UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Report No. 3619 Revised

MEMORANDUM

To: Executive Committee of Faculty Council (March 21, 2019)
Faculty Council (April 11, 2019)

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

Date: March 28, 2019

Re: **EGEC Information Update**

REPORT CLASSIFICATION

This is a routine or minor policy matter that has been approved by the Engineering Graduate Education Committee on behalf of Faculty Council[1]. It will be considered by the Executive Committee for endorsing and forwarding to Faculty Council for information.

NEW COURSE APPROVED

ECE1784H	Trustworthy Machine Learning

MINOR MODIFICATIONS

MASc in Biomedical Engineering Field 1: Neural/Sensory Systems and Rehabilitation; Field 2: Biomaterials, Tissue Engineering and Regenerative Medicine; Field 3: Nanotechnology, Molecular Imaging and Systems Biology; Field 4: Engineering in a Clinical Setting	IBBME proposes to lower the GPA requirement for admission and to change the core course requirements for the program. The minimum GPA for admission is lowered from A- to mid B (GPA=3.0 in final two years of undergraduate degree). The required core courses is changed but the number of total course credits stays the same. (See Appendix 1, Minor Modification proposal)

[1] As a result of the 2005 Task Force on Graduate Education at the University of Toronto, EGEC has delegated authority to "consider and approve on behalf of Faculty Council and/or recommend to Faculty Council and/or SGS, matters relating to graduate curriculum, policy, new initiatives, program and course changes".

MHSc in Clinical Engineering	IBBME proposes to lower the GPA requirement for admission and to change the core course requirement for the program. The minimum GPA for admission is lowered from A- to mid B (GPA=3.0 in final two years of undergraduate degree). The core courses required are changed but the number of total course credits stays the same. (See Appendix 2, Minor Modification proposal)
MEng in Biomedical Engineering Field 1: Neural/Sensory Systems and Rehabilitation; Field 2: Biomaterials, Tissue Engineering and Regenerative Medicine; Field 3: Nanotechnology, Molecular Imaging and Systems Biology; Field 4: Engineering in a Clinical Setting	IBBME proposes to lower the minimum admission requirement and to change the description of the course requirements. The minimum GPA for admission is lowered from A- to mid B (GPA=3.0 in final two years of undergraduate degree). The Biomedical Engineering Technology course list and Biomedical Sciences course list will be merged into the Biomedical Engineering course list. Students will now select courses in two lists instead of three. The number of total course credits stays the same. (See Appendix 3, Minor Modification proposal)
PhD in Biomedical Engineering Field 1: Neural/Sensory Systems and Rehabilitation; Field 2: Biomaterials, Tissue Engineering and Regenerative Medicine; Field 3: Nanotechnology, Molecular Imaging and Systems Biology; Field 4: Engineering in a Clinical Setting; Field 5: Clinical Engineering	IBBME proposes to lower the minimum GPA requirement for admission and to change the core course requirement for the program. The minimum GPA for admission is lowered from A- to the minimum requirements set by SGS (Degree Regulations) which is B+ (GPA 3.3) for students admitted with a Master's degree. The GPA will be calculated for the Master's degree. The GPA requirement will remain at A- for students admitted with an undergraduate degree (as per SGS Degree Regulations for direct-entry students). The core courses required are changed but the number of total course credits stays the same. (See Appendix 4, Minor Modification proposal)
Collaborative Master's and Doctoral Specialization in Engineering Education	Add Doctorate (PhD) and Master's (MA) in Higher Education (See Appendix 5, Minor Modification proposal)

RECOMMENDATION FOR FACULTY COUNCIL

For information.

APPENDIX 1

University of Toronto

Minor Modification Proposal: Change to an Existing Graduate Program or Collaborative Specialization

This template should be used to bring forward all proposals for minor modifications to program or admissions requirements for existing graduate programs or collaborative specializations under the University of Toronto's Quality Assurance Process.

Program/Collaborative Specialization being modified:	MASc in Biomedical Engineering
Graduate unit:	IBBME
Faculty/academic division:	Faculty of Applied Science & Engineering
Dean's office contact:	Julie Audet, Vice-Dean, Graduate Studies
Version date:	March 28, 2019

1 Summary

x	Changing admission requirements		Renaming field, concentration or emphasis
x	Changing program requirements		Renaming of program or collaborative specialization (please notify VPAP before governance)
	Changing timing of program requirements		Creating a new emphasis
			Changes to programs affecting an MOA

This proposal sets out to (1) clarify admission requirements and (2) modify program requirements:

1. Clarification of admission requirements:

The current MASc program admission requirements are: A bachelor's degree in dentistry, engineering, medicine, or one of the physical or biological sciences from a recognized university with a minimum academic standing of A- in the final two years of study.

We propose to set the minimum academic standing to a mid-B (3.0 GPA) or higher in the two final years of study or over senior level-courses.

The rationale for this change is to standardize degree requirements within the different master's programs at IBBME. The change in the minimum grade requirements is also set to align IBBME with SGS' minimum grade requirements.

2. Modification of degree requirements:

The current degree requirements for MASc students are 2.0 FCE, which include BME1450 and three additional courses (1.5 FCE), one of which is physical science or life science depending on the student's undergraduate degree.

We propose the following change, which maintains the total FCE required for degree completion at 2.0, and includes 1.0 FCE of elective courses:

- Two of the following (1.0 FCE): BME1477H: Biomedical Engineering Project Design and Execution; BME1479H: Statistical Discovery Techniques for Biomedical Researchers; or BME1478H: Coding for Biomedical Engineers [course code pending approval]
- Two half course electives relevant to the student's area of research (1.0 FCE)

2 Effective Date of Change

September 1, 2019

3 Academic Rationale

1. Clarification of admission requirements:

The rationale for the change in degree requirements is to align the degree requirements internally across all the master's degrees offered at IBBME. Qualifying a mid-B (3.0 GPA) minimum requirement for admission would ensure the MASc program admission requirements are aligned with the minimum GPA required by SGS for admission in the master's programs. Moreover, this change would provide the opportunity for graduate education to a greater number of qualified individuals. The previous requirement for a GPA of A- (3.7) discouraged many meritorious applicants with relevant experience from applying to the program.

2. Modification of program requirements:

The rationale for amending degree requirements is to ensure the course offerings equip students with knowledge and skills applicable to their research and current market trends.

Lastly, this modification will align the MASc program with the MHSc and PhD course requirements at IBBME.

4 Impact on Students

Students currently enrolled in MASc program will be expected to complete program requirements as specified at the commencement of their degree. Greater flexibility however, will be provided to current student as they choose electives.

Incoming students in 2019 will be expected to complete the new course requirements.

5 Consultation

Consultation involved past and present MASc students enrolled in the program, the Director of IBBME (W. Chan), the Associate Director Graduate Programs IBBME (J.E. Davies), and the Vice-Dean, Graduate Studies (J. Audet).

The new course offerings as well the as the choice provided were well received by both faculty and students during consultations over the past year.

6 Resources

None required.

7 Governance Approval

Unit sign-off	IBBME Graduate Curriculum Committee: January 23, 2019
Dean's office sign-off	Julie Audet, Vice-Dean, Graduate Studies: March 12, 2019
Faculty/division council approval (or delegated body) if applicable	Engineering Graduate Education Committee (EGEC) on behalf of the Faculty of Applied Science & Engineering (FASE): March 13, 2019

Appendix A: Calendar Entry

Please use track changes to indicate where changes have been made.

7.1.1 Master of Applied Science

7.1.1.1 Program Description

The ~~research-intensive~~ MASc program is a research-stream, thesis based program which provides a strong academic foundation for students who want to become immersed in the discipline of biomedical engineering and is designed to offer students challenging and rewarding research opportunities ~~to~~within the context of using engineering principles to enhance the quality of our health-care system.

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

7.1.1.2 Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy IBBME's additional admission requirements stated below.
- A bachelor's degree in dentistry, engineering, medicine, or one of the physical or biological sciences from a recognized university with a minimum academic standing of mid-B or (3.0 GPA) in the final two years of study or over senior level-courses.

7.1.1.3 Program Requirements

- **Coursework.** The program normally comprises **at least 2.0 full-course equivalents (FCEs)** including:
  - Two of the following (1.0 FCE): BME1477H (0.5 FCE): Biomedical Engineering Project Design and Execution; BME1479H (0.5 FCE): Statistical Discovery Techniques for Biomedical Researchers; or BME1478H (0.5 FCE): Coding for Biomedical Engineers [course code pending approval] ~~BME 1450H *Bioengineering Science* (0.5 FCE); and~~
  - Two half course electives relevant to the student's area of research (1.0 FCE)~~an appropriate life science or engineering course (0.5 FCE). Engineering and physical science students must take a life science course, such as JPB 1022H (or an equivalent); life science students must take an engineering or physical science course, such as JPB 1055H (or an equivalent).~~
- Students must participate in:
  - either BME1010H or BME1011H: Graduate Seminar series (0.0 FCE).
  - JDE1000H: Ethics in Research (0.0 FCE).
  - health and safety training workshops.
- Successful completion of a **research thesis** in at least one of the biomedical engineering research fields: 1) Neural/Sensory Systems and Rehabilitation; 2) Biomaterials, Tissue Engineering and Regenerative Medicine; 3) Nanotechnology, Molecular Imaging and Systems Biology; or 4) Engineering in a Clinical Setting.

7.1.1.4 Program Length

5 sessions full-time (typical registration sequence: F/W/S/F/W)

7.1.1.5 Time Limit

3 years full-time

APPENDIX 2

University of Toronto

Minor Modification Proposal: Change to an Existing Graduate Program or Collaborative Specialization

This template should be used to bring forward all proposals for minor modifications to program or admissions requirements for existing graduate programs or collaborative specializations under the University of Toronto's Quality Assurance Process.

Program/Collaborative Specialization being modified:	MHSc in Clinical Engineering
Graduate unit:	IBBME
Faculty/academic division:	Applied Science & Engineering
Dean's office contact:	Julie Audet, Vice-Dean, Graduate Studies
Version date:	March 28, 2019

1 Summary

x	Changing admission requirements		Renaming field, concentration or emphasis
x	Changing program requirements		Renaming of program or collaborative specialization (please notify VPAP before governance)
	Changing timing of program requirements		Creating a new emphasis
			Changes to programs affecting an MOA

This proposal sets out (1) to clarify admission requirements and (2) to modify program requirements:

1. Clarification of admission requirements:

At this time, admission requirements for the MHSc program are: students who hold a bachelor of applied science and engineering degree. We propose to specify the degree equivalents accepted for admission as follows: four year bachelor's degree in engineering, medicine, dentistry or one of the physical or biological sciences from a recognized university with a mid-B (3.0 GPA) or higher in the final 2 years of study or over senior level-courses.

The rationale for this change is to standardize degree requirements within our institute for the master's programs. The change in the minimum grade requirements is also to align IBBME with SGS' minimum grade requirements. The change stems from ongoing inquiries from prospective students about degree requirements and expectations, and seeks to ensure greater transparency, as well as improved access to information.

2. Modification of program requirements:

The course requirements for MHSc students are currently: BME1405H (0.5 FCE), BME1436H (0.5 FCE), BME1439H (0.5 FCE), and one elective (0.5 FCE), relevant to a student's area of research; BME1450H (0.5 FCE) and a life sciences course (0.5 FCE), such as JPB1022H (or an equivalent) and a practical experience course BME4444Y (FCE 1.0), for a total of 4.0 FCEs.

We propose the following change, which maintains the total FCE required at 4.0, and includes 1.0 FCE of elective courses:

- BME1405H (0.5 FCE) and BME1436H (0.5 FCE)
- Two of the following (1.0 FCE): BME1477H: Biomedical Engineering Project Design and Execution (formerly BME1450); BME1479H: Statistical Discovery Techniques for Biomedical Researchers; or BME1478H: Coding for Biomedical Engineers [course code pending approval]
- Two half course electives relevant to the student's area of research (1.0 FCE) and a practical experience course BME4444Y (1.0 FCE)

2 Effective Date of Change

September 1, 2019

3 Academic Rationale

1. Clarification of admission requirements:

The rationale for the change in degree requirements is to align the degree requirements internally across all degrees offered at IBBME. The MASc and PhD programs at IBBME both accept students with four year degrees from engineering, dentistry, medicine or one of the physical or biological sciences.

The change is also meant to reduce the ambiguity pertaining to degree requirements, an issue that has been expressed by students who have contacted IBBME to determine their eligibility for the program.

Qualifying a mid-B (3.0 GPA) minimum requirement for admission, would ensure the MHSc program admission requirements are aligned with SGS minimum requirements. Moreover, this change would provide the opportunity for graduate education to a greater number of qualified individuals.

2. Modification of program requirements:

The rationale for amending degree requirements is to address feedback from students about the required course offerings (see below), specifically referring to BME1405 and BME1439.

The modification seeks to ensure the course offerings equip students with knowledge and skills applicable to their research and current market trends. Lastly, this modification will align the MHSc program with the MASc and PhD course requirements.

4 Impact on Students

The proposed admission change would bear no effect on students continuing in the program. Incoming students would continue to gain admission into the program upon securing a research supervisor.

The modifications in program requirements would apply only to the incoming class of September 2019. Students who enrolled in the program in 2018 would have completed their course work, as such these changes would not be applicable to them. Should there be a student with outstanding electives, they would be encouraged to choose a course applicable to their studies, as previously noted.

5 Consultation

Consultation involved past and present MHSc students enrolled in the MHSc program, the Industry Liaison Officer IBBME (E. Bloch), the Associate Director Professional Program IBBME (J. Andrysek), the Director of IBBME (W. Chan), and the Vice-Dean, Graduate Studies (J. Audet).

Over the past few years, MHSc students have commented on overlapping course material presented in BME1405: Clinical Engineering Instrumentation I and BME1439: Clinical Engineering Instrumentation II. To address this concern and guarantee that students are able to benefit from the breadth and specificity of the courses, BME1405 will remain a required course, while students will have the option of enrolling in BME1439 as an elective. Students also noted ambiguity about specific life science and engineering requirements, which is addressed by the new changes.

Prospective students applying to the MHSc program were found to request clarification regarding degree requirements. The new admission requirements would alleviate the said ambiguity.

Taken together, the changes proposed sought to address the concerns brought up by the key stakeholders and ensure the program is in line with other offering at IBMME.

6 Resources

None required.

7 Governance Approval

Unit sign-off	IBBME Graduate Curriculum Committee: January 23, 2019
Dean's office sign-off	Julie Audet, Vice-Dean, Graduate Studies: March 12, 2019
Faculty/division council approval (or delegated body) if applicable	Engineering Graduate Education Committee (EGEC) on behalf of the Faculty of Applied Science & Engineering: March 13, 2019

Appendix A: Calendar Entry

Please use track changes to indicate where changes have been made.

7.1.1 Master of Health Science

7.1.1.1 Program Description

The MHSc program educates students on how to apply and implement medical technologies to optimize modern health-care delivery. This professional degree program consists of academic courses and a research thesis and provides students with real-world exposure through a practical experience course ~~internship~~ with a private sector company, a hospital, or a research facility.

7.1.1.2 Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy IBBME's additional admission requirements stated below.

- ~~Selected students who hold a bachelor of applied science degree in engineering.~~ Selected students with a 4 year bachelor's degree in engineering, medicine, dentistry or one of the physical or biological sciences from a recognized university with a mid-B (3.0 GPA) or higher in the final 2 years of study or over senior level-courses.

7.1.1.3 Program Requirements

- **Coursework.** Students must normally complete **4.0 full-course equivalents (FCEs)** as follows:

    - BME1405H (0.5 FCE), BME1436H (0.5 FCE)

    - Two of the following (1.0 FCE): BME1477H (0.5 FCE): Biomedical Engineering Project Design and Execution; BME1479H (0.5 FCE): Statistical Discovery Techniques for Biomedical Researchers; or BME1478H (0.5 FCE): Coding for Biomedical Engineers [course code pending approval]

    - Two half course electives relevant to the student's area of research (1.0 FCE) ~~BME 1439H (0.5 FCE), and one elective (0.5 FCE), relevant to a student's area of researchBME1450H (0.5 FCE) and a life sciences course (0.5 FCE), such as JPB1022H (or an equivalent)~~BME4444Y (1.0 FCE) ~~of internships~~ Practical Experience Course ~~(BME4444Y)~~ in health-care facilities, the medical device industry, or health-care consulting firms. The internship must total a minimum of 625 hours.

- Students must participate in:

    - either BME1010H or BME1011H: Graduate Seminar series (0.0 FCE) and

    - JDE1000H: Ethics in Research (0.0 FCE).

- Successful completion of a **thesis**.

7.1.1.4 Program Length

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

7.1.1.5 Time Limit

3 years full-time

APPENDIX 3

University of Toronto
Minor Modification Proposal: Change to an Existing Graduate Program or Collaborative Specialization

This template should be used to bring forward all proposals for minor modifications to program or admissions requirements for existing graduate programs or collaborative specializations under the University of Toronto's Quality Assurance Process.

Program/Collaborative Specialization being modified:	MEng
Graduate unit:	IBBME
Faculty/academic division:	Applied Science and Engineering
Dean's office contact:	Julie Audet, Vice-Dean, Graduate Studies
Version date:	March 28, 2019

1 Summary

x	Changing admission requirements		Renaming field, concentration or emphasis
x	Changing program requirements		Renaming of program or collaborative specialization (please notify VPAP before governance)
	Changing timing of program requirements		Creating a new emphasis
			Changes to programs affecting an MOA

This proposal sets out to (1) clarify degree requirements, (2) merge course concentration areas for MEng students at IBBME.

(1) Change in admission requirements:

At this time admission requirements for the MEng program are a bachelor's degree in engineering or equivalent with an A- average in the two final years of study. We propose to specify the degree equivalents accepted for admission as follows: four year bachelor's degree in engineering, medicine, dentistry or one of the physical or biological sciences from a recognized university with a mid-B average (3.0 GPA) or higher in the final two years of study or over senior level-courses.

The rationale for this change is to standardize degree requirements within our institute and to align IBBME with SGS' minimum grade requirements. The change stems from ongoing inquiries from prospective students about degree requirements and expectations, and seeks to ensure greater transparency, as well as improved access to information.

(2) Change in program requirements:

The current course requirements for MEng students are: 1.0 FCE in biomedical engineering (BME) technology pillar courses, 1.0 FCE in the biomedical sciences pillar courses and 1.0 FCE commercialization and entrepreneurship courses, a 1.5 FCEs practical experience course, and 0.5 FCE graduate course elective. Of the 5.0 FCEs, 3.5 FCEs must be BME courses and the remaining 1.5 FCEs can be any graduate level course.

In the interest of streamlining course selection for students we propose the merging for the Biomedical Engineering Technology Pillar (1.0 FCE) and Biomedical Sciences Pillar (1.0 FCE) into *Biomedical Engineering Pillar* (2.0 FCEs). The total BME courses would remain 3.5 FCEs, with the remaining three courses (1.5 FCEs) taken at any graduate level department.

2 Effective Date of Change

September 1, 2019

3 Academic Rationale

(1) Change in admission requirements:

The rationale for the change in degree requirements is to both align the degree requirements internally within IBBME and among other departments in the Faculty of Applied Science & Engineering. The MASc and PhD programs at IBBME both accept students with four year degrees from engineering, dentistry, medicine or one of the physical or biological sciences. Similarly, the departments of Electrical & Computer Engineering, Civil Engineering, and Mechanical & Industrial Engineering accept students with a general four year bachelor's in science equivalent.

The change is also meant to reduce the ambiguity pertaining to degree requirements, an issue that has been expressed by students who have contacted IBBME to determine their eligibility for the program. Students with degrees other than engineering have previously been accepted to the program, on a case by case basis and have performed well as compared to their peers.

Qualifying a mid-B (3.0 GPA) minimum requirement over the final two years of study for admission, would ensure the MEng program admission requirements are aligned with SGS minimum GPA requirement for admission in the master's programs. Moreover, this change would provide the opportunity for graduate education to a greater number of qualified individuals.

(2) Change in program requirements:

The rationale for merging the biomedical engineering and sciences pillars is to remove unnecessary ambiguity from course selection and ensure students enrol in courses that best suit their interest and strengths. The research and education programs at IBBME are found at the intersection of biomedical science and engineering. The course themes/pillars as a result are not mutually exclusive and therefore cause unnecessary confusion for students. The unification of the said pillars under a new classification of biomedical engineering would provide students with clear instructions for course selection, while maintaining the same number of FCEs and learning objectives.

4 Impact on Students

Since the MEng degree is a year-long program, the proposed changes would not have an impact on students currently enrolled in the program full-time. For students enrolled on a part-time basis, the change in the pillar structure would simplify the process of course selection. Any additional courses in which they enroll would subsequently be added to biomedical engineering pillar. Students will achieve the same learning outcomes and maintain the same course load as originally set out in the program.

Incoming students will be able to navigate the course offerings and program requirements more easily and will spend less time requesting course approval, as requested by students currently in the program (see below).

5 Consultation

Consultation involved students currently enrolled in the MEng program, the Industry Liaison Officer IBBME (E. Bloch), the Associate Director Professional Program IBBME (J. Andrysek), the Director of IBBME (W. Chan), and the Vice-Dean, Graduate Studies (J. Audet).

A call for feedback about the course selection was sent to MEng students who commenced the program in Sept. 2018 by email. Students were happy with the course offerings, however, they found the process of course selection to be conflicting and confusing due to overlapping courses within the pillars. They sought greater transparency in making sure they fulfil degree requirements while ensuring they had their choice from courses in a variety of themes.

Prospective students applying to the MEng program were found to request clarification regarding degree requirements at a higher rate compared to students applying to other programs.

Taken together, the changes proposed sought to address the concerns brought up by the key stakeholders and ensure the program is in line with other offering at IBBME and within the Faculty of Applied Science and Engineering and the School of Graduate Studies (SGS).

6 Resources

None required.

7 Governance Approval

Unit sign-off	IBBME Graduate Curriculum Committee: January 23, 2019
Dean's office sign-off	Julie Audet, Vice-Dean, Graduate Studies: March 12, 2019
Faculty/division council approval (or delegated body) if applicable	Engineering Graduate Education Committee (EGEC) on behalf of the Faculty of Applied Science & Engineering: March 15, 2019

Appendix A: Calendar Entry

Please use track changes to indicate where changes have been made.

7.1.1 Master of Engineering

7.1.1.1 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 ~~internship~~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 Rehabilitation. Students can take the program on a full-time or part-time basis.

7.1.1.2 Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy IBBME's additional admission requirements stated below.

A 4-year bachelor's degree in engineering, medicine, dentistry or one of the physical or biological sciences from a recognized university, ~~or equivalent from a recognized university~~ with at least a mid-B average (3.0 GPA) ~~over senior level coursesof A-~~ in the final two years of study or over senior-level courses.

7.1.1.3 Program Requirements

- **Coursework.** The program comprises at least **5.0 full-course equivalents (FCEs)** as follows:
    - at least 2~~1~~.0 FCE in biomedical engineering ~~technology~~ courses.
    - at least 1.0 FCE in commercialization and entrepreneurship courses ~~including~~ such as BME1800H, ~~and~~ BME1801H, BME1802H, and BME1405.

~~o at least 1.0 FCE in biomedical sciences courses;~~

    - a 1.5 FCE Practical Experience in Applied Research course ~~internship~~ in biomedical device development, usually over one session for the full-time option (BME1899Y), ~~and~~ or over three sessions for the part-time option (BME1898Y). The internship must be in at least one of the following biomedical engineering research fields: 1) Neural/Sensory Systems and Rehabilitation; 2) Biomaterials, Tissue Engineering and Regenerative Medicine; 3) Nanotechnology, Molecular Imaging and Systems Biology; or 4) Engineering in a Clinical Setting. The ~~internship~~ 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 FCE can be a half course in either biomedical engineering~~technology~~, commercialization and entrepreneurship, or any graduate level course the student is interested in. ~~biomedical sciences.~~

- For the 5.0 FCEs, 3~~2~~.5 FCEs must be BME courses (or a joint BME course with the designator JCB, JEB, JPB, JSB, DEN, or JMM) this includes: the practicum project BME1899Y or BME1898Y (1.5 FCE), BME commercialization and entrepreneurship courses 1.0 FCE and BME biomedical engineering courses (2.0 FCE). The remaining three courses (1.5 FCEs) can be taken from any other department associated with the program. All courses must be graduate level, which includes both 500- and 1000-level. Students can take a maximum of one 500-level course.

~~• A curriculum plan must be submitted to the program director prior to the start of the program.~~

- ~~A written report submitted to the program director.~~

- Health and safety training workshops.
- Students have the option of completing an emphasis in 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.

7.1.1.4 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)

7.1.1.5 Time Limit

2 years full-time;
6 years part-time

7.1.1.6 Course List

~~**7.1.1.6.1 Biomedical Engineering Technology**~~

BME 1405H	Clinical Engineering Instrumentation I
BME 1436H	Clinical Engineering Surgery
BME 1439H	Clinical Engineering Instrumentation II
~~BME 1452H~~	~~Signal Processing for Bioengineering~~
BME 1457H	Biomedical Nanotechnology
BME 1458H	Pattern Discovery Methods for Biomedical Engineering
BME 1462H	Biological Image Analysis
BME 1464H	Orthopaedic Biomechanics and Mechanics of Biomaterials
BME 1471H	Rehabilitation Engineering
BME 1472H	Fundamentals of Neuromodulation Technology and Clinical Applications
BME 1473H	Acquisition and Processing of Bioelectric Signals

BME 1480H	Experimental Design and Multivariate Analysis in Bioengineering
JEB 1365H	Ultrasound: Theory and Applications in Biology and Medicine
JEB 1433H	Medical Imaging
JEB 1444H	Neural Engineering
JEB 1447H	Sensory Communications
JMB 1050H	Biological and Bio-inspired Materials
BME 1453H	Cell and Tissue Engineering
BME 1454H	Regenerative Medicine: Fundamentals and Applications
BME 1459H	Protein Engineering
BME 1460H	Quantitative Fluorescence Microscopy: Theory and Application to Live Cell Imaging
BME/JBP 1022H	Human Physiology as Related to Bioengineering II
JCB 1349H	Molecular Assemblies: Structure/Function/Properties

~~**Biomedical Science**~~

~~BME 1453H~~	~~Cell and Tissue Engineering~~

~~BME 1454H~~	~~Regenerative Medicine: Fundamentals and Applications~~
~~BME 1459H~~	~~Protein Engineering~~
~~BME 1460H~~	~~Quantitative Fluorescence Microscopy: Theory and Application to Live Cell Imaging~~
~~BME/JBP 1022H~~	~~Human Physiology as Related to Bioengineering II~~
~~JCB 1349H~~	~~Molecular Assemblies: Structure/Function/Properties~~

7.1.1.6.2 Commercialization and Entrepreneurship

BME 1800H	Biomedical Product Development I
BME 1801H	Biomedical Product Development II
BME 1899Y or BME 1898Y	~~Internship in~~Practical Experience in Applied Research (FT)/ Practical Experience in Applied Research (PT)
BME 1405H	Clinical Engineering Instrumentation I

BME 1802H	Biomedical Devices – Human Factors

APPENDIX 4

University of Toronto

Minor Modification Proposal: Change to an Existing Graduate Program or Collaborative Specialization

This template should be used to bring forward all proposals for minor modifications to program or admissions requirements for existing graduate programs or collaborative specializations under the University of Toronto's Quality Assurance Process.

Program/Collaborative Specialization being modified:	PhD (all 5 fields defined in the PhD): Field 1: Neural/Sensory Systems and Rehabilitation; Field 2: Biomaterials, Tissue Engineering and Regenerative Medicine; Field 3: Nanotechnology, Molecular Imaging and Systems Biology; Field 4: Engineering in a Clinical Setting Field 5: Clinical Engineering
Graduate unit:	IBBME
Faculty/academic division:	Applied Science & Engineering
Dean's office contact:	Julie Audet, Vice-Dean, Graduate Studies
Version date:	March 28, 2019

1 Summary

x	Changing admission requirements		Renaming field, concentration or emphasis
x	Changing program requirements		Renaming of program or collaborative specialization (please notify VPAP before governance)
	Changing timing of program requirements		Creating a new emphasis
			Changes to programs affecting an MOA

This proposal sets out to (1) clarify admission requirements and (2) modify program requirements for PhD students at IBBME.

The current PhD program admission requirements are: A bachelor's degree in dentistry, engineering, medicine, or one of the physical or biological sciences from a recognized university with a minimum academic standing of A- in the final two years of study. We propose to change the minimum grade requirements for admission in the PhD program to align IBBME with SGS' minimum grade requirements which is B+ for students with a Master's degree and A- for students admitted directly with an undergraduate degree.

In terms of the program requirements, students will complete the same total number of FCEs, but will choose their required courses from a list of three options, as applicable to their research.

The PhD program at IBBME is composed of 5 fields: (1) Neural/Sensory Systems and Rehabilitation; (2) Biomaterials, Tissue Engineering and Regenerative Medicine; (3) Nanotechnology, Molecular Imaging and Systems Biology; (4) Engineering in a Clinical Setting; and (5) Clinical Engineering. The modification described are equivalent across the five fields. The specific changes are discussed in details below:

PhD in Biomedical Engineering, fields 1-4:

1. PhD

Current:

- 1.0 FCE (BME1450 and life science or physical science course)

Proposed:

Two of the following (1.0 FCE): BME1477H: Biomedical Engineering Project Design and Execution; BME1478H: Coding for Biomedical Engineers [pending approval of course code]; or BME1479H: Statistical Discovery Techniques for Biomedical Researcher

2. PhD Transfer

Current:

- 3.0 FCE (Required BME 1450 and life science or physical science course)

Proposed:

- Two of the following (1.0 FCE): BME1477H: Biomedical Engineering Project Design and Execution; BME1478H: Coding for Biomedical Engineers [pending approval of course code]; or BME1479H: Statistical Discovery Techniques for Biomedical Researchers.
- Elective courses relevant to the student's area of research (2.0 FCE)

3. PhD Direct-Entry

Current:

- 3.0 FCE (Required BME1450 and life science or physical science course)

Proposed:

- Two of the following (1.0 FCE): BME1477H: Biomedical Engineering Project Design and Execution; BME1478H: Coding for Biomedical Engineers [pending approval of course code]; or BME1479H: Statistical Discovery Techniques for Biomedical Researchers.
- Elective courses relevant to the student's area of research (2.0 FCE)

PhD in Clinical Engineering (field 5):

1. PhD

Current:

- Minimum of 1.0 FCE:
    - 1.0 FCE (BME1450 and life science or physical science course)
    - 0.5 FCE in Clinical Engineering IBBME courses, if not formally trained as clinical engineer

Proposed:

- Minimum of 1.0 FCE:
    - Two of the following (1.0 FCE): BME1477H: Biomedical Engineering Project Design and Execution; BME1478H: Coding for Biomedical Engineers [pending approval of course code]; or BME1479H: Statistical Discovery Techniques for Biomedical Researcher
    - 0.5 FCE in Clinical Engineering IBBME courses, if not formally trained as clinical engineer (BME1405H, BME1439H, BME1436or BME4444Y)

2. PhD Transfer

Current:

- Total of 5.0 FCE including:
    - 4.0 FCE MHSc course requirements:
        - BME 1450H (0.5 FCE)
        - BME1405H (0.5 FCE), BME1436H (0.5 FCE), BME1439H (0.5 FCE), and one elective (0.5 FCE), relevant to a student's area of research;
        - a life sciences course (0.5 FCE), such as JPB1022H (or an equivalent)
        - Practical experience course BME4444Y (FCE 1.0)
    - 1.0 FCE for PhD level courses

Proposed:

- Total of 5.0 FCE including:
    - 4.0 FCE MHSc course requirements:
        - Two of the following (1.0 FCE): BME1477H: Biomedical Engineering Project Design and Execution; BME1478H: Coding for Biomedical Engineers [pending approval of course code]; or BME1479H: Statistical Discovery Techniques for Biomedical Researchers
        - BME1405H (0.5 FCE) and BME1436H (0.5 FCE)
        - Two half course electives relevant to the student's area of research (1.0 FCE)
        - Practical experience course BME4444Y (FCE 1.0)
    - 1.0 FCE for PhD level courses

3. PhD Direct-Entry

Current:

- Total of 3.0 FCE including:

- BME 1450
- Life science or physical science course (0.5 FCE)
- 0.5 FCE in IBBME clinical engineering courses (BME 1405H, BME1439H, BME1436H or BME4444Y)

Proposed:

- Total of 3.0 FCE including
  - Two of the following (1.0 FCE): BME1477H: Biomedical Engineering Project Design and Execution; BME1478H: Coding for Biomedical Engineers [pending approval of course code]; or BME1479H: Statistical Discovery Techniques for Biomedical Researchers.
  - 0.5 FCE in IBBME clinical engineering courses
  - Elective courses relevant to the student's area of research (1.5 FCEs)

The rationale for this change is to standardize degree requirements within our institute and ensure that both required and elective courses are applicable to each student's research.

2 Effective Date of Change

September 1, 2019.

3 Academic Rationale

The rationale for the change in minimum GPA for admission in the PhD program is that currently with a minimum GPA set A-, several meritorious applicants with relevant research experience but a lower GPA are discouraged from applying to the PhD program. Amending the degree requirements is to ensure the course offerings equip students with knowledge and skills applicable to their research and current market trends. This modification will also align the PhD program with the MASc and MHSc course requirements at IBBME.

4 Impact on Students

Students currently enrolled in the PhD program will be expected to complete program requirements as specified at the commencement of their degree. Greater flexibility, however, will be provided to current student when they choose electives, as the new course offerings will also be available to them.

Incoming students in 2019 will be expected to complete the new course requirements.

5 Consultation

Consultation involved past and present MASc students enrolled in the program, the Industry Liaison Officer IBBME (E. Bloch), the Associate Director Graduate Programs IBBME (J.E. Davies), the Director of IBBME (W. Chan) and the Vice-Dean, Graduate Studies (J. Audet).

The new course offerings as well the as the choice provided were well received by both faculty and students during consultations over the past year.

6 Resources

None required.

7 Governance Approval

Unit sign-off	IBBME Graduate Curriculum Committee: January 23, 2019
Dean's office sign-off	Julie Audet, Vice-Dean, Graduate Studies: March 12, 2019
Faculty/division council approval (or delegated body) if applicable	Engineering Graduate Education Committee (EGEC) on behalf of the Faculty of Applied Science & Engineering (FASE): March 15, 2019

Appendix A: Calendar Entry

Please use track changes to indicate where changes have been made.

7.1.1 Doctor of Philosophy

7.1.1.1 Program Description

The PhD program offers courses and a strong research thesis component. Students emerge from this program ready to pursue careers in academia, medicine, industry, and government. Students with a particular interest in conducting biomedical engineering research with a primary clinical focus may pursue a field in clinical engineering within the Biomedical Engineering PhD program.

Applicants may enter the PhD program via one of three routes: 1) following completion of an appropriate master's degree; 2) transfer from the University of Toronto MASc or MHSc program; or 3) direct entry following completion of an appropriate bachelor's degree.

7.1.2 Fields: 1) Neural/Sensory Systems and Rehabilitation
2) Biomaterials, Tissue Engineering and Regenerative Medicine
3) Nanotechnology, Molecular Imaging and Systems Biology
4) Engineering in a Clinical Setting

7.1.3 PhD Program

7.1.3.1 Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy IBBME's additional admission requirements stated below.

- Applicants must have master's degree in dentistry, engineering, medicine, or one of the physical or biological sciences with an overall average of at least B+ (GPA 3.3) from a recognized university. ~~Applicants must have an undergraduate degree in engineering.~~

- ~~At least a B+ standing from a recognized university in the last two years of study.~~

7.1.3.2 Program Requirements

- **Coursework.** Normally, students must complete **at least 1.0 full-course equivalent (FCE)** including:

  - ~~Engineering and physical science students are required to take a life science course (0.5 FCE), such as JPB 1022H (or an equivalent). Life science students must take a physical science course (0.5 FCE), such as JPB 1055H (or an equivalent).~~Two of the following (1.0 FCE): BME 1477H: Biomedical Engineering Project Design and Execution; BME1478H: Coding for Biomedical Engineers [pending approval of course code] or BME1479H: Statistical Discovery Techniques for Biomedical Researchers.

  - Students are also expected to ~~take BME 1450H *Bioengineering Science* and~~ pursue a **thesis topic** relevant to 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; and 4) Neural/Sensory Systems Rehabilitation; or 5) Clinical Engineering.

- Within 12 months of registration, students must pass a **qualifying examination** covering the broad field of biomedical engineering appropriate to their background.
- Successful completion of a **thesis**, representing an original investigation in biomedical engineering.
- Students will continue to meet with their supervisory committee at least once every 12 months until recommendation for the **departmental oral examination** is made. On the recommendation of the supervisory committee and special approval from their department Graduate Chair or Coordinator, candidates have the opportunity to waive the departmental oral examination and proceed directly to the **Doctoral Final Oral Examination**.
- Students must participate in:

o either BME1010H or BME1011H: Graduate Seminar *series* (0.0 FCE)

o JDE1000H: Ethics in Research (0.0 FCE)

o Health and safety training workshops.

7.1.3.3 Program Length

4 years

7.1.3.4 Time Limit

6 years

7.1.4 PhD Program (Transfer)

7.1.4.1 Transfer Requirements

- Highly qualified master's students (MHSc students in Clinical Engineering or MASc students in any field) may be considered for transfer into the PhD program in any of the five fields. ~~. . To be eligible to transfer to the PhD, Clinical Engineering MHSc students must complete 3.0 full-course equivalents (FCEs) within the MHSc curriculum.~~ MASc and MHSc students who transfer to ~~the~~a PhD ~~in the field of Clinical Engineering~~ must fulfil the admission requirements listed under the specific field of the PhD program they are transferring to.~~in section 7.1.7.1 and the PhD program requirements listed in section 7.1.9.2. MHSc students who transfer to the other PhD fields must fulfil the PhD program requirements listed in section 7.1.4.2.~~

7.1.4.2 Program Requirements

- **Coursework.** Students who transfer without completing a master's degree in biomedical engineering must complete the total course requirements for both degrees: 2.0 full-course equivalents (FCEs) for the master's level plus 1.0 FCE for the PhD level, for a total of **3.0 FCEs**:

o ~~Engineering and physical science students must take a life science course (0.5 FCE), such as JPB 1022H (or an equivalent). Life science students must take a physical science course (0.5 FCE), such as JPB1055H (or an equivalent).~~Two of the following (1.0 FCE): BME1477H (0.5 FCE): Biomedical Engineering Project Design and Execution; BME1479H (0.5 FCE): Statistical

Ddiscovery Ttechniques for Bbiomedical Rresearchers; or BME1478H (0.5 FCE): Coding for Biomedical Engineers (course code under review).

- Elective courses relevant to the student's area of research (2.0 FCEs)
- Students are expected to take BME1450H *Bioengineering Science* (0.5 FCE) and pursue a thesis topic relevant to at least one of the following Biomedical Engineering research fields: 1) Neural/Sensory Systems and Rehabilitation; 2) Biomaterials, Tissue Engineering and Regenerative Medicine; 3) Nanotechnology, Molecular Imaging and Systems Biology; 4) Engineering in a Clinical Setting; or 5) Clinical Engineering.

- Within 12 months of registration, students must pass a **qualifying examination** covering the broad field of biomedical engineering appropriate to their background.
- Successful completion of a **thesis**, representing an original investigation in biomedical engineering.
- Students will continue to meet with their supervisory committee at least once every 12 months until recommendation for the **departmental oral examination** is made. On the recommendation of the supervisory committee and special approval from their department Graduate Chair or Coordinator, candidates have the opportunity to waive the departmental oral examination and proceed directly to the **Doctoral Final Oral Examination**.
- Students must participate in:
  - either BME1010H or BME1011H: Graduate Seminar series (0.0 FCE)
  - JDE1000H: Ethics in Research (0.0 FCE)
  - Health and safety training workshops.

7.1.4.3 Program Length

5 years

7.1.4.4 Time Limit

7 years

7.1.5 PhD Program (Direct-Entry)

7.1.5.1 Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy IBBME's additional admission requirements stated below.
- Direct entry with a bachelor's degree may be considered in exceptional cases. Applicants must have an undergraduate degree in dentistry, engineering, medicine, or one of the physical or biological sciences.
- At least a A- standing from a recognized university in the last two years of study.

7.1.5.2 Program Requirements

- **Coursework.** Normally, students must complete **3.0 full-course equivalents (FCEs)** including:

o ~~Engineering and physical science students must take a life science course (0.5 FCE), such as JPB1022H (or an equivalent). Life science students must take a physical science course (0.5 FCE), such as JPB1055H (or an equivalent).~~Two of the following (1.0 FCE): BME1477H: Biomedical Engineering Project Design and Execution; BME1478H: Coding for Biomedical Engineers [pending approval of course code]; or BME1479H: Statistical Discovery Techniques for Biomedical Researchers.

o Elective courses relevant to the student's area of research (2.0 FCEs)

o Students are also expected to ~~take BME 1450H Bioengineering Science (0.5 FCE) and~~ pursue a thesis topic relevant to at least one of the following Biomedical Engineering research fields: 1) Neural/Sensory Systems and Rehabilitation; 2) Biomaterials, Tissue Engineering and Regenerative Medicine; 3) Nanotechnology, Molecular Imaging and Systems Biology; 4) Engineering in a Clinical Setting~~; or 5) Clinical Engineering~~.

- Successful completion of a **thesis**, representing an original investigation in biomedical engineering.

- Students will continue to meet with their supervisory committee at least once every 12 months until recommendation for the **departmental oral examination** is made. On the recommendation of the supervisory committee and special approval from their department Graduate Chair or Coordinator, candidates have the opportunity to waive the departmental oral examination and proceed directly to the **Doctoral Final Oral Examination**.

- Students must participate in:

o either BME1010H or BME1011H *Graduate Seminar* series (0.0 FCE)

o JDE1000H *Ethics in Research* (0.0 FCE)

o health and safety training workshops.

7.1.5.3 Program Length

5 years

7.1.5.4 Time Limit

7 years

7.1.6 Field: 5) Clinical Engineering

7.1.7 PhD Program

7.1.7.1 Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy IBBME's additional admission requirements stated below.

- Applicants must have master's degree in dentistry, engineering, medicine, or one of the physical or biological sciences with an overall average of at least B+ (GPA 3.3) from a recognized university.

~~At least a B+ standing from a recognized university in the last two years of study.~~

- ~~Applicants must have an undergraduate degree in engineering.~~

7.1.7.2 Program Requirements

- **Coursework.** Normally, students must complete **at least 1.0 full-course equivalent (FCE)** including:

o ~~Engineering and physical science students must take a life science course (0.5 FCE), such as JPB1022H (or an equivalent). Life science students must take a physical science course (0.5 FCE), such as JPB1055H (or an equivalent).~~Two of the following (1.0 FCE): BME1477H: Biomedical Engineering Project Design and Execution; BME1478H: Coding for Biomedical Engineers [pending approval of course code]; or BME1479H: Statistical Discovery Techniques for Biomedical Researchers.

o If a student does not have a formal degree in clinical engineering, 0.5 FCE from one of the IBBME clinical engineering courses (BME1405H, BME1439H, BME1436H, or BME4444H) is required. A student who possesses protracted professional engineering experience (five or more years) will be exempt from this requirement.

o ~~Students are expected to take BME1450H Bioengineering Science (0.5 FCE) and pursue a **thesis topic** relevant to at least one of the following Biomedical Engineering research fields: 1) Neural/Sensory Systems and Rehabilitation; 2) Biomaterials, Tissue Engineering and Regenerative Medicine; 3) Nanotechnology, Molecular Imaging and Systems Biology; 4) Engineering in a Clinical Setting; or 5) Clinical Engineering.~~

- Students must (1) conduct their research in a clinical environment and (2) be co-supervised by both engineering and health science faculty. The primary supervisor must be IBBME-appointed; however, the co-supervisor could be from a clinical unit other than IBBME but must be appointed to SGS.

- Within 12 months of registration, students must pass a **qualifying examination** covering the broad field of biomedical engineering appropriate to their background.

- Successful completion of a **thesis**, representing an original investigation in biomedical engineering.

- Students will continue to meet with their supervisory committee at least once every 12 months until recommendation for the **departmental oral examination** is made. On the recommendation of the supervisory committee and special approval from their department Graduate Chair or Coordinator, candidates have the opportunity to waive the departmental oral examination and proceed directly to the **Doctoral Final Oral Examination**.

- Students must participate in:

o either BME 1010H or BME 1011H: Graduate Seminar series (0.0 FCE)

- JDE 1000H: Ethics in Research (0.0 FCE)
- health and safety training workshops.

7.1.7.3 Program Length
4 years

7.1.7.4 Time Limit
6 years

7.1.8

7.1.9 PhD Program (Transfer)

7.1.9.1 Transfer Requirements

- Highly qualified master's students (MHSc students in Clinical Engineering or MASc students in any field) may be considered for transfer into the PhD program in any of the ~~five three~~five research fields. To be eligible to transfer to the PhD, C~~c~~linical Engineering MHSc students must complete 3.0 full-course equivalents (FCEs) within the MHSc curriculum. MHSc students who transfer to the PhD in the field of Clinical Engineering must fulfil the PhD program requirements listed below~~in section 7.1.9.2~~. MHSc students who transfer to the other PhD fields must fulfil the program requirements of the PhD field, as described in the applicable section.~~listed in section 7.1.4.2.~~

7.1.9.2 Program Requirements

- **Coursework.** Students who transfer without completing a master's degree in biomedical engineering must complete the total course requirements for both degrees: 4.0 full-course equivalents (FCEs) for the master's level plus 1.0 FCE for the PhD level, for a total of **5.0 FCEs**:

o ~~Engineering and physical science students must take a life science course (0.5 FCE), such as JPB1022H (or an equivalent). Life science students must take a physical science course (0.5 FCE), such as JPB1055H (or an equivalent).~~Two of the following (1.0 FCE): BME1477H: Biomedical Engineering Project Design and Execution; BME1478H: Coding for Biomedical Engineers [pending approval of course code]; or BME1479H: Statistical Discovery Techniques for Biomedical Researchers

o Elective courses relevant to the student's area of research (2.0 FCEs)

o If a student does not have a formal degree in clinical engineering, 0.5 FCE from one of the IBBME clinical engineering courses (BME1405H, BME1439H, BME1436H, or BME4444H) is required. A student who possesses protracted professional engineering experience (five or more years) will be exempt from this requirement.

~~o Students are expected to take BME 1450H *Bioengineering Science* (0.5 FCE) and pursue a thesis topic relevant to at least one of the following Biomedical Engineering research fields: 1) Neural/Sensory Systems and Rehabilitation; 2) Biomaterials, Tissue Engineering and Regenerative Medicine; 3) Nanotechnology, Molecular Imaging and Systems Biology; 4) Engineering in a Clinical Setting; or 5) Clinical Engineering.~~

- Students must (1) conduct their research in a clinical environment and (2) be co-supervised by both engineering and health science faculty. The primary supervisor must be IBBME-appointed; however, the co-supervisor could be from a clinical unit other than IBBME but must be appointed to SGS.
- Within 12 months of registration, students must pass a **qualifying examination** covering the broad field of biomedical engineering appropriate to their background.
- Successful completion of a **thesis**, representing an original investigation in biomedical engineering.
- Students will continue to meet with their supervisory committee at least once every 12 months until recommendation for the **departmental oral examination** is made. On the recommendation of the supervisory committee and special approval from their department Graduate Chair or Coordinator, candidates have the opportunity to waive the departmental oral examination and proceed directly to the **Doctoral Final Oral Examination**.
- Students must participate in:

o either BME1010H or BME1011H: Graduate Seminar *series* (0.0 FCE)

o JDE1000H: Ethics in Research (0.0 FCE)

o health and safety training workshops.

7.1.9.3 Program Length

5 years

7.1.9.4 Time Limit

7 years

7.1.10

7.1.11 PhD Program (Direct-Entry)

7.1.11.1 Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy IBBME's additional admission requirements stated below.
-
- Direct entry with a bachelor's degree may be considered in exceptional cases. Applicants must have an undergraduate degree in dentistry, engineering, medicine, or one of the physical or biological sciences.

~~Direct entry with a bachelor's degree may be considered in exceptional cases.~~Direct entry with a bachelor's degree may be considered in exceptional cases. Applicants must have an undergraduate degree in dentistry, engineering, medicine, or one of the physical or biological ~~sciences.~~

~~At least a A- standing from a recognized university in the last two years of study.~~

7.1.11.2 Program Requirements

- **Coursework.** Normally, students must complete **3.0 full-course equivalents (FCEs)** including:

  - ~~Engineering and physical science students must take a life science course (0.5 FCE), such as JPB1022H (or an equivalent). Life science students must take a physical science course (0.5 FCE), such as JPB1055H (or an equivalent).~~Two of the following (1.0 FCE): BME1477H: Biomedical Engineering Project Design and Execution; BME1478H: Coding for Biomedical Engineers [pending approval of course code]; or BME1479H: Statistical Discovery Techniques for Biomedical Researchers

  - Elective courses relevant to the student's area of research (2.0 FCEs)

  - If a student does not have a formal degree in clinical engineering, 0.5 FCE from one of the IBBME clinical engineering courses (BME1405H, BME1439H, BME1436H, or BME4444H) is required. A student who possesses protracted professional engineering experience (five or more years) will be exempt from this requirement.

  - ~~Students are also expected to take BME 1450H Bioengineering Science (0.5 FCE) and pursue a thesis topic relevant to at least one of the following Biomedical Engineering research fields: 1) Neural/Sensory Systems and Rehabilitation; 2) Biomaterials, Tissue Engineering and Regenerative Medicine; 3) Nanotechnology, Molecular Imaging and Systems Biology; 4) Engineering in a Clinical Setting; or 5) Clinical Engineering.~~

- Students in the Clinical Engineering field must (1) conduct their research in a clinical environment and (2) be co-supervised by both engineering and health science faculty. The primary supervisor must be IBBME-appointed; however, the co-supervisor could be from a clinical unit other than IBBME but must be appointed to SGS.

- Within 12 months of registration, students must pass a **qualifying examination** covering the broad field of biomedical engineering appropriate to their background.

- Successful completion of a **thesis**, representing an original investigation in biomedical engineering.

- Students will continue to meet with their supervisory committee at least once every 12 months until recommendation for the **departmental oral examination** is made. On the recommendation of the supervisory committee and special approval from their department Graduate Chair or Coordinator, candidates have the opportunity to waive the departmental oral examination and proceed directly to the **Doctoral Final Oral Examination**.

- Students must participate in:

  - either BME1010H or BME1011H: Graduate Seminar series (0.0 FCE)

  - JDE 1000H: Ethics in Research (0.0 FCE)

  - health and safety training workshops.

7.1.11.3 Program Length

5 years

7.1.11.4 Time Limit

7 years

APPENDIX 5

University of Toronto

Minor Modification Proposal: Participation in a Collaborative Specialization

This template should be used to bring forward all proposals to add or withdraw participation of a degree program from a graduate collaborative specialization for governance approval under the *University of Toronto Quality Assurance Process*.

Collaborative specialization:	Collaborative Master's and Doctoral Specialization in Engineering Education
Collaborative specialization director:	Prof. Greg Evans, Institute for Studies in Transdisciplinary Engineering Education & Practice (ISTEP)
Lead Faculty:	Applied Science & Engineering
Degree program(s) being added:	MA, MEd and PhD in Higher Education
Unit offering above degree program:	Department of Leadership, Higher Education and Adult Education, Ontario Institute for Studies in Education (OISE)
Dean's office contact:	Julie Audet, Vice-Dean, Graduate Studies
Version date:	March 24, 2019
Effective date:	April 11, 2019
Approvals:	Engineering Education Advisory Committee: March 17, 2019 Engineering Graduate Education Committee (EGEC) on behalf of the Faculty of Applied Science & Engineering: March 17, 2019

Core Graduate Faculty Research Synopses

Core faculty members are those who are eligible to teach and/or supervise in the collaborative specialization, as appropriate. Core faculty members must hold graduate faculty membership in one of the participating degree programs. The process of identifying a graduate faculty member as a collaborative specialization core faculty member is initiated by the faculty member or the collaborative specialization director. Both the faculty member's home unit chair/director and the collaborative specialization director must agree, as well as the faculty member involved. The collaborative specialization director is responsible for maintaining records of agreements concerning assignment of core faculty members to the collaborative specialization. Formal graduate faculty memberships in the collaborative specialization supporting units are not required for core faculty members.

There must be at least one core graduate faculty member from each participating program whose teaching and/or research expertise relate to that of the collaborative specialization subject area.

Prof. Creso Sá, Professor and Program Coordinator, Higher Education Program
Research focus: Science & technology policy, the evolving role of universities in the economy
Publications:

1) Veletanlić, E. & Sá, C. (in press). Government programs for university-industry partnerships: Logics, design, and implications for academic science. Research Evaluation.
2) Sá, C. & Holt, C. (2019). Profiles of Entrepreneurship Students: Implications for Policy and Practice. Education + Training, 61(2), 122-135.

Prof. Leesa Wheelahann, Professor
Research focus: Social justice in access to and the outcomes of education
Publications:

1) Arnold, Christine, Wheelahan, Leesa, Moodie, Gavin, Beaulieu, Jacqueline, & Taylor-Cline, Jean-Claude. (2018). Mapping the typology of transition systems in a liberal market economy: the case of Canada. *Journal of Education and Work, Early online*. doi:https://doi.org/10.1080/13639080.2017.1414941
2) Wheelahan, Leesa (2015). 'Not just skills: what a focus on knowledge means for vocational education', *Journal of Curriculum Studies*, 47:6, 750-762.

Prof. Ruth Childs, Professor
Research focus: design and equity of large-scale assessments, admissions processes, and other evaluation systems.
Publications:

1) Brijmohan, A., Khan, G. A., Orpwood, G., Brown, E. S., & Childs, R. A. (2018). Collaboration between content experts and assessment specialists: Using a validity argument framework to develop a college mathematics assessment. *Canadian Journal of Education*, 41, 584-600.
2) Childs, R. A., Broomes, O., & Herbert, M. B. (2018). Deciding whether to respond: A latent class analysis of nonresponse on Ontario's Grade 9 Assessment of Mathematics. *Alberta Journal of Educational Research*, 64, 70-87.

Prof. Stephanie Waterman, Associate Professor
Research focus: Native American/Indigenous student experiences, indigenous methodologies, critical race theories
Publications:

1) Waterman, S. J., Lowe, S. C., & Shotton. H. J. (Eds.) (2018). *Beyond access: Indigenizing programs for Native American student success*. Sterling, VA: Stylus.
2) Waterman, S. J. & Harrison, I. D. (2017). Indigenous Peoples Knowledge Community (IPKC): Self-determination in higher education. *Journal of Student Affairs Research & Practice, 54*(3), 316-328.

Calendar Copy

Append calendar copy for entire collaborative specialization with track changes highlighted in red. For proposals adding new coursework-only participating programs, the calendar copy should clearly show that at least 30% of the courses taken towards the degree are in the area of specialization including the core course.

Engineering Education

Lead Faculty

Applied Science and Engineering

Participating Degree Programs

Chemical Engineering and Applied Chemistry—MASc, PhD
Civil Engineering—MASc, PhD
Curriculum Studies and Teacher Development—MA, PhD
Higher Education – MA, MEd, PhD
Mechanical and Industrial Engineering—MASc, PhD

Overview

The Collaborative Specialization in Engineering Education is an interdisciplinary program designed for students within home programs in engineering or education who are interested in pursuing courses and research in engineering education. This collaborative specialization allows students to join a small community of scholars interested in research and learning at the nexus of education and engineering practice. A core course provides students with an introduction to engineering learning, knowledge, assessment, and culture and community, while the theoretical foundations, methods, and topics related to engineering education research are explored in a seminar course.

Research is supervised by a graduate faculty member in the student's home graduate unit. Opportunities exist to assess and apply research findings as part of instructional initiatives within the Faculty of Applied Science and Engineering. Upon successful completion of the degree requirements of the participating home graduate unit and the collaborative specialization, students receive the notation "Completed Collaborative Specialization in Engineering Education" on their transcript and parchment.

Contact and Address

Web: http://gradstudies.engineering.utoronto.ca/research-degrees/collaborative-program-engineering-education
Email: natalieyl.leung@utoronto.ca
Telephone: (416) 978-5932
Fax: (416) 978-8605

Collaborative Specialization in Engineering Education
Faculty of Applied Science and Engineering
55 College Street
Toronto, Ontario M5S OC9
Canada

Engineering Education: Master's Level

Admission Requirements

- Applicants to the collaborative specialization must apply to and be admitted to both the collaborative specialization and a graduate degree program in one of the collaborating graduate units.

- Applicants to the collaborative specialization must submit the following:
    - curriculum vitae (CV)
    - personal statement explaining how the proposed plan of study and specific research interests relate to engineering education
    - letter of recommendation from a faculty member confirming their willingness to supervise and support the student's research and outlining why the student would be well suited for the Engineering Education Collaborative Specialization.

Specialization Requirements

Students must meet all respective degree requirements of the School of Graduate Studies, the participating home graduate unit, and the collaborative specialization. Collaborative specialization students must:

- Complete a total of 0.5 full-course equivalent (FCE) as follows:
    - the core course APS 1204H Instructional Design in Engineering Education.
- Participate continuously in a seminar series (CR/NCR) APS 1205Y Engineering Education Research Seminar.
- Undertake the major paper or thesis required by the home degree program with a focus on engineering education under the supervision of a collaborative specialization core faculty member.

Engineering Education: Doctoral-Level Program

Admission Requirements

- Applicants to the collaborative specialization must apply to and be admitted to both the collaborative specialization and a graduate degree program in one of the collaborating graduate units.
- Applicants to the collaborative specialization must submit the following:
    - curriculum vitae (CV)
    - personal statement explaining how the plan of study and specific research interests relate to engineering education
    - letter of recommendation from a faculty member confirming their willingness to supervise and support the student's research and outlining why the student would be well suited for the Engineering Education Collaborative Specialization.

Specialization Requirements

Students must meet all respective degree requirements of the School of Graduate Studies, the participating home graduate unit, and the collaborative specialization. Collaborative specialization students must:

- Complete a total of 1.0 full-course equivalent (FCE) as follows:
    - the core course APS 1204H Instructional Design in Engineering Education (0.5 FCE)
    - an elective course in engineering education (0.5 FCE); see the elective course list.
- Participate continuously in a seminar series (CR/NCR) APS 1206Y beginning in Year 1; deliver a seminar on the research topic in Year 2; design and deliver one or more instructional workshops and make a final presentation on their research, both in the final year.
- Complete the thesis required by the home degree program with a focus on engineering education under the supervision of a collaborative specialization core faculty member.

- Complete the core course APS 1204H; students who have completed the course at the master's level may substitute an elective course at the doctoral level from the elective list and with the approval of the collaborative specialization director.

Engineering Education: Courses

Core Courses

APS 1204H	Instructional Design in Engineering Education
APS 1205Y	Engineering Education Research Seminar—Master's Level
APS 1206Y[0]	Engineering Education Research Seminar—Doctoral Level

[0] *Course that may continue over a program. The course is graded when completed.*

Elective Courses (PhD Level Only)

Department of Curriculum, Teaching and Learning

CTL 1018H	Introduction to Qualitative Inquiry in Curriculum, Teaching, and Learning
CTL 1028H	Constructive Feedback in Teaching
CTL 1032H	Knowing and Teaching
CTL 1041H	Research Methods in Education
CTL 1042H	Instrument Development in Education
CTL 1047H	Course Self-Assessment
CTL 1206H	Teaching and Learning Science
CTL 1207H	Teaching and Learning about Science: Issues and Strategies in Science, Technology, Society and Environment (STSE) Education
CTL 1211H	Action Research in Science, Mathematics, and Technology Education
CTL 1215H	Teaching and Learning about Science and Technology: Beyond Schools

CTL 1218H	Culture and Cognition in Mathematics, Science, and Technology Education
CTL 1306H	Qualitative Research Methods in Education: Concepts and Methods
CTL 1603H	Introduction to Knowledge Building
CTL 1608H	Constructive Learning and Design of Online Environments
CTL 1842H	Mixed Methods Research in Education: Combining Qualitative and Quantitative Inquiries
CTL 1846H	Assessment for Teaching and Learning

Department of Leadership, Higher and Adult Education

LHA1812	Education and the Professions
LHA 1848	Innovative Curricula in Higher Education and Professional Programs
LHA 5809	Teaching and Learning in Higher Education
LHA5807	Globalization, Lifelong Learning, Professional and Vocational Education
LHA 5814	Scholarship of Teaching and Learning in the Professions
LHA1807	System-wide planning and policy in higher education
LHA1806	Systems of Higher Education
LHA1835	Logics and Strategies of Case Study Research

Faculty of Applied Science and Engineering

APS 520H	Technology, Engineering, and Global Development
APS 530H	Appropriate Technology and Design for Global Development
APS 1001H	Project Management

APS 1003H	Professional Education and Instruction
APS 1010H	Cognitive and Psychological Foundations of Effective Leadership
APS 1011H	Concepts and Application of Authentic Leadership
APS 1012H	Managing Business Innovation and Transformational Change
APS 1013H	Applying Innovation in Engineering and Business Operations
APS 1018H	History and Philosophy of Engineering
APS 1501H	Leadership and Leading in Groups and Organizations
JEI 1901H	Technology, Society, and the Environment I
MIE 1402H	Experimental Methods in Human Factors Research
MIE 1403H	Analytical Methods in Human Factors Research
MIE 1413H	Statistical Models in Empirical Research
MIE 1415H	Analysis and Design of Cognitive Work

Faculty of Information

KMD 2001H	Human-Centred Design