional capacity/autonomy is defined in the MEng in BME program as the ability to translate ideas into commercial realities. This is reflected in students who are able to: • Prepare research papers and practicum reports. • Integrate professional, social, ethical and environmental considerations into their decision analysis. • Display proficient contemporary technical and scientific comprehension and lifelong learning. • Complete the degree requirements in a timely manner. • Demonstrate project management skills. Revise plans and adapt to the unexpected.	The program design and requirements that ensure these student outcomes for professional capacity/autonomy are: • Individual exams in the Engineering Technology; Commercialization and Entrepreneurship; and Biosciences pillar courses. • Evaluation of internship report (quality of research proposal, research design and innovation and conclusions). • Course papers and case studies for the core Commercialization and Entrepreneurship courses where students will have the opportunity to explore in-depth topics (specifically in the Regulatory Requirements Module and the Biomedical Engineering Ethics Module). • Independent work in the internship.

Master of Engineering Degree Level Expectations (Approved by FASE Council in March 2011)	Program Learning Outcomes	How the Program Design/Structure Supports the Attainment of the Degree Level Expectations and Program Learning Outcomes
5. Level of Communications Skills The ability to communicate ideas, issues, and conclusions clearly in oral and written form. This includes being capable of constructing a credible argument and presenting it in appropriate formats.	Level of communications skills is defined in the MEng in BME program as an ability for proficient technical and scientific communication. This is reflected in students who are able to: • Construct a credible argument and present it in appropriate formats. • Generate research and position papers. • Make professional presentations. • Condense complex topics and analyses into simple and easily communicated messages for a diverse set of stakeholders.	The program design and requirements that ensure these student outcomes for level of communication skills are: • Course papers and case studies for the Biomedical Technology; Commercialization and Entrepreneurship; and Medical Sciences, where students will have the opportunity to explore in-depth topics. • Internship report.
6. Awareness of Limits of Knowledge Cognizance of the complexity of knowledge, its underlying assumptions, and the potential contributions of other interpretations, methods, and disciplines.	Awareness of the limits of knowledge is defined in the MEng in BME program as cognizance of the complexity of knowledge, its underlying assumptions, and the potential contributions of other interpretations, methods and disciplines. This is reflected in students who are able to:	The program design and requirements that ensure these student outcomes for level of awareness of limits of knowledge are: • Evaluation of internship report (quality of research proposal, research design and innovation and conclusions). For the internship report, one of the performance indicators used will be that the student

Master of Engineering Degree Level Expectations (Approved by FASE Council in March 2011)	Program Learning Outcomes	How the Program Design/Structure Supports the Attainment of the Degree Level Expectations and Program Learning Outcomes
	• Critically assess a complex problem with opposite and conflicting perspectives (patients, physicians and businesspersons). • Prepare a research proposal (practicum) and develop a research plan. • Judge when it is necessary to consult experts in specific areas. • Recognize limitations of methods used (in medicine, engineering and business). • Envision areas for future work/research, or next steps in research and development.	has the ability to reflect on overall design strategy and has identified areas where alternative or better approaches could have been used, if applicable and the student has considered the validity of his/her assumptions.

10 Appendix B: Proposed Learning Outcomes and Degree Level Expectations

The learning outcomes and degree-level expectations remain unchanged. See Appendix A.

Appendix C: Current Calendar Copy with Changes Tracked

Master of Engineering

Program Description

The MEng program is an accelerated, professional program with a focus on the design and commercialization of biomedical devices. Students will have the opportunity to take on applied design challenges and meet the growing demands of this industry through a four-month practical experience through internships, research projects, or practical course activities.

The MEng program is offered in the fields of 1) Biomaterials, Tissue Engineering and Regenerative Medicine; 2) Engineering in a Clinical Setting; 3) Nanotechnology, Molecular Imaging and Systems Biology; and 4) Neural/Sensory Systems and Rehabilitation.

Students can take the program on a full time, part-time, or extended full-time basis.

Full-Time Option

Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy BME's additional admission requirements stated below.
- A four-year bachelor's degree in engineering, medicine, dentistry, or one of the physical or biological sciences from a recognized university, with at least a mid-B average (3.0 grade point average [GPA]) in the final two years of study or over senior-level courses.

Program Requirements

- **Coursework.** Students must successfully complete a total **5.0 full-course equivalents (FCEs)** as follows:

    - At least 2.0 FCEs in biomedical engineering courses; these include all BME and joint BME course offerings.
    - At least 1.0 FCE in commercialization and entrepreneurship courses such as BME1800H, BME1801H, BME1802H, and BME1405H.
    - A ~~1.5~~ 1.0 FCE *Practical Experience in Applied Research* course in biomedical device development, usually over one session a full-time placement (BME1899Y), or over three sessions for a part time ~~option~~ placement (BME1898Y). The internship must be in at least one of the following biomedical engineering research fields: 1) Biomaterials, Tissue Engineering and Regenerative Medicine; 2) Engineering in a Clinical Setting; 3) Nanotechnology, Molecular Imaging and Systems Biology; or 4) Neural/Sensory Systems and Rehabilitation. The practical experience course can be taken in academic research laboratories, government institutions, health-care facilities, in the industry, or in health-care consulting firms.
    - The remaining ~~0.5~~ 1.0 FCE can be ~~a~~ two half courses in either biomedical engineering, commercialization and entrepreneurship, or any graduate-level course the student is interested in.
- All courses must be at the graduate level, which includes both 500- and 1000-level. Students can take a maximum of one 500-level course.
- Health and safety training workshops.
- Students have the option of completing an emphasis in Engineering and Globalization; Entrepreneurship, Leadership, Innovation and Technology in Engineering (ELITE); or Forensic Engineering as part of their degree program. Please see details in the Biomedical Engineering MEng Emphases section.

Program Length

3 sessions full time (typical registration sequence: F/W/S);
9 sessions part-time (typical registration sequence: F/W/S/F/W/S/F/W/S)

Time Limit

2 years full time;
6 years part-time

Extended Full-Time Option

Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy BME's additional admission requirements stated below.
- A four-year bachelor's degree in engineering, medicine, dentistry, or one of the physical or biological sciences from a recognized university, with at least a mid-B average (3.0 grade point average [GPA]) in the final two years of study or over senior-level courses.

Program Requirements

- **Coursework.** Students must successfully complete a total **5.0 full-course equivalents (FCEs)** as follows:
  - At least 2.0 FCEs in biomedical engineering courses; these include all BME and joint BME course offerings.
  - At least 1.0 FCE in commercialization and entrepreneurship courses such as BME 1800H, BME 1801H, BME 1802H, and BME 1405H.
  - A 1.0 FCE *Practical Experience in Applied Research* course in biomedical device development, usually over one session for a full time placement (BME 1899Y) or over three sessions for a part time placement (BME1898Y). The placement must be in at least one of the following biomedical engineering research fields: 1) Biomaterials, Tissue Engineering and Regenerative Medicine; 2) Engineering in a Clinical Setting; 3) Nanotechnology, Molecular Imaging and Systems Biology; or 4) Neural/Sensory Systems and Rehabilitation. The practical experience course can be taken in academic research and teaching laboratories, government institutions, health-care facilities, in the industry, or in health-care consulting firms.
  - The remaining 1.0 FCE can be two half courses in either biomedical engineering, commercialization and entrepreneurship, or any graduate-level course the student is interested in.
  - All courses must be at the graduate level, which includes both 500- and 1000-level. Students can take a maximum of one 500-level course.
  - Health and safety training workshops.
  - Students have the option of completing an emphasis in Engineering and Globalization; Entrepreneurship, Leadership, Innovation and Technology in

Engineering (ELITE); or Forensic Engineering as part of their degree program. Please see details in the Biomedical Engineering MEng Emphases section.

Program Length

6 sessions (typical registration sequence: F/W/S/F/W/S)

Time Limit

3 years