UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Report No. 3651

MEMORANDUM

To: Executive Committee of Faculty Council (April 7, 2020)
Faculty Council (April 29, 2020)

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

Date: March 18, 2020

Re: **Change of Coursework Requirements and Program Length of Master of Engineering in Cities Engineering and Management (MEngCEM) Program**

REPORT CLASSIFICATION

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

SUMMARY

The current requirements for MEngCEM program are 6.0 FCE and the program length is four sessions. In contrast, the Civil MEng program requirement is 5.0 FCE and the program length is three sessions. The extra requirements for the MEngCEM have been a disincentive to enrolment in the program, particularly for international students.

To make the MEngCEM program more appealing and to bring it into alignment with the department's Civil MEng program, it is proposed to change the program length from four sessions to three sessions; reduce the coursework requirement from 5.0 to 4.0 FCEs; and change the number of core CEM courses from five to four.

It is also proposed to replace the current MEngCEM's three themes (which are confusing to students) with four core courses, three infrastructure engineering electives in one of eight specialization areas, and one technology management elective. Students will be required to choose a specialization area when selecting infrastructure engineering electives.

Details on the proposed changes to the MEngCEM program are described in the attached report.

CONSULTATION

Consultations regarding the proposed changes involved current MEngCEM graduate students, the CivMin Graduate Studies Committee, CivMin faculty, and the Faculty's Engineering Graduate Education Committee. All expressed support.

RECOMMENDATION FOR COUNCIL

THAT the changes to the coursework requirements and program length of the Master of Engineering in Cities Engineering and Management (MEngCEM) program, as described in Report 3651, be approved effective September 1, 2020.

University of Toronto
Major Modification Proposal

Significant Modifications to Existing Graduate and Undergraduate Programs

Program being modified:	Master of Engineering in Cities Engineering and Management: regular and extended full-time options
Proposed major modification:	Change of program length and coursework requirements
Department/unit:	Civil & Mineral Engineering
Faculty/academic division:	Applied Science & Engineering
Dean's office contact:	Julie Audet, Vice-Dean, Graduate Studies
Proponent:	Brent Sleep, Chair, Civil & Mineral Engineering
Version date:	March 18, 2020

1. Summary

Proposed changes to the Master of Engineering in Cities Engineering and Management (MEngCEM) program include:

i. The length of the program is to be changed from four sessions to three sessions

ii. The coursework requirement will be reduced from 5.0 to 4.0 full course equivalents (FCEs)

iii. The number of core CEM courses is to be changed from five to four. CEM1005 will no longer be a core course in the program

iv. The revised program will consist of four core courses, three infrastructure engineering electives in one of eight specialization areas, and one technology management elective

v. In addition to the required final technical report and presentation the practicum requirements will now include an interim report.

2. Effective Date

September 1, 2020

3. Academic Rationale

The current requirements for MEngCEM program are 6.0 FCE: 5.0 FCE of coursework plus a four-month, 1.0 FCE mandatory program-related practicum. In contrast, the Civil MEng program requirement is 5.0 FCE, comprised of coursework or coursework and a project. In addition, the MEngCEM has a program length of four sessions, compared to three sessions for the Civil MEng. These extra requirements for the MEngCEM compared to the Civil MEng have been a disincentive to enrolment in the program, particularly for international students. For a comparison of similar programs with a mandatory practical experience requirement in the Faculty of Applied Science & Engineering, the MEng in the Institute of Biomaterials & Biomedical Engineering is a three-session program with 3.5 FCE of coursework and a 1.5 FCE internship.

The original program was presented as having themes. In the current Calendar description, for Theme A, Infrastructure Engineering, any four courses in the Faculty of Applied Science & Engineering, except APS courses, could be taken. Theme B, Cities as Complex Systems, consisted of the core courses (CEM1001 to CEM1005), and a choice of one Technology Management elective, Theme C consisted of the Practicum. This presentation of the program as consisting of Themes was confusing to students. The revised program is presented as consisting of four core courses, three infrastructure engineering electives in one of eight specialization areas, and one technology management elective. Students will be required to choose a specialization area when selecting infrastructure engineering electives.

A curriculum review indicated that there was significant overlap between CEM1001 and CEM1005. Both courses had a focus on public policy and urban infrastructure, and both courses covered decision making in cities, citizen engagement, and transportation policy. Other elements of CEM1005 are covered in some of the technology management electives.

Cities engineering and management and urban infrastructure are priority areas for the Department of Civil & Mineral Engineering and the Faculty of Applied Science & Engineering. Aligning the MEngCEM requirements with those of the other MEng programs in the Faculty will aid in attracting excellent students to these areas, consistent with the unit's academic plan to make the MEngCEM a robust program.

4. Description of the Proposed Major Modification(s)

The proposed changes to the MEngCEM program are:

i. The length of the program is to be changed from four sessions to three sessions

ii. The coursework requirement will be reduced from 5.0 to 4.0 FCE

iii. The number of core CEM courses is to be changed from five to four. CEM1005, currently offered in Session 4, will no longer be a core course in the program

iv. The practicum requirements will now include an interim report.

There are minimal changes to what students will know or be able to do on completion of the program, beyond taking one less core course and one less elective course. Learning outcomes for the program have been modified to reflect the changes in the program and choices of electives (see Appendix A). With the removal of the core course in Session 4, full-time students will be able to complete the program in three sessions. The Associate Chair, Graduate in the Civil& Mineral Engineering Department will monitor academic progress of the students to ensure that milestones are met and that practicum placements are obtained.

5. Impact of the Change on Students

The proposed changes will allow full-time MEngCEM students to complete the program in 3 sessions as instead of 4 sessions, consistent with other MEng programs in the Department with a corresponding reduction in tuition fees. Extended full-time MEngCEM students will have the same options available as extended full-time MEng students in the Department, being able to complete the program in 6 sessions instead of 8 sessions, with a corresponding reduction in tuition fees. The change in the number of core courses will not have a significant impact as the MEngCEM students will have access to a variety of other courses that cover similar topics.

6. Consultation

Consultations regarding the proposed changes involved current MEngCEM graduate students (ongoing discussions and feedback from students over the past two years), the CIVMIN Graduate Studies Committee (Jan 7, 2020), CivMin faculty through a Departmental Council meeting (Jan 20, 2020) and graduate program chairs of relevant FASE departments and institutes via the Engineering Graduate Education Committee (March 18, 2020). All expressed support.

This major modification will not have an impact on other programs.

7. Resources

There will be no resource implications as a result of these changes to faculty complement, space and libraries. The proposed modification will not affect any existing agreements with other institutions.

It is anticipated that enrolment in the MEngCEM will increase. The current enrolment of 10-12 students is below expectations for the program of 25 students. There may be a need for additional TA resources if numbers reach 25 or more. FASE is below its combined domestic master's EFTE target this year and an increase to 25 students is not expected to lead to an

exceedance of the FASE combined domestic master's EFTE enrolment targets.

8. UTQAP Process

The UTQAP pathway is summarized in the table below.

Steps	**Dates**
Development/consultation within unit	Jan 2020
Approval by CivMin Department Council	Jan 20, 2020
Consultation with Dean's office (and VPAP)	Feb 2020
Approval by FASE Engineering Graduate Education Committee	Mar 18, 2020
Approval by FASE Council	Apr 29, 2020
Reported to the Provost for inclusion in annual report to AP&P	May 2020
Included in annual report to Ontario Quality Council	Jun 2020

Appendix A: Current Learning Outcomes and Degree-Level Expectations with Changes Tracked

The proposed major modifications to the MEngCEM will not affect the program's learning outcomes or degree-level expectations.

Master of Engineering Degree Level Expectations (DLEs)	**Master of Engineering Program Learning Objectives and Outcomes**	**How Program Design & Requirement Supports the Attainment of Student Learning Outcomes**
EXPECTATIONS: The Master of Engineering in Cities Engineering and Management (MEngCEM) is awarded to students who have demonstrated:		
1. Depth and Breadth of Knowledge A systematic understanding of knowledge, and a critical awareness of current problems and/or new insights, much of which is at, or informed by, the forefront of the academic discipline, field of study, or area of professional practice.	Depth and breadth of knowledge is defined in MEngCEM as a systematic understanding of current problems and/or new insights, much of which is at the forefront of professional practice. This is reflected in students who are able to: ▪ Display expertise in at least one area of infrastructure ▪ Critically assess a complex problem with opposite and conflicting perspectives ▪ Understand the political process and how it works	The program design and requirement elements that ensure these student outcomes for depth and breadth of knowledge are: ▪ Embedded in the program where students take core courses related to cities, infrastructure engineering electives in a specialization area, and a technology management elective~~themes (that comprise the program~~ ▪ ~~The requirement for depth and breadth in the infrastructure engineering courses, where at least two courses are focused on one infrastructure type and at least one must be in a different but complementary area~~ ▪ Inherent in the ~~complex systems~~ core courses where students explore city economic, political, and

Master of Engineering Degree Level Expectations (DLEs)	Master of Engineering Program Learning Objectives and Outcomes	How Program Design & Requirement Supports the Attainment of Student Learning Outcomes
2. Knowledge of Methodologies A conceptual understanding and methodological competence that (a) Enables a working comprehension of how established techniques of inquiry are used to interpret knowledge in the discipline; (b) Enables a critical evaluation of current developments in the discipline; (c) Enables a treatment of technical issues and judgments based on established principles and techniques.	Knowledge of Methodologies is defined in MEngCEM as a conceptual understanding and methodological competence that enables: ▪ A working knowledge of how established techniques of inquiry are used to create and interpret knowledge in the discipline ▪ A critical evaluation of current research and scholarship in the area of professional competence ▪ A treatment of complex issues and judgments based on established principles and technique This is reflected in students who are able to: ▪ Critically assess a complex problem with opposite and conflicting perspectives ▪ Condense complex topics and analyses into simple and easily communicated messages for a diverse set of stakeholders	The program design and requirement elements that ensure these student outcomes are attained are: ▪ Outstanding instructors whose expertise will bring both theory and practice to the classroom ▪ Course papers in courses where students will have the opportunity to explore in-depth topics ▪ The assessment for their practicum reports
3. Level of Application of Knowledge Competence in the research process by applying an existing body of knowledge in the critical analysis of a new question or of a specific problem or issue in a new setting.	Application of knowledge is defined in MEngCEM as competence in applying an existing body of knowledge in the critical analysis of a new question or of a specific problem or issue in a new setting. This is reflected in students who are able to: ▪ Demonstrate expertise in an infrastructure type ▪ Critically and comprehensively assess a complex problem from the viewpoints of stakeholders	The program design and requirement elements that ensure these student outcomes for level and application of knowledge are: ▪ Exams and projects in the courses ▪ Captured in the practicum experience ▪ Demonstrated in the practicum report

Master of Engineering Degree Level Expectations (DLEs)	Master of Engineering Program Learning Objectives and Outcomes	How Program Design & Requirement Supports the Attainment of Student Learning Outcomes
4. Professional Capacity/Autonomy a. The qualities and transferable skills necessary for employment requiring i) The exercise of initiative and of personal responsibility and accountability; and ii) Decision-making in complex situations; b. The intellectual independence required for continuing professional development; c. The ethical behavior consistent with academic integrity and the use of appropriate guidelines and procedures for responsible conduct of research; and d. The ability to appreciate the broader implications of applying knowledge to particular contexts.	Professional capacity/autonomy is defined in MEngCEM as the qualities and transferable skills necessary for employment requiring the exercise of initiative and of personal responsibility and accountability; and decision-making in complex situations; the intellectual independence required for continuing professional development; the ethical behaviour consistent with academic integrity; and, the ability to appreciate the broader implications of applying knowledge to particular contexts. This is reflected in students who are able to: ▪ Prepare research papers ▪ Integrate professional, social, and environmental considerations into their decision analyses	The program design and requirement elements that ensure these student outcomes for professional capacity/autonomy are: ▪ Individual exams and projects in the ~~Theme A courses~~infrastructure engineering and technology management electives ▪ Course papers required in the ~~Theme B~~core courses ▪ Independent work in the practicum
5. Level of Communications Skills The ability to communicate ideas, issues and conclusions clearly.	Communications Skills are defined in MEngCEM as the ability to communicate ideas, issues and conclusions clearly. This is reflected in students who are able to: ▪ Construct a credible argument and present it in appropriate formats ▪ Generate research and position papers ▪ Make professional presentations	The program design and requirement elements that ensure these student outcomes for level of communication skills are: ▪ Course papers and presentations ▪ Practicum report ▪ Practicum presentation

Appendix B: Calendar Copy with Changes Tracked

Master of Engineering in Cities Engineering and Management

Program Description

Cities are the economic engines of the world. Highly-skilled professionals, armed with both technical expertise and a fundamental understanding of the cross-disciplinary issues, are needed to help our cities tackle challenges to ensure the well-being of their inhabitants and economies. In the Masters of Engineering: Cities Engineering and Management (MEngCEM) program, students prepare for rewarding careers in government and the private sector, addressing the critical issues and growing needs of urban centres.

To proactively respond to the changing needs of cities, the MEngCEM program offers students a practicum to apply what they have learned in the classroom.

The MEngCEM program can be completed through full-time studies over three~~four~~ continuous sessions or through an extended full-time (EFT) option over six sessions~~three years~~.

Full-Time Option

Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy the Department of Civil Engineering's additional admission requirements stated below.
- A completed undergraduate degree equivalent to a four-year University of Toronto program with a minimum final-year grade point average (GPA) of mid-B (3.0 out of 4.0 or 75%). Competitive admission averages are typically near or above 80% (A–).
- Applicants whose primary language is not English and who graduated from a university where the language of instruction and examination was not English must demonstrate proficiency in English. See General Regulations section 4.3 for requirements.
- Applicants with backgrounds in an applied science other than engineering may be admitted.
- Applicants must have one year of work experience before admission to the program.

Program Requirements

- The program requires completion of ~~6~~5.0 full-course equivalents (FCEs) as follows:
    - ~~10 half courses (5.0 FCEs)~~ 8 half courses (4.0 FCE) consisting of 4 core courses (see below), 3 infrastructure engineering electives in one of 8 specialization areas, and 1 technology management elective. Core courses are:
        - CEM1001 - The Challenges of Urban Policy-Making
        - CEM1002 - Data Analytics and Cities
        - CEM1003 - Infrastructure and Urban Prosperity
        - CEM1004 - Cities as Complex Systems
    - 1.0 FCE Practicum typically completed during the Summer of Year 1.
- ~~The program consists of three required themes (see course list below):~~
    - ~~Theme A Infrastructure Engineering: minimum of four half courses chosen from Theme A course list (2.0 FCEs); each student's course selection requires approval by the Program Director prior to enrolment~~
    - ~~Theme B Cities as Complex Systems: four required half courses (2.0 FCEs)~~
    - ~~Theme C Practicum: includes presentation and technical report (1.0 FCE)~~
- ~~Two half course electives (1.0 FCE) chosen from either Theme A or B list of courses, or from the list of Technology Management courses below.~~

Program Length

3~~4~~ sessions (typical registration sequence: F/W/S~~/F~~)

Time Limit

3 years

Extended Full-Time Option

Minimum Admission Requirements

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

- A completed undergraduate degree equivalent to a four-year University of Toronto program with a minimum final-year grade point average (GPA) of mid-B (3.0 out of 4.0 or 75%). Competitive admission averages are typically near or above 80% (A–).
- Applicants whose primary language is not English and who graduated from a university where the language of instruction and examination was not English must demonstrate proficiency in English. See General Regulations section 4.3 for requirements.
- Applicants with backgrounds in an applied science other than engineering may be admitted.
- Applicants must have one year of work experience before admission to the program.

Program Requirements

- The program requires completion of 5~~6~~.0 full-course equivalents (FCEs) as follows:
    - ~~10 half courses (5.0 FCEs)~~8 half courses (4.0 FCE) consisting of 4 core courses (see below), 3 infrastructure engineering electives in one of 8 specialization areas, and 1 technology management elective. The core courses are as follows:
        - CEM1001 - The Challenges of Urban Policy-Making
        - CEM1002 - Data Analytics and Cities
        - CEM1003 - Infrastructure and Urban Prosperity
        - CEM1004 - Cities as Complex Systems
    - 1.0 FCE Practicum typically completed during the Summer of Year 2.
- ~~The program consists of three required themes (see course list below):~~
    - ~~Theme A Infrastructure Engineering: minimum of four half courses chosen from Theme A course list (2.0 FCEs); each student's course selection requires approval by the Program Director prior to enrolment~~
    - ~~Theme B Cities as Complex Systems: four required half courses (2.0 FCEs)~~
    - ~~Theme C Practicum: includes presentation and technical report (1.0 FCE)~~
- ~~Two half-course electives (1.0 FCE) chosen from either Theme A or B list of courses, or from the list of Technology Management courses below.~~

Program Length

~~6~~9 sessions (typical registration sequence: F/W/S/F/W/S/F/W/S)

Time Limit

3 years

Civil and Mineral Engineering: Cities Engineering and Management MEngCEM Courses

Courses must be approved by the Program Director.

~~Theme A~~

~~Eligible courses include graduate courses with course prefixes as follows: AER, BME, CHE, CIV, ECE, MIE, and MSE, including some courses at the 500 level.~~

~~Theme B~~
~~Required~~Core Courses

CEM 1001H	The Challenges of Urban Policy-Making (Core)
CEM 1002H	Empirical Study of Cities (Core)
CEM 1003H	Infrastructure and Urban Prosperity (Core)
CEM 1004H	Cities as Complex Systems (Core)
~~CEM 1005H~~	~~Integrative Decision Making for Cities (Core) Theme C~~
CEM 1000Y	Cities Engineering and Management Practicum (required)

Infrastructure Engineering Course Electives

Students must choose 3 courses in one of the following specialization areas:

Transportation, Cyber Security, Urban Structures, Sustainable Energy Systems, Operations Research, Environmental Issues for Healthy Cities, Resilience of Critical Infrastructure, Communications Networks.

The course choices (subject to change) in each infrastructure engineering specialiation area are:

Transportation

Course Code	Title & Description
CIV516H	Public Transit Operations and Planning
CIV531H	Transport Planning
CIV1506H	Freight Transportation and ITS Applications
CIV1508H	Airport Planning and Engineering
CIV1532H	Fundamentals of ITS and Traffic Management
CIV1535H	Transportation and Development
CIV1538H	Transportation Demand Analysis
CIV1598H	Special Studies in Civil Engineering - Transportation: Urban Operations Research

Cyber Security

Course Code	Title & Description
ECE568H	Computer Security
ECE1508H	Special Topics in Communications
ECE1518H	Seminar in Identity, Privacy and Security
ECE1776H	Computer Security, Cryptography and Privacy

Urban Structures

Course Code	Title & Description
APS1024H	Infrastructure Resilience Planning
APS1025H	Infrastructure Protection
CIV576H	Sustainable Buildings
CIV1164H	Bridge Engineering
CIV1167H	Advanced Structural Dynamics
CIV1169H	Advanced Topics in Building Design
CIV1252H	Infrastructure Renewal

Sustainable Energy Systems

Course Code	Title & Description
APS510H	Innovative Technologies and Organizations in Global Energy Systems
ECE1092H	Smart Grid Case Studies
MIE515H	Alternative Energy Systems
MIE1120H	Current Energy Infrastructure and Resources
MIE1240H	Wind Power
MIE1715H	Lifecycle Engineering

Operations Research

Course Code	Title & Description
MIE1603H	Integer Programming
MIE1616H	Research Topics in Healthcare Engineering
MIE1620H	Linear Programming and Network Flows
MIE1621H	Non-Linear Optimization
MIE1721H	Reliability
MIE1723H	Engineering Asset Management
MIE1727H	Statistical Methods of Quality Assurance

Environmental Issues for Healthy Cities

Course Code	Title & Description
CHE1433H	Air Dispersion Modelling
CIV549H	Groundwater Flow and Contamination
CIV1303H	Water Resources Systems Modelling
CIV1308H	Physical and Chemical Treatment Processes
CIV1309H	Biological Treatment Processes
CIV1311H	Advanced and Sustainable Drinking Water Treatment

Course Code	Title & Description
APS1024H	Infrastructure Resilience Planning
APS1025H	Infrastructure Protection
APS1031H	Infrastructure Planning
URD1044H	Urban Design and Development
URD2041H	Planning and Real Estate Development

Resilience of Critical Infrastructure

Course Code	Title & Description
APS1024H	Infrastructure Resilience Planning
APS1025H	Infrastructure Protection
APS1031H	Infrastructure Planning
URD1044H	Urban Design and Development
URD2041H	Planning and Real Estate Development

Communications Networks

Course Code	Title & Description
ECE1508H	Special Topics in Communications
ECE1520H	Data Communications I
ECE1524H	Service Provider Networks
ECE1541H	Communication Networks I
ECE1545H	Special Topics in Data Communications: Stochastic Network Calculus
ECE1548H	Advanced Network Architectures: Network Softwarization: Principles and Foundations

Technology Management Course Electives (Course List is Subject to Change)

APS 1001H	Project Management
APS 1005H	Operations Research for Engineering Management
APS 1009H	Natural Resources Management
APS 1010H	Cognitive and Psychological Foundations of Effective Leadership
APS 1012H	Managing Business Innovation and Transformational Change
APS 1015H	Social Entrepreneurship
APS 1016H	Financial Management for Engineers
APS 1017H	Supply Chain Management and Logistics
APS 1024H	Infrastructure Resilience Planning

APS 1025H	Infrastructure Protection
APS 1031H	Infrastructure Planning
APS 1036H	Formative Experiential Entrepreneurial Learning (FEEL)
APS 1037H	Infrastructure Engineering in Remote First Nation Communities in Ontario
APS 1038H	Strategic Sustainability Management for Businesses and Products
APS 1039H	Enterprise Risk Management
APS 1040H	Quality Control for Engineering Management
APS 1088H	Business Planning and Execution for Canadian Entrepreneurs
APS 1202H	Engineering and Sustainable Development
CHE 1435H	Fundamentals of Aerosol Physics and Chemistry
CIV 1307H	Life Cycle Assessment and Sustainability of Engineering Activities