McGill

New Program/Major or Minor/Concentration Proposal Form

(2017)

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

M.Eng.

2.0 Administering Faculty/Unit

Graduate and Postdoctoral Studies

1.1 Major (Legacy= Subject)(30-char. max.)

Sustainability in Engineering and Design

Offering Faculty/Department

Engineering / TISED

1.2 Concentration (Legacy = Concentration/Option)
If applicable to Majors only (30 char. max.)

Non-Thesis

3.0 Effective Term of Implementation
(Ex. Sept. 2004 = 200409)
Term

201909

1.3 Minor (with Concentration, if Applicable) (30 char. max.)

4.0 Rationale and Admission Requirements for New Proposal

SEE P1-2

5.0 Program Information
Please check appropriate box(es)

5.1 Program Type
- Bachelor's Program
- → **Master's**
- M.Sc. (Applied) Program
- Dual Degree/Concurrent Program
- Certificate
- Diploma
- Graduate Certificate
- Graduate Diploma
- Ph.D. Program
- Doctorate Program (Other than Ph.D.)
- Self-Funded/Private Program
- Off-Campus Program
- Distance Education Program (By Correspondence)
- 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)
- → **Non-Thesis** (N)
- Other
- Please specify

5.3 Level
- Undergraduate
- Dentistry/Law/Medicine
- Continuing Studies (Non-Credit)
- Collegial
- → **Masters & Grad Dips & Certs**
- Doctorate
- Post-Graduate Medicine/Dentistry
- Graduate Qualifying
- Postdoctoral Fellows

5.4 FQRSC (Research) Indicator
(for GPS) Yes ___ **No _X_**

5.5 Requires Resources
Yes _X_ No ___

6.0 Total Credits

45

7.0 Consultation with

Related Units	→ **Yes**	No
Financial Consult	→ **Yes**	No

Attach list of consultations.

8.0 Program Description (Maximum 150 words)

The Master of Engineering in Sustainability in Engineering and Design; Non-Thesis, focuses on the critical sustainability challenges of the 21st century. The program provides students with the opportunity to apply systems-based frameworks and sustainability metrics to analyze problems and design solutions for sustainability in engineering and design. It provides an interdisciplinary working environment for those working on sustainability.

9.0 List of proposed program for the New Program/Major or Minor/Concentration.

If new concentration (option) of existing Major/Minor (program), please attach a program layout (list of all courses) of existing Major/Minor.

Proposed program (list courses as follows: Subj Code/Crse Num, Title, Credit weight under the headings of: Required Courses, Complementary Courses, Elective Courses)

Master of Engineering (M.Eng.) in Sustainability in Engineering and Design; Non-Thesis *(45 credits)*

Required Courses (27 credits)

SEAD 500 Foundations of Sustainability for Engineering and Design (3)
SEAD 510 Energy Analysis (4)
SEAD 520 Life Cycle-based Environmental Footprinting (3)
SEAD 530 Economics for Sustainability in Engineering and Design (3)
SEAD 540 Industrial Ecology and Systems (3)
SEAD 550 Decision-Making for Sustainability in Engineering & Design (3)
SEAD 660 Strategies for Sustainability (3)
SEAD 670 Collaborative Design for Sustainability (5)

Complementary Courses (18 credits)

9-18 credits from the following:

Stream 1 - Sustainable Processes and Manufacturing

CHEE 511 Catalysis for Sustainable Fuels and Chemicals (3)
CHEE 521 Nanomaterials and the Aquatic Environment + (3)
CIVE 521 Nanomaterials and the Aquatic Environment + (3)
CIVE 663 Environmental Fate of Organic Chemicals (4)
CIVE 677 Water-Energy Sustainability (4)
MECH 534 Air Pollution Engineering (3)
MECH 560 Eco-design and Product Life Cycle Assessment (3)
MIME 511 Advanced Subsurface Ventilation and Air Conditioning (3)
MIME 588 Reliability Analysis of Mining Systems (3)
URBP 506 Environmental Policy and Planning (3)

+ Students can take only one of CHEE 521 or CIVE 521

Stream 2 - Renewable Energy and Energy Efficiency

CHEE 511 Catalysis for Sustainable Fuels and Chemicals (3)
CIVE 677 Water-Energy Sustainability (4)
ECSE 562 Low-Carbon Power Generation Engineering (4)
MECH 534 Air Pollution Engineering (3)

Attach extra page(s) as needed

Stream 3 - Sustainable Urban Development

ARCH 515 Sustainable Design (3)
ARCH 517 Sustainable Residential Development (3)
ARCH 564 Design for Development (3)
MECH 534 Air Pollution Engineering (3)
URBP 504 Planning for Active Transportation (3)
URBP 620 Transportation Economics (3)
URBP 551 Urban Design and Planning (3)
URBP 651 Redesigning Suburban Space (3)

Stream 4 - Sustainable Infrastructure

ARCH 515 Sustainable Design (3)
ARCH 564 Design for Development (3)
CIVE 540 Urban Transportation Planning (3)
CIVE 621 Sustainable Design of Municipal Systems (4)
CIVE 623 Durability of Construction Materials (4)
CIVE 629 Sustainable Design: Water and Wastewater Facilities (4)
CIVE 652 Bioprocesses for Wastewater Resource Recovery (4)
SEAD 515 Climate Change Adaptation and Engineering Infrastructure (3)
URBP 620 Transportation Economics (3)
URBP 651 Redesigning Suburban Space (3)

List A

0-6 credits from the following:

BIEN 520 High Throughput Bioanalytical Devices (3)
CHEE 541 Electrochemical Engineering (3)
CHEE 543 Plasma Engineering (3)
CIVE 550 Water Resources Management (3)
ECSE 507 Optimization and Optimal Control (3)
ECSE 608 Machine Learning (4)
MECH 535 Turbomachinery and Propulsion (3)
MECH 559 Engineering Systems Optimization (3)
MECH 652 Dynamics of Combustion (4)
MIME 556 Sustainable Materials Processing (3)
URBP 619 Land Use and Transportation Planning (3)

NOTE: Other unlisted 500 level or higher courses taught at McGill may be permitted, subject to approval by the program director.

List B

0-6 credits from the following:

SEAD 600 Sustainability Research 1 (3)
SEAD 602 Sustainability Research 2 (3)

NOTE: Students must find a supervisor before registering for this course, subject to approval by the program director.

PROGRAM RATIONALE

A critical need

Industrial and urban development of the last century has been built on notions of an unlimited supply of natural resources (Davidson et al. 2010). While the world has experienced tremendous societal advances, including a global increase in living standards, we are becoming more and more aware of the unsustainable rates at which development patterns are consuming natural resources and producing waste (Anastas and Zimmerman, 2006). Phenomena such as water scarcity, desertification, deforestation, reduced fish stocks and agricultural productivity, are all being increasingly experienced and present tangible effects of overharvesting the earth's natural resources. In addition, steadily increasing levels of greenhouse gas emissions in the earth's atmosphere contribute to rising global environmental and climate changes and point to the acute need to rethink our consumption patterns (IPCC, 2014). Each of the last three decades has been successively warmer at the earth's surface than any preceding decade since 1850 (IPCC, 2014). This global trend has already started to effect climate patterns, contribute to rising sea levels and the occurrence of disaster events (IPCC, 2014). Engineers and designers play a significant role in developing and maintaining the projects, infrastructure and systems society uses. Thus, addressing the challenges of sustainability requires a specially trained group of engineers and designers who can lead the charge for sustainability thinking in their profession and in collective efforts to move society towards a future sustainable economy.

Sustainability as a wicked problem

Engineers and designers of the 21st century are tasked with devising creative new solutions that consider the constraints of our earth's carrying capacity while continuing to address the needs of a growing population used to an increasing standard of living (Davidson et al. 2007). There is an increasing acknowledgment that challenges such as climate change, resource scarcity, and environmental degradation should be recognized as *wicked problems* or problems that are not immediately solvable (Seager et al. 2012). Problems such as global pollution and resource extraction are tied to complex systems at varying scales, it is not likely that they are solvable with one solution but, rather, multiple approaches will be required (Seager et al. 2012). One of the fundamental problems with current approaches to address sustainability questions in most disciplines is that the methods and frameworks of their respective bodies of knowledge continue to be applied and very rarely are sustainability questions framed in wicked terms (Seager et al. 2012).

Training engineers and designers to address sustainability problems

Most accredited Engineering and Design programs in North America do not specifically teach students to operate in a "wicked milieu" (Seager et al. 2012). Tackling complex sustainability problems asks for different ways of forming problems. Seager et al. argue that a fundamental shift needs to occur to understand wicked problems as conditions to be governed, as opposed to problems to be solved (Seager et al. 2012). Students will need to be equipped to recognize and grapple with the ethical, adaptive, and cross-disciplinary challenges embedded in their practice development programs (Wiek et al. 2010). Davidson et al. elaborate further on the skills necessary for engineers and designers of the future. (1) They must be familiar with the concepts, language, and sources of information related to natural and social sciences. While not always expected to be experts in these domains, they should be comfortable and fluent in dealing with such experts. (2) Engineers must also have an awareness of major dilemmas that are best addressed by other disciplines. (3) In addition, they must be able to develop first-order predictions about potential outcomes and changes to environmental, economic, and social systems that result from engineering and design decisions (Davidson et al. 2010). Wiek et al. go further to propose a framework of five interrelated competencies that are seen as critical to tackling complex problems of sustainability in engineering and design. These include systems thinking, the ability to anticipate, the ability to strategize, normative competence strategies, and interpersonal abilities (Wiek et al. 2011). The goal of the proposed program is to train engineers and designers who can make progress on complex problems, primarily because it provides them with interdisciplinary and multi-faceted training.

DEFINITION OF THE BODY OF KNOWLEDGE

Defining sustainability in engineering and design

The concept of sustainability was initially popularized by the "Our Common Future" report, which addresses the term in the context of industrial and urban development as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). This broad definition has, over the years, been interpreted in many ways from different disciplinary perspectives. The National Association for Environmental Management defines sustainability as "a term that describes a company's strategies for acting as a responsible corporate citizen, ensuring its operations are financially sustainable and minimizing its environmental footprint" (US Dept. Labour, 2012). Engineers Canada has defined the term as "the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs, through the balanced application of integrated planning and the combination of environmental, social, and economic decision-making processes" (2016). The American Society of Civil Engineers defines sustainability as "a set of economic, environmental and social conditions in which all of society has the capacity and opportunity to maintain and improve its quality of life indefinitely without degrading the quantity, quality or the availability of economic, environmental and social resources" (ASCE, 2018). The American Institute of Architects has defined the term as "the ability to provide healthy and safe environments for people and the preservation of the earth's capability of sustaining a shared high quality of life" (COTE, 2018).

Drawing from all of these definitions, sustainability in engineering and design typically refers to the sustainable (re)design of products, systems and services and includes some form of environmental and social performance in the evaluation of designs (Allen et al. 2009). While simple in the abstract, reducing this concept to quantitative tools and performance metrics, from which engineers can precisely define questions and solve problems, is much more difficult and oftentimes not possible (Allenby et al. 2007; Davidson et al. 2010). The definitions above point to an expanded need for sustainable engineering and design to address more than technical solutions to wicked problems, and must also address social, economic, and environmental considerations (Lubichenco. 1998; Hokanson et al. 2007; Beddoe et al. 2009 Seager et al. 2012).This calls for a need to develop new frameworks, which teach engineers to designers to operate in inter-disciplinary and collaborative contexts, to allow for more complex problem solving (Seager et al. 2012). A nationwide benchmarking study conducted by the Center for Sustainable Engineering, identified four critical competencies for future engineers tackling problems for sustainability. They include, (1) an ability to appreciate complex "wicked" problems and design for multiple objectives, (2) the ability to analyze problems with systems-based frameworks such life-cycle analysis, sustainable design, industrial ecology and the circular economy, (3) the ability to collaboratively work with other disciplines in a interdisciplinary setting and finally, (4) the ability to understand and design engineering solutions at multiple scales (Allen et al. 2009). The diagram represented in Figure 1.0 below interprets these competencies and is used as a pedagogical concept map to help guide the development of the proposed master's program.

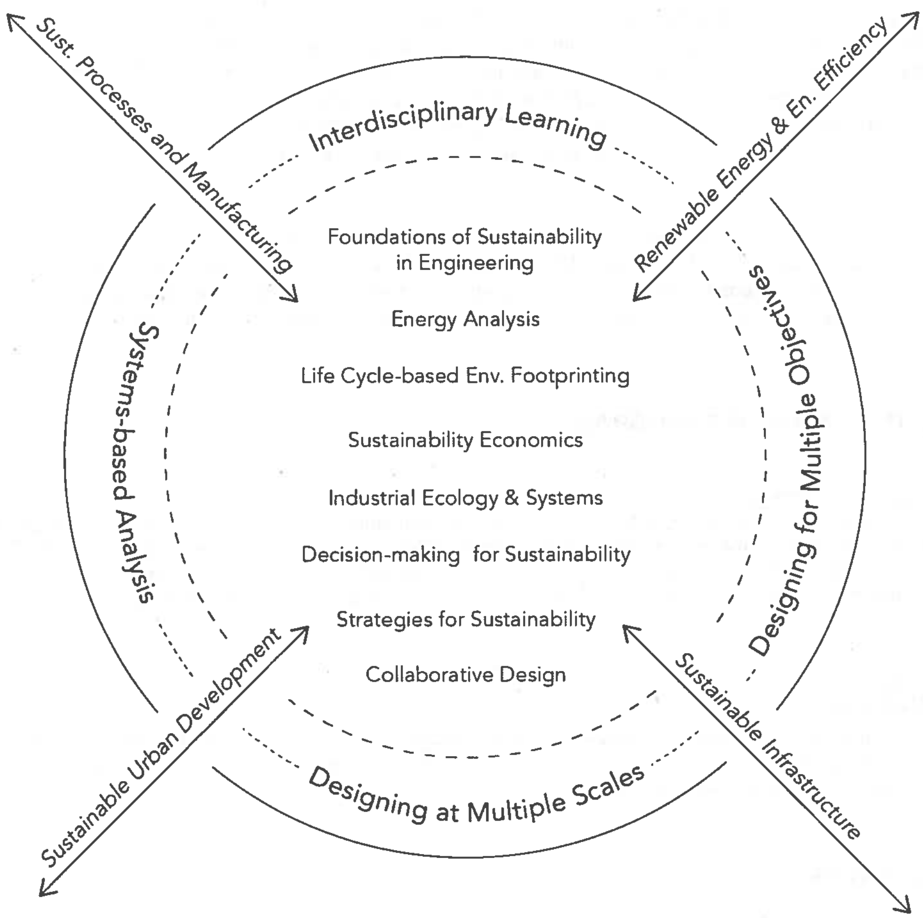

Figure 1
Concept map, adapted from key competencies outlined in *Incorporating Sustainability into Chemical Engineering Education* (Allen et al, 2009).

ORIGINALITY OF THE PROPOSAL

Sustainability in engineering and design in higher education

The proposed Master of Engineering in Sustainability in Engineering and Design; Non-Thesis will be the first M.Eng. program in Canada to offer a broad approach to teaching sustainability in engineering and design. Students will be trained with critical skills in sustainability in engineering and design while also being able to specialize in the engineering field of their choice. With the exception of a select few institutions, such as Carnegie Mellon University and Cambridge University, there remain very few schools that address sustainability in engineering and design in broad terms. If interdisciplinarity remains one of the critical tenants of sustainability thinking, there is a need to move beyond what Seager et al. call the "single treatment approach" (2012) and to introduce broader programs that integrate sustainability throughout the curriculum (Seager et al. 2012).

Over the past decade, several schools of engineering and design have begun to embrace the need to include sustainability content in education (Rowe, 2007). In recent years, several new masters and Ph.D. programs in sustainability in engineering and design have emerged, most of which have specialized on very focused disciplinary fields, such as sustainable water systems (U of Michigan) or sustainable design and construction (Stanford University). It has been noted that this trend is not surprising as new programs, not grounded in traditional core disciplines, make some people — and educational institutions — wary. This narrow focus may, in fact, be working against some of the interdisciplinary objectives implicit in sustainable thinking (Mascarelli, 2013). Christ et al. have also expressed a need to exert caution regarding discipline-specific program transformations, "due to the well-founded desire to retain a foundation in a core discipline" (Christ et al. 2015).

Industry demand

Both local and global trends suggest a growing desire in industry for professionals who are adept in applying sustainability concepts to a diverse range of practical problems. A recent survey with industry professionals from nine prominent Quebec-based corporations revealed a need for sustainability experts in engineering and design and a 15.4% increase in employment of sustainability managers over the past ten years (MBCG study, 2015). A strong demand also exists nationally. In 2013, there were over 730,000 environmental professionals in Canada, which accounted for just over 4% of the country's labour force (Barbier, 2016). A recent study looking at Canada's cleantech sector (which includes technology related to recycling, energy information, green transportation, electric motors, green chemistry, lighting, and greywater) identified 856 companies which provide 55,200 jobs throughout Canada (SDTC, 2017). This has increased by 5% since 2012 (SDTC, 2012). Globally, research also suggests that sustainability is becoming an increasingly important priority for businesses worldwide. In a survey of 2,711 global corporations, undertaken by McKinsey and Co, 70% of respondents claim that their organizations have some form of governance for sustainability in place, an increase of 56% since 2014 (McKinsey & Co, 2017). These statistics are further reinforced by the most recent UN Global Compact report, which suggests that strategies for sustainable development are monitored at the CEO level in 69% of businesses surveyed, up 4% since 2008, and that 70% of companies are reporting publicly about specific sustainability targets (UN Compact, 2017).

Student interest

By conducting an in-depth needs analysis, TISED was able to gauge demand from prospective students, alumni, and employers, with very positive results. Student demand was assessed through a survey of 591 respondents, where the sample included current undergraduate and graduate students, as well as undergraduate and graduate alumni. 31% of respondents expressed an interest in applying to the program, the most enthusiastic segment coming from undergraduate alumni. The second most interested group were current undergraduate students (TISED Survey, 2015).

McGILL, SUSTAINABILITY AND THE TISED MASTER'S PROGRAM

Vision 2020: Climate and Sustainability Action Plan
link: https://www.mcgill.ca/sustainability/sustainability-strategy
The proposed Master of Engineering in Sustainability in Engineering and Design; Non-Thesis contributes to the university's long-term target of attaining the university AASHE platinum rating by 2030. With the introduction of this program, TISED has created over 14 new course, and 9 course revisions, which directly advance sustainability teaching throughout the Faculty of Engineering and that will provide credits toward this platinum classification. The program also contributes to Research, Education, and Connectivity on campus, three critical themes of the university's Vision 2020 strategic plan.

Guiding principals of the Faculty of Engineering
link: http://www.mcgill.ca/engineering/about/guiding-principles

As a program designed around interdisciplinary learning, and advancing state-of-the-art concepts for thinking on engineering and design for sustainability, the program addresses all five of the guiding principles of the Faculty of Engineering: Collaboration and Networking, New Approaches, Sustainability, Personal Development, and Environmental Scanning.

RELEVANCE TO THE UNIVERSITY NETWORK

A review of all of McGill's existing graduate-level programs was undertaken to determine whether the university may offer a similar program outside of the Faculty of Engineering. The findings did not identify any programs with considerable overlap. The results are listed below.

M.Sc. Bioresource Engineering (46 credits)

Offered by the dept. of Bioresource Engineering (Faculty of Agricultural and Environmental Sciences)

Comments: The water resource management and waste management components of this degree may overlap slightly with a few complementary courses offered in the Sustainable Infrastructure stream of the proposed Master of Engineering in Sustainability in Engineering and Design; Non-Thesis; however the content in the bioresource program is not specifically discussed in the context of sustainability.

M.Sc. Geography / Environment (Thesis) (45 credits)

Offered by dept. of Geography (Faculty of Science)

Comments: The similarities between this program and the proposed Master of Engineering in Sustainability in Engineering and Design; Non-Thesis, lie mainly in the approach to advancing interdisciplinary learning through seminar-based courses that receive students from various departments. There is very little content overlap, and the geography/environment degree does not focus on engineering content. It should however be noted that this program provides significant training of undergraduate and graduates through research and other co-curricular activities.

COMPARABLE M.ENG. PROGRAMS IN SUSTAINABILITY IN ENGINEERING & DESIGN

A scan was undertaken of similar M.Eng. programs offered at both national and international institutions. Several programs were found to address sustainability in engineering and design within very specific fields, such as renewable energy or sustainable infrastructure. Very few offered a program with comparable breadth as the proposed Master of Engineering in Sustainability in Engineering and Design; Non-Thesis. Table 1 summarizes the findings of the study. It compares the similarities and differences between 14 different master's programs. The results of this analysis underscore a pressing need for a leading post-secondary institution to provide a comprehensive interdisciplinary program in sustainability in engineering and design. The proposed Master of Engineering in Sustainability in Engineering and Design; Non-Thesis addresses this need with a broad curriculum that allows students a high degree of freedom to specialize in the area of their interest.

			Required Core			*Stream or Concentration*					
	University	Title	Analysis	Social Sciences	Design	Energy	Processes & Manuf.	Urban Design	Research	Intern	Credit
Quebec	*McGill*	M.Eng Sustainability in Engineering and Design	X	X	X	X	X	X	X	0%	45
	Polytechnique Mtl	M.Eng in Chem. Engineering - Energy and Sust Dev	X	X	-	X	-	-	-	33%	45
	Polytechnique Mtl	M.Eng in Industrial Engineering - Organizational Resilience	X	X	-	-	X	-	-	33%	45
Canada	*U of British Columbia*	M.Eng Energy Leadership in Clean Energy Engineering	X	X	-	X	-	-	-	0%	30
	U of Calgary	M.Eng Interdis spec. in Energy and Environment	X	-	-	X	-	-	-	0%	30
	U of Ottawa	M.Sc Environmental Sustainability	-	X	-	-	-	-	X	19%	31.5
	Queens University	M.Eng in Applied Sustainability (CMAS)	-	X	-	X	X	-	X	0%	30
	U of Toronto	M.Eng in Civil Engineering - Sust Urban Systems	X	-	-	X	-	X	X	0%	30
International	*Arizona State U*	MSc in Eng Sustainable Engineering	X	X	-	X	-	X	-	0%	30
	U of Cambridge	MPhil in Engineering for Sustainable Development	X	X	X	X	-	X	X	0%	30
	Carnegie Mellon U	M.Sc in Civil and Env. Engineering - Env.Eng, Sust & Sc	X	X	X	X	X	X	X	0%	32
	U of Colorado Denver	M.Eng Environmental and Sustainability Engineering	-	X	-	-	-	X	-	0%	30
	U of Michigan	M.Sc Sust Systems & M.Sc in Civil Engineering	-	X	X	X	X	-	-	0%	54
	Rochester Tech	M Sc in Sustainable Systems	-	X	X	X	X	X	-	0%	30
	Stanford U	M.Sc in Civil and Env Engineering in Sust Design and Construction -Sustainable Urban Systems	-	X	X	-	-	X	-	0%	30

Table 1
A comparison of 14 different master's programs in engineering and design.

PROGRAM STRUCTURE

The proposed Master of Engineering in Sustainability in Engineering and Design; Non-Thesis will be a course-based master's program of 45 credits, taken over a minimum of three academic terms. All courses are a minimum of three credits and each provides a minimum of 39 total contact hours. McGill uses a semester system, with three semesters per Academic Year: Fall (September – December), Winter (January – April) and Summer (May – August). The majority of classes will be offered in the Fall and Winter semesters. The program structure is summarized in Figure 2.

Sixty percent (27 credits) of the program curriculum consists of required core courses. The remaining forty percent (18 credits) consist of complementary courses, which offer students the flexibility of focusing their studies on the particular field of their interest. Four program streams have been created and provide a framework to help students focus on the particular areas of (1) Sustainable Processes and Manufacturing, (2) Renewable Energy and Energy Efficiency, (3) Sustainable Urban Development and (4) Sustainable Infrastructure. All stream courses address sustainability content and complement the skills being taught in the core classes. Stream courses are also designed to be accessible to the breadth of engineers, architects and planners entering the program. Complementary List A identifies courses which teach sustainability concepts and skills at advanced levels. This list provides course options for students who come into the program with advanced knowledge of a particular field. Students may also take up to 6 credits of courses offered at McGill which directly relate to the program and its training goals. Courses on List B consist of the complementary research courses which allow students to undertake a self-directed research project in collaboration with another professor of engineering at McGill.

Required Core Courses (27 credits)

The program's (required) core courses are designed to equip students with the necessary concepts, skills and tools in the context of interdisciplinarity, and to devise solutions from holistic strategies, using quantitative sustainability metrics. Learning Objectives for the core training include:

1. Understanding multiple concepts and paradigms for sustainability from different disciplines and stakeholders.
2. An appreciation of the complexity of sustainability problems and an understanding that engineering solutions must address multiple solutions at varying scales.

3. Apply systems based frameworks such as life cycle analysis, environmental foot printing, ecological economics, industrial ecology and social and political ecology, and the ability to apply these frameworks to analyze complex problems, and create systems based solutions.
4. Evaluate and formulate sustainability metrics to the analysis of proposed solutions for engineering and design.
5. An understanding of the professional roles and obligations of engineers and designers in addressing sustainability challenges.
6. Apply skills and competencies of collaboratively working in an interdisciplinary setting.

Core courses are designed to be delivered in a sequence. In the first semester, students will take SEAD 500 Foundations for Sustainability in Engineering, SEAD 510 Energy Analysis, and SEAD 520 Life Cycle-based Environmental Footprinting. These courses introduce students to the theoretical understandings of sustainability in engineering and design, as well as equip them with critical analytical tools that will be used throughout the remainder of the program. Over the second semester, students are asked to explore engineering problems, through interdisciplinary perspectives, which often fall outside a typical engineering education. Courses include SEAD 530 Economics for Sustainability in Engineering and Design, SEAD 540 Industrial Ecology and Systems, and SEAD 550 Decision-Making for Sustainability in Engineering & Design. Two advanced-level courses are taught in the third semester and require students to synthesize and apply their knowledge towards problem solving in a management/governance context (in SEAD 660 Strategies for Sustainability), and towards the design (or redesign) of products, buildings, or infrastructure (in SEAD 670 Collaborative Design for Sustainability).

TERM 1

Course	Credits	Prerequisites / notes
SEAD 500 *Foundations of Sustainability for Engineering and Design*	3	
SEAD 510 *Energy Analysis*	4	
SEAD 520 *Life Cycle-based Environmental Footprinting*	3	
Complementary	3	select from Stream Courses or List A
Complementary	3	select from Stream Courses or List A
	16	

TERM 2

Course	Credits	Prerequisites / notes
SEAD 530 *Economics for Sustainability in Engineering and Design*	3	
SEAD 540 *Industrial Ecology and Systems*	3	
SEAD 550 *Decision-Making for Sustainability in Engineering & Design*	3	
Complementary	3	select from Stream Courses or List A
Complementary	3	select from Stream Courses or List A or List B*
	15	

TERM 3

Course	Credits	Prerequisites / notes
SEAD 660 *Strategies for Sustainability*	3	min 9 SEAD credits
SEAD 670 *Collaborative Design for Sustainability*	5	min 9 SEAD credits
Complementary	3	select from Stream Courses or List A
Complementary	3	select from Stream Courses or List A or List B*
	14	

Summary	Credits
Required Courses	27
Complementary (Stream Courses, List A, List B)	18
	45

*approval from an academic advisor is required to take courses from list B

Figure 2
Proposed Curriculum for M.Eng. in Sustainability in Engineering and Design

Complementary Courses (18 credits)

Stream Courses (9-18 credits)
Four streams, which focus on specific themes. It is anticipated that more courses will be added to this list in the future as new courses related to sustainability are introduced across the faculty.

Stream 1 - Sustainable Processes and Manufacturing (SPM)*:* Aimed at teaching leading approaches in manufacturing and industry to reduce energy use, water, materials and resource use, and environmental impacts, with particular emphasis on prospective or consequential life-cycle assessments of products and processes. Courses in this stream also relate to assessments of the impact of industrial chemicals and nanomaterials on the environment. Policies and institutions for implementing sustainable solutions are also covered.

Stream 2 - Renewable Energy and Energy Efficiency (REEE)*:* Focused on generation and distribution of low-/no-carbon energy and its relation to storage and energy-carrier systems. The stream will train students on technology assessment for sustainable energy supply and use, and the nexus between energy systems and water resources. The synthesis of renewable fuels from biomass, waste and carbon dioxide will be covered. This stream includes the impact of power-generation systems and combustion processes on the environment.

Stream 3 - Sustainable Urban Development (SUD)*:* Explores the design and re-engineering of urban environments to reduce natural resource consumption, waste generation, and energy use, in the context of urban growth and development in the local and global context. Adapting cities to climate change pressures towards resilient and low environmental footprint urban systems, reduced energy consumption in construction methods, residential development, public urban spaces, and densification strategies are covered.

Stream 4 - Sustainable Infrastructure (SI)*:* Focuses on how critical infrastructure, such as buildings, bridges, transportation networks, water supply, waste disposal can be built and operated in a manner to reduce natural resource consumption, waste generation, and energy use. Considerations for adapting infrastructure for climate change through future climate scenario-informed design criteria, materials use and operation strategies. Opportunities and technologies for resource and energy recovery from waste is examined.

Complementary List A - Additional Courses (0-6 credits)
In addition to the 20 stream electives discussed above, students are also eligible to take classes from a list of 14 advanced-level courses. These courses all directly address sustainability but require an advanced level of knowledge from a particular field of engineering and may not be immediately accessible to all of the diverse sets of backgrounds coming into the program. Courses on this list provide additional options for students who have specialized expertise in a particular field that they would like to further pursue. Students may also take up to 6 credits of other unlisted graduate courses taught at McGill. Courses must directly relate to the program and its training goals, and are subject to approval by the program director.

Complementary List B - Research Courses (0-6 credits)
The research course provides an opportunity for students to explore issues of sustainability within their respective field of engineering. Students must find a supervisor before registering for this course, subject to approval by the program director, and are required to complete a written report and a presentation before the end of the semester. Research projects should address and include perspectives from the social sciences.

SOURCES

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"Sustainability's Deepening Imprint." McKinsey & Company, Dec. 2017, www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/sustainabilitys-deepening-imprint.

10.0 Approvals

Routing Sequence	Name	Signature	Date
Department	Subhasis Ghoshal	SGhoshal	18 Apr 2018
Curric/Acad Committee	Laurent Mydlarski	[illegible]	02 May 2018
Faculty 1	Laurent Mydlarski	[illegible]	17 May 2018
Faculty 2			
Faculty 3			
CGPS			
SCTP			
APC			
Senate			

Submitted by

Name	
Phone	
Email	
Submission Date	

To be completed by ARR:

CIP Code

CONSULTATION REPORT FORM
RE COURSE PROPOSALS

DATE: April 19, 2018

TO: Meyer Nahon, *Chair, department of Mechanical engineering*

FROM: David Harlander, *Academic Program Manager*, TISED

The attached proposal has been submitted to the Curriculum/Academic Committee, and it has been decided that your department should be consulted.

M.Eng Major Sustainability in Engineering and Design Program
SEAD 540 Industrial Ecology and Systems
SEAD 600/2 Sustainability Research Courses
SEAD 670 Collaborative Design for Sustainability

Explanation:

New M.Eng. in Sustainability in Engineering and Design program being proposed by TISED.
Two newly created core courses for the program. (SEAD 540, SEAD670)
Two newly created research courses for the program. (SEAD 600/2)

Please review this proposal and let me know as soon as possible, on this form, whether or not your department has any objections to, or comments regarding, the proposal.

__X__ NO OBJECTIONS ________ **SOME OBJECTIONS**

COMMENTS:

A number of MECH courses are listed as option courses in this program. There is no guarantee that these courses will be offered every year.

Signature: ____________________

Date: **April 24, 2018**

CONSULTATION REPORT FORM
RE COURSE PROPOSALS

DATE: April 19, 2018

TO: Sylvie de Blois, *Director,* McGill School of Environment

FROM: David Harlander, *Academic Program Manager*, TISED

The attached proposal has been submitted to the Curriculum/Academic Committee, and it has been decided that your department should be consulted.

M.Eng Major Sustainability in Engineering and Design Program
SEAD 500 Foundations of Sustainability for Engineering and Design

Explanation:
New M.Eng. in Sustainability in Engineering and Design program being proposed by TISED.
One newly created core courses for the program (SEAD 500)

Please review this proposal and let me know as soon as possible, on this form, whether or not your department has any objections to, or comments regarding, the proposal.

X (but some comments)__NO OBJECTIONS___________ SOME OBJECTIONS

COMMENTS:

Through its emphasis on environmental issues, multidisciplinarity and sustainability, the proposed program has definitely some conceptual overlap with an MSE proposal for an interfaculty *PhD in Environment and Sustainability*, but the former is a Master program targeted at the engineering and design community, while the latter would be a PhD program with a broader scope in the natural sciences, social sciences and Humanities available to students outside Engineering. Ideally, there would be opportunities for synergies between these programs and potentially opportunities for future MSE graduate students to take relevant courses in this new Eng. Major if the program allows and for some of the graduates of this new Eng. Major to enroll in an interdisciplinary PhD at McGill. The proposed course SEAD 500 has similarities to a new graduate core course the MSE would propose in the context of its new PhD in the fact that it recognises the importance of a multidisciplinary perspective on sustainability, but in the case of SEAD 500, the course again is targeted towards engineering and design.

Note that the document refers to the M.Sc. Geography / Environment (Thesis) program in the department of Geography (Faculty of Science) as one of two relevant existing graduate-level programs at McGill. The interdisciplinary aspect of the Geography Master actually comes from the fact that it includes the Environment Option which is offered by the McGill School of Environment in 15

units at McGill (including Bioresource Eng.). This Option is on hold for 2018-2019 pending revisions on some of its courses. It is likely that the M.Eng Major Sustainability in Engineering and Design Program would impact engineering students currently interested in sustainability and who would have taken Envr Option courses or registered in programs offering the Env Option, although It is less likely to impact students in units like Geography or Anthropology. Overall, the M.Eng Major Sustainability in Engineering and Design Program is a welcome addition to the sustainability offering at McGill in a relevant field.

Signature: Sylvie de Blois

Date: **April 30th, 2018**

CONSULTATION REPORT FORM
RE COURSE PROPOSALS

DATE: April 19, 2018

TO: George Demopoulos, *Chair department of Mining and Materials*

FROM: David Harlander, *Academic Program Manager*, TISED

The attached proposal has been submitted to the Curriculum/Academic Committee, and it has been decided that your department should be consulted.

M.Eng Major Sustainability in Engineering and Design Program
SEAD 530 Economics for Sustainability in Engineering and Design
SEAD 550 Decision-making for Sustainability in Engineering and Design
SEAD 600/2 Sustainability Research Courses
SEAD 670 Collaborative Design for Sustainability

Explanation:

New M.Eng. in Sustainability in Engineering and Design program being proposed by TISED.
Three newly created core courses for the program (SEAD 530, SEAD 550, SEAD 670).
One newly created research course for the program (SEAD 600/2)

Please review this proposal and let me know as soon as possible, on this form, whether or not your department has any objections to, or comments regarding, the proposal.

___X___ NO OBJECTIONS __________ SOME OBJECTIONS

COMMENTS:

Signature: [signature]____________________

Date: **April 30th, 2018**____________________

CONSULTATION REPORT FORM
RE COURSE PROPOSALS

DATE: April 19, 2018

TO: Martin Bressani, *Director, School of Architecture*

FROM: David Harlander, *Academic Program Manager*, TISED

The attached proposal has been submitted to the Curriculum/Academic Committee, and it has been decided that your department should be consulted.

M.Eng Major Sustainability in Engineering and Design Program
SEAD 600/2 Sustainability Research Courses
SEAD 670 Collaborative Design for Sustainability

Explanation:
New M.Eng. in Sustainability in Engineering and Design program being proposed by TISED.
One newly created research course for the master's program (SEAD 600/2)
One newly created core course for the master's program (SEAD670).

Please review this proposal and let me know as soon as possible, on this form, whether or not your department has any objections to, or comments regarding, the proposal.

x **NO OBJECTIONS** ________ **SOME OBJECTIONS**

COMMENTS:

The School of Architecture is delighted to be able to participate to this new initiative, happy to contribute to an interdisciplinary program. Recent hires at the School (Salmaan Craig and Kiel Moe) will be particularly interested in further participation. It is understood that additional TA support may be required as applicable.

Signature:

Date: **22 avril 2018**

CONSULTATION REPORT FORM
RE COURSE PROPOSALS

DATE: April 19, 2018

TO: Dan Nicolau, *Chair of the Department of Bioengineering*

FROM: David Harlander, *Academic Program Manager*, TISED

The attached proposal has been submitted to the Curriculum/Academic Committee, and it has been decided that your department should be consulted.

M.Eng Major Sustainability in Engineering and Design Program
SEAD 600/2 Sustainability Research Courses
SEAD 670 Collaborative Design for Sustainability

Explanation:
New M.Eng. in Sustainability in Engineering and Design program being proposed by TISED.
One newly created core course for the program. (SEAD 670)
One newly created research course for the program. (SEAD 600/2)

Please review this proposal and let me know as soon as possible, on this form, whether or not your department has any objections to, or comments regarding, the proposal.

___X___ **NO OBJECTIONS** ______ **SOME OBJECTIONS**

COMMENTS:

Signature: ______________________

Date: ______________________

David Harlander, Mr

From: Sylvain Coulombe, Prof.
Sent: Friday, April 27, 2018 6:18 PM
To: David Harlander, Mr
Cc: Subhasis Ghoshal, Prof
Subject: Re: Consultation on TISED's new masters program

Sorry David.

I consulted with my two Associate Chairs (undergraduate and graduate) and we don't have any opposition. Please go ahead with our green light.

Sylvain

Le ven. 27 avr. 2018 à 18:14, David Harlander, Mr <david.harlander@mcgill.ca> a écrit :

> Dear Sylvain Coulombe,
>
> I wanted to follow up with you on the consultation report for TISED's proposed master's program and three new courses. These are scheduled to be reviewed by the Engineering Academic Committee next week and it would be good to have CHEE's approval. Would it be possible to have this before ***noon on Monday April 30th***?
>
> Please let me know if you have any questions.
>
> Best regards,
>
> David
>
> **From:** Sylvain Coulombe, Prof.
>
> **Sent:** Friday, April 20, 2018 10:30 AM
> **To:** David Harlander, Mr
> **Cc:** Subhasis Ghoshal, Prof
>
> **Subject:** Re: Consultation on TISED's new masters program

Hi David

This is the end of the term with a lot of presentations and marking to do. Tuesday will not be possible.

I will aim for Friday next week.

SC

Le ven. 20 avr. 2018 à 09:12, David Harlander, Mr <david.harlander@mcgill.ca> a écrit :

Dear Sylvain Coulombe,

TISED is planning to submit a proposal for a new M.Eng. Major in Sustainability in Engineering and Design to the EAC next month and would like some feedback from CHEE on four items:

1) The master's program proposal
2) SEAD 540 Industrial Ecology and Systems
3) SEAD 600/2 Sustainability Research courses
4) SEAD 670 Collaborative Design for Sustainability

I have attached a .pdf file with course outlines and details for each of the items, as well as a consultation form document. Can you please forward this message to the responsible party in CHEE and respond to the attached consultation form? We would greatly appreciate it if you could get back to us before ***noon on Tuesday April 24th***.

Please do not hesitate to contact me if you have any questions.

Thanks in advance for taking the time to review this,

David Harlander M.Arch.

Academic Project Manager / Research Assistant
Trottier Institute for Sustainability in Engineering and Design (TISED)
(514) 398-5781 | www.mcgill.ca/tised

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Sylvain Coulombe, ing., Ph.D. | Professor & Department Chair | Gerald Hatch Faculty Fellow | Plasma Processing Laboratory | Department of Chemical Engineering, McGill University | ppl.research.mcgill.ca/coulombe/

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Sylvain Coulombe, ing., Ph.D. | Professor & Department Chair | Gerald Hatch Faculty Fellow | Plasma Processing Laboratory | Department of Chemical Engineering, McGill University | ppl.research.mcgill.ca/coulombe/

CONSULTATION REPORT FORM
RE COURSE PROPOSALS

DATE: April 19, 2018

TO: Van-Thanh-Van Nguyen, *Chair of department of Civil Engineering*

FROM: David Harlander, *Academic Program Manager*, TISED

The attached proposal has been submitted to the Curriculum/Academic Committee, and it has been decided that your department should be consulted.

M.Eng Major Sustainability in Engineering and Design Program
SEAD 600/2 Sustainability Research Courses
SEAD 670 Collaborative Design for Sustainability

Explanation:

New M.Eng. in Sustainability in Engineering and Design program being proposed by TISED.
Two newly created core courses for the program (SEAD 600/2, SEAD670)

Please review this proposal and let me know as soon as possible, on this form, whether or not your department has any objections to, or comments regarding, the proposal.

X **NO OBJECTIONS** ______ **SOME OBJECTIONS**

COMMENTS:

Signature: [signature]

Date: April 27, 2018

CONSULTATION REPORT FORM
RE COURSE PROPOSALS

DATE: April 19, 2018

TO: Andrew Kirk, *Chair of dept. of Electrical and Computer Engineering*

FROM: David Harlander, *Academic Program Manager*, TISED

The attached proposal has been submitted to the Curriculum/Academic Committee, and it has been decided that your department should be consulted.

M.Eng Major Sustainability in Engineering and Design Program
SEAD 600/2 Sustainability Research Courses
SEAD 670 Collaborative Design for Sustainability

Explanation:

New M.Eng. in Sustainability in Engineering and Design program being proposed by TISED.
One newly created research course for the program (SEAD 600/2)
One newly created core courses for the program (SEAD670)

Please review this proposal and let me know as soon as possible, on this form, whether or not your department has any objections to, or comments regarding, the proposal.

X
______________ NO OBJECTIONS ______________ SOME OBJECTIONS

COMMENTS:

Signature: ______________________________

Date: **23/4/18**

CONSULTATION REPORT FORM
RE COURSE PROPOSALS

DATE: April 19, 2018

TO: Richard Shearmur, *Director School of Urban Planning*

FROM: David Harlander, *Academic Program Manager*, TISED

The attached proposal has been submitted to the Curriculum/Academic Committee, and it has been decided that your department should be consulted.

M.Eng Major Sustainability in Engineering and Design Program
SEAD 600/2 Sustainability Research Courses
SEAD 670 Collaborative Design for Sustainability

Explanation:
New M.Eng. in Sustainability in Engineering and Design program being proposed by TISED.
One newly created core courses for the program (SEAD 670)
One newly created research course for the program (SEAD 600/2).

Please review this proposal and let me know as soon as possible, on this form, whether or not your department has any objections to, or comments regarding, the proposal.

X
______________ NO OBJECTIONS ______________ SOME OBJECTIONS

COMMENTS:

Signature: ______________________________________

Date: **Friday 27th April**

CONSULTATION REPORT FORM
RE COURSE PROPOSALS

DATE: April 19, 2018

TO: Marilyn Scott, *Associate Dean (Academic),*
Faculty of Agricultural and Environmental Sciences

FROM: David Harlander, *Academic Program Manager*, TISED

The attached proposal has been submitted to the Curriculum/Academic Committee, and it has been decided that your department should be consulted.

M.Eng Major Sustainability in Engineering and Design Program

Explanation:
New M.Eng. in Sustainability in Engineering and Design program being proposed by TISED.

Please review this proposal and let me know as soon as possible, on this form, whether or not your department has any objections to, or comments regarding, the proposal.

NO OBJECTIONS

COMMENTS: Overall, looks very good !

Signature: Jan Adamowski

Date: **April 24 2018**

CONSULTATION REPORT FORM
RE COURSE PROPOSALS

DATE: April 19, 2018

TO: Nigel Roulet, *Chair ,* Department of Geography

FROM: David Harlander, *Academic Program Manager*, TISED

The attached proposal has been submitted to the Curriculum/Academic Committee and it has been decided that your department should be consulted.

M.Eng Major Sustainability in Engineering and Design Program

Explanation:
A newly developed core course for the proposed Master's in Sustainability in Engineering and Design.

Please review this proposal and let me know as soon as possible, on this form, whether or not your department has any objections to, or comments regarding, the proposal.

___X___ **NO OBJECTIONS** ________ **SOME OBJECTIONS**

COMMENTS:

Signature: Nigel T. Roulet

Digitally signed by Nigel T. Roulet
DN: cn=Nigel T. Roulet, o=McGill University, ou=Geography, email=nigel.roulet@mcgill.ca, c=CA
Date: 2018.04.24 15:31:51 -04'00'

Date: ________________

CONSULTATION REPORT FORM
RE COURSE PROPOSALS

DATE: April 19, 2018

TO: Morty Yalovsky, *Vice Dean of Faculty and Programs,*
Desautels Faculty of Management

FROM: Subhasis Ghoshal, *Director*, TISED

The attached proposal has been submitted to the Curriculum/Academic Committee, and it has been decided that your department should be consulted.

SEAD 660 Strategies for Sustainabilty

Explanation:
One new core course in the proposed M.Eng in Sustainability in Engineering and Design program.

Please review this proposal and let me know as soon as possible, on this form, whether or not your department has any objections to, or comments regarding, the proposal.

____X____ **NO OBJECTIONS** __________ **SOME OBJECTIONS**

COMMENTS:

Signature: ______________________________

Date: **April 30, 2018**____________________