McGill

New Program/Concentration Proposal Form

(2019)

1.0 Degree Title
Please specify the two degrees for concurrent degree programs

> M.Eng.

1.1 Major (Subject/Discipline) (30-char. max.)

> Biological and Biomedical Engineering

1.2 Concentration (Option) (30 char. max.)

> Non-Thesis

1.3 Complete Program Title (info from boxes 1.0+1.1+1.2+5.2)

> M.Eng. Biological and Biomedical Engineering (Non-Thesis)

2.0 Administering Faculty or GPS

> Graduate and Postdoctoral Studies

Offering Faculty & Department

> Interfacutly Studies/Engineering, Bioengineering /Medicine, Biomedical Engineering

3.0 Effective Term of Implementation
(Ex. Sept. 2019 or 201909)
Term

> Sept. 2022

4.0 Rationale and Admission Requirements for New Program/Concentration

This non-thesis option aims to provide students with the advanced knowledge and competencies required by the non-academic job market in biological engineering and biomedical engineering. The non-thesis option will be based on the same courses as the thesis option but will require more course credits, and it will provide hands-on experience through projects carried out during internships. See document attached. The admission requirements are the same as for the thesis option in that candidates to the M. Eng (non-thesis) in Biological and Biomedical Engineering should hold a Bachelor's degree in engineering or science with a strong emphasis on mathematics and the physical sciences, and some exposure to the life sciences (physiology, cell biology or molecular biology).

5.0 Program Information
Indicate an "x" as appropriate

5.1 Program Type

- Bachelor's Program
- X Master's
- M.Sc.(Applied) Program
- Dual Degree/Concurrent Program
- Certificate
- Diploma
- Graduate Certificate
- Graduate Diploma
- Professional Development Cert
- Ph.D. Program
- Doctorate Program
- (Other than Ph.D.)
- Self-Funded/Private Program
- Off-Campus Program
- Distance Education Program
- Other (Please specify)

5.2 Category

- Faculty Program (FP)
- Major
- Joint Major
- Major Concentration (CON)
- Minor
- Minor Concentration (CON)
- Honours (HON)
- Joint Honours Component (HC)
- Internship/Co-op
- Thesis (T)
- x Non-Thesis (N)
- Other
- Please specify

5.3 Level

- Undergraduate
- Dentistry/Law/Medicine
- Continuing Studies (Non-Credit)
- Collegial
- x Masters & Grad Dips & Certs
- Doctorate
- Post-Graduate Medicine/Dentistry
- Graduate Qualifying

5.4 Requires Centrally-Funded Resources

Yes ___   No _x_

6.0 Total Credits or CEUs (if latter, indicate "CEUs" in box)

> 45

7.0 Consultation with

Related Units	Yes	No X
Financial Consult	Yes	No X

Attach list of consultations.

8.0 Program Description (Maximum 150 words)

> The M.Eng. in Biological and Biomedical Engineering; Non-Thesis program focuses on the life sciences, the physical sciences and engineering, industrial practices and processes, and data science related to areas such as biological products, biomedical devices or medical imaging. Hands-on experience available through projects carried out during internships.

9.0 List of proposed new Program/Concentration

M.Eng.; Biological and Biomedical Engineering Non-Thesis (45 credits)

Internship Courses (18 credits)
BBME 681 Internship 1 (9 credits)
BBME 682 Internship 2 (9 credits)

Required Courses (3 credits)
BBME 600D1 Seminars in Biological and Biomedical Engineering (1.5 credits)
BBME 600D2 Seminars in Biological and Biomedical Engineering (1.5 credits)

OR

BBME 600N1 Seminars in Biological and Biomedical Engineering (1.5 credits)
BBME 600N2 Seminars in Biological and Biomedical Engineering (1.5 credits)

Complementary Courses (24 credits)
Minimum of 12 credits must come from the core courses listed below. At least 6 credits must be chosen from the "quantitative" courses listed below:

Quantitative Core Courses:
BIEN 510 Engineered Nanomaterials for Biomedical Applications (3 credits)
BIEN 530 Imaging and Bioanalytical Instrumentation (3 credits)
BIEN 550 Biomolecular Devices (3 credits)
BIEN 560 Design of Biosensors (3 credits)
BIEN 570 Active Mechanics in Biology (3 credits)
BIEN 590 Cell Culture Engineering (3 credits)
BMDE 502 BME Modelling and Identification (3 credits)
BMDE 503 Biomedical Instrumentation (3 credits)
BMDE 512 Finite-Element Modelling in Biomedical Engineering (3 credits)
BMDE 519 Biomedical Signals and Systems (3 credits)
BMDE 520 Machine Learning for Biomedical Data (3 credits)
BMDE 610 Functional Neuroimaging Fusion (3 credits)
BMDE 660 Advanced MR Imaging and Spectroscopy of the Brain (3 credits)
MDPH 607 Medical Imaging (3 credits)

Non-Quantitative Core Courses:
BIEN 535 Electron Microscopy and 3D Imaging for Biological Materials (3 credits)
BIEN 540 Information Storage and Processing in Biological Systems (3 credits)
BIEN 580 Synthetic Biology (3 credits)
BIEN 680 Bioprocessing of Vaccines (4 credits)
BMDE 501 Selected Topic in Biomedical Engineeirng (3 credits)
BMDE 504 Biomaterials and Bioperformance (3 credits)
BMDE 505 Cell and Tissue Engineering (3 credits)
BMDE 508 Introduction to Micro and Nano-Bioengineering (3 credits)
BMDE 510 Topics in Astrobiology (3 credits)
BMDE 525D1 Design of Assistive Technologies: Principles and Praxis (3 credits)
BMDE 525D2 Design of Assistive Technologies: Principles and Praxis (3 credits)
BMDE 650 Advanced Medical Imaging (3 credits)
BMDE 651 Orthopaedic Engineering (3 credits)
BMDE 654 Biomedical Regulatory Affairs - Medical Devices (3 credits)

The remaining 12 credits of complementary courses must come from core or non-core complementary courses chosen from BBME courses or from other courses, at the 500 level or higher. At least 6 of the 12 credits must have both life sciences content and content from the physical sciences, engineering, or computer science. The selection of courses must have the prior written approval of the Graduate Program Director.

Attach extra page(s) as needed

10.0 Approvals

Routing Sequence	Name	Signature	Meeting Date
Department	Yu (Brandon) Xia	*Xay*	Sep. 24, 2021
Curric/Acad Committee	Roni Khazaka	*Roni Khazaka*	Sep 22, 2021
Faculty 1			
Faculty 2	Roni Khazaka	*Roni Khazaka*	Oct 5, 2021
Faculty 3			
CGPS			
SCTP			
APC			
Senate			

Submitted by

Name

Phone

Email

Submission Date

To be completed by ES:

CIP Code

Faculty of Engineering

10.0 Approvals			
Routing Sequence	Name	Signature	Meeting Date
Department	Yu (Brandon) Xia	*signature*	Sep. 24, 2021
Curric/Acad Committee	Melissa Vollrath- FCC Chair	ExpressVPN Client	Oct 12, 2021
Faculty 1	Aimee Ryan- Assoc. Dean- FMHS	2021.10.14 11:40:15 -04'00'	Oct 14, 2021
Faculty 2			
Faculty 3			
CGPS			
SCTP			
APC			
Senate			

Submitted by

Name

Phone

Email

Submission Date

To be completed by ES:

CIP Code

Faculty of Medicine and Health Sciences

REMINDERS:
*Box 5.4 – Must be completed; see section 6.5.4 within the New Program Guidelines at:
https://www.mcgill.ca/sctp/guidelines.
**All new program proposals must be accompanied by a 2-3 page support document.

Existing Program:

Master of Engineering (M.Eng.) Biological and Biomedical Engineering (Thesis) (45 credits)

Thesis Courses (30 credits)

BBME 693 Thesis Research 1 (6 credits)
BBME 694 Thesis Research 2 (6 credits)
BBME 695 Thesis Submission (12 credits)
BBME 696 Thesis Research 3 (3 credits)
BBME 697 Thesis Research 4 (3 credits)

Required Courses (3 credits)

BBME 600D1 Seminars in Biological and Biomedical Engineering (1.5 credits)
BBME 600D2 Seminars in Biological and Biomedical Engineering (1.5 credits)

OR

BBME 600N1 Seminars in Biological and Biomedical Engineering (1.5 credits)
BBME 600N2 Seminars in Biological and Biomedical Engineering (1.5 credits)

Complementary Courses (12 credits)

3 credits from the following quantitative courses:

BIEN 510 Engineered Nanomaterials for Biomedical Applications (3 credits)
BIEN 530 Imaging and Bioanalytical Instrumentation (3 credits)
BIEN 550 Biomolecular Devices (3 credits)
BIEN 560 Design of Biosensors (3 credits)
BIEN 570 Active Mechanics in Biology (3 credits)
BIEN 590 Cell Culture Engineering (3 credits)
BMDE 502 BME Modelling and Identification (3 credits)
BMDE 503 Biomedical Instrumentation (3 credits)
BMDE 512 Finite-Element Modelling in Biomedical Engineering (3 credits)
BMDE 519 Biomedical Signals and Systems (3 credits)
BMDE 610 Functional Neuroimaging Fusion (3 credits)
BMDE 660 Advanced MR Imaging and Spectroscopy of the Brain (3 credits)
MDPH 607 Medical Imaging (3 credits)

3 credits from the following:
BIEN 510 Engineered Nanomaterials for Biomedical Applications (3 credits)
BIEN 530 Imaging and Bioanalytical Instrumentation (3 credits)
BIEN 540 Information Storage and Processing in Biological Systems (3 credits)
BIEN 550 Biomolecular Devices (3 credits)
BIEN 560 Design of Biosensors (3 credits)
BIEN 570 Active Mechanics in Biology (3 credits)
BIEN 590 Cell Culture Engineering (3 credits)
BIEN 680 Bioprocessing of Vaccines (4 credits)
BMDE 501 Selected Topics in Biomedical Engineering (3 credits)
BMDE 502 BME Modelling and Identification (3 credits)
BMDE 503 Biomedical Instrumentation (3 credits)

BMDE 504 Biomaterials and Bioperformance (3 credits)
BMDE 505 Cell and Tissue Engineering (3 credits)
BMDE 508 Introduction to Micro and Nano-Bioengineering (3 credits)
BMDE 512 Finite-Element Modelling in Biomedical Engineering (3 credits)
BMDE 519 Biomedical Signals and Systems (3 credits)
BMDE 525D1 Design of Assistive Technologies: Principles and Praxis (3 credits)
BMDE 525D2 Design of Assistive Technologies: Principles and Praxis (3 credits)
BMDE 610 Functional Neuroimaging Fusion (3 credits)
BMDE 650 Advanced Medical Imaging (3 credits)
BMDE 654 Biomedical Regulatory Affairs - Medical Devices (3 credits)
BMDE 660 Advanced MR Imaging and Spectroscopy of the Brain (3 credits)
MDPH 607 Medical Imaging (3 credits)

6 credits at the 500-level or higher chosen from a list on the program web site https://www.mcgill.ca/bbme/students/courses or from other courses, at the 500 level or higher, at least 3 credits of which have both life sciences content and content from the physical sciences, engineering, or computer science, with the prior written approval of the Thesis Supervisor and the Graduate Program Director.

Master of Engineering Biological and Biomedical Engineering (non-thesis)

Rationale

In addition to the interfaculty graduate degree in Biological and Biomedical Engineering (BBME) M.Eng. with thesis (soon to be renamed to M.Sc.) designed with a research orientation often leading to the BBME PhD program, it is proposed to implement a BBME M.Eng. non-thesis program. The main driver of this initiative is to empower graduates from the McGill Bioengineering Department undergraduate program, and also other graduates with Bachelor's degrees in biological and biomedical engineering or other areas of engineering and science, to effectively join the non-academic job market equipped with the most advanced knowledge and competencies.

BBME M.Eng. (non-thesis) students will acquire well-balanced theoretical and practical knowledge. This will be achieved in part through deepening their knowledge of the biological and biomedical engineering fields by advanced courses taught by McGill's world-class professors, associated research centre scientists, national and international academic partners, governmental research and regulatory centres and industry professionals. The non-thesis option will also expose students to internship projects in industry and government laboratories, making BBME M.Eng. (non-thesis) graduates competitive in the new global economy.

Within McGill's Faculty of Engineering, all the departments except the newly created Bioengineering Department have established non-thesis Master's degrees to respond to the needs of advanced professional training required by employers. (See annex 1).
In the Faculty of Agriculture, similar motivations led to the creation of the Master of Science (Applied) program, a non-thesis program as an alternative to traditional thesis programs. In that program, the content is course- and laboratory-based and includes an internship in a research laboratory.

Positioning the program within the current academic context

Within Québec academic institutions, most of the engineering faculties and schools offer M.Eng. or equivalent degrees that are professionally oriented. For example, École Polytechnique de Montréal (EPM) has a "**non-thesis Master's** with focus on the development of the student's knowledge and the acquisition of a specialty with activities mainly centred on classes and the completion of a project or internship. EPM offers the M.Eng. degree non-thesis in all engineering disciplines covered by their different departments, including **génie biomédical**[1].

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[1] Maîtrise professionnelle en Génie biomédical- Option génie clinique (Programme conjoint)Maîtrise (professionnelle ou recherche) en Génie biomédical (Programme conjoint)

Laval University also offers professional Master's degrees in all engineering disciplines taught in the Faculty of Engineering departments.

Within Canada, leading academic institutions such as the University of Toronto offer very flexible **Master of Engineering degrees** providing a mix of technical, leadership and business competencies emphasizing the industrial-relevance. A **Master of Health Science in Clinical Engineering** is also offered by the Institute of Biomaterials & Biomedical Engineering in Toronto University. Both the University of British Columbia and the University of Waterloo offer Professional M.Eng. degrees in the relevant engineering fields, as an alternative to the traditional M.Sc. thesis focusing on a research path and a PhD program.

Based on an extensive survey of the Quebec and Canadian landscape of academic institutions offering non-thesis Master's degrees in sciences/engineering and particularly Biological and Biomedical Engineering, the proposed initiative of a McGill BBME M.Eng. (non-thesis) aims to align the BBME program with those of our Faculty of Engineering at McGill and other well-regarded universities, which offer both professional and research-based programs. The program will effectively offer a program that will meet the national and global needs for a highly qualified workforce with hands-on expertise in the field.

From an international perspective, the professional Master's degree (non-thesis) has been adopted by most universities offering an Engineering degree. The primary motivation for implementing these degrees is to respond more effectively to the engineering job market by providing more advanced knowledge and expertise, through graduate and specialized courses and eventually hands-on training, to graduates from the Bachelor program in the specific discipline. Among many successfully implemented Professional Master's programs in the US, the MIT Master's Degree in Biomedical Engineering (MEBE) has been designed as a fifth-year program leading to a Bachelor's degree in a science or engineering discipline, along with a Master of Engineering in Biomedical Engineering. The program emphasizes the fusion of engineering with modern molecular-to-genomic biology. Similarly, in Europe, most of the engineering faculties and schools provide the undergraduate students with the option of completing a Master's degree after the completion of their Bachelor's degree with an additional year of specialization through advanced courses and eventually internship in a professional environment.

In summary, there is a need, as strongly underlined by experts from industry and governmental organizations, for bioengineers and students with Bachelor's degrees in science and engineering to acquire advanced knowledge and competencies to accelerate their integration into professional life.

Building on successful experiences in implementing professional Master's degrees in engineering at McGill, and successful industry partnerships, we propose a Master of Engineering (M.Eng.) in Biological and Biomedical Engineering (non-thesis) offering advanced courses and a research project/internship at McGill as an alternative to the traditional Master's

thesis. This Master's degree is well aligned with the needs of the job market and will have a positive socio-economic impact for Québec and Canada.

Clientele

While the thesis program attracts research-oriented students, the non-thesis program will attract students who are interested in biological and biomedical engineering and in acquiring professional experience.

Program structure

The 45-credit program will consist of two terms (Fall and Winter) of courses (27 credits) followed by two terms (Summer and Fall) of internship (18 credits). The courses will include core BBME, BIEN and BMDE courses as well as approved 500- and 600-level courses from other departments, as in the current BBME thesis program.

Admissions requirements (same as the BBME Master's program with thesis)

The BBME graduate program prides itself on the academic diversity of the students – hailing from all areas of engineering and from the physical and life sciences – who choose to pursue graduate degrees with us.

- Applicants with an undergraduate engineering degree should have a Cumulative Grade Point Average (CGPA) of at least 3.3 out of 4, and must have taken a university-level general life-science course.

- Applicants who are not coming from an engineering background must meet the following criteria:
  - Applicants should have a Cumulative Grade Point Average (CGPA) of at least 3.3 out of 4, or the equivalent, in their undergraduate program.
  - Applicants must have taken at least four courses (12 credits) of university-level quantitative courses of which at least 2 must be Math:
    - Math prerequisites may include statistical, numerical and computational methods (but not programming, for example). See list of appropriate McGill courses.
    - Quantitative courses may include those from physics, chemistry, engineering, computer-science, medical-physics, and quantitative life-science courses, and other courses that apply math to different fields.
  - Applicants must have taken at least four courses (12 credits) of university-level natural-science courses of which at least 1 must be a general life-science course:
    - Natural-science courses include courses such as biology, physiology, anatomy, physics, chemistry, engineering, computer-science, medical-physics, etc.

- The required general life-science course can be in physiology, cell biology, molecular biology or a similar area. See list of appropriate McGill courses.
- Québec CÉGEP-level courses are not considered university-level courses and do not qualify as pre-requisites.

Applicants lacking some pre-requisites (at most two prerequisites, including the life-science requirement) may be accepted to the program on the condition that they make up the deficits in the first year of their graduate program. Since these courses will be at the undergraduate level, they will not count toward the course requirements of their graduate program.