UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Report No. 3788

MEMORANDUM

To: Executive Committee of Faculty Council (April 8, 2025)
Faculty Council (April 29, 2025)

From: Professor Lisa Romkey
Chair, Engineering Graduate Education Committee

Date: March 28, 2025

Re: Engineering Graduate Education Committee Information Update

REPORT CLASSIFICATION

This is a routine or minor policy matter that will be considered by the Executive Committee for approving and forwarding to Faculty Council to receive for information.

MINOR MODIFICATION

The following modifications to the PhD and MEng programs in Civil & Mineral Engineering were approved by the Engineering Graduate Education Committee.

CHANGE TO AN EXISTING GRADUATE PROGRAM OR EMPHASIS

New Emphasis: Semiconductor Fabrication and Inspection	MEng students in the Departments of Electrical & Computer Engineering, and Materials Science & Engineering can earn an emphasis in the area of Semiconductor Fabrication and Inspection by completing four courses, including a core course (JEM1068) in "Semiconductor Fabrication and Inspection". This new emphasis will provide an unprecedented experiential and interdisciplinary learning environment for semiconductor fabrication and inspection. Hands-on training will be carried out at the Toronto Nanofabrication Centre (TNFC), a Micro/Nanotechnology research and training facility and the Open Center for the Characterisation of Advanced Materials (OCCAM). Students will get a chance to perform deposition, lithography and etching at TNFC's cleanroom and learn to measure the dimensions of the fine patterns formed on semiconductor wafers using OCCAM's state-of-the-art electron microscopes. See Appendix I for further details.

NEW COURSES APPROVED

The following new courses have been approved by the Engineering Graduate Education Committee.

CHE1149: Chemical Engineering Data Organization	Artificial Intelligence (AI) and Data Informed Decision Making (DIDM) rely heavily on data and the use of AI and DIDM is necessary in order to maintain competitiveness. Industry benchmarks indicate that 70-80% of the effort in implementing AI and DIDM is associated with the task of acquiring pertinent data. Organizing and thereby making industrial data easier to acquire would help mitigate the efforts involved. This course introduces the current tools used to address this problem. Students will learn about industry standards, approaches, and data transport protocols. Working both in team and individual environments, these concepts will be applied to real world scenarios.
CIV1287: Construction Virtualization and Analytics	Advanced practices in construction project management are enabled by several fundamental shifts. The course will explore the interplay between two of the most significant shifts. First, smart hardware (from virtual reality to robotics and IoT), which are transforming site technology and construction methods. Second, and probably more importantly, advanced data analytics and the use of machine learning are revolutionizing work processes and decision making. This course creates a co-learning environment for students to explore state of the art in the virtualization and analytics systems in the industry, and to critically analyze the enabling factors and the building blocks behind these two shifts. It will enable students to evaluate the contribution and role of several types of technologies and data systems in virtualization and analytics. The course will provide students with means to compare diverse trends in these two domains, and to synthesize how the interaction between them can create changes to project planning and management and the overall organizational culture. Ultimately, it will provide students with a chance to discover the paradigm shifts in our models (or lack, thereof) of knowledge that underpin advances in these two domains.
CIV1507: Analytics for Transit & Mobility Systems	Transit agencies worldwide witness a growing trend of data abundance and diversity, presenting opportunities to enhance transit system effectiveness but requiring specialized knowledge and experience with analytics for harnessing such data. Transportation agencies and companies overseeing other modes and emerging mobility services face the same challenges. This course provides students with in-depth exposure to emerging data types, sources, and standards for transit and other mobility systems. The course will cover a range of analytics for harnessing diverse data in various planning and management applications. While special focus will be given to transit applications, other mobility modes and services will be considered as appropriate.

JEM1068: Semiconductor Fabrication and Inspection	The course will cover the fabrication process and the inspection techniques of semiconductors. It is an introduction to the fundamentals of micro- and nano-fabrication processes with emphasis on cleanroom practices. It will cover: 1) The physical principles of optical lithography, electron-beam lithography, alternative nanolithography techniques, and thin film deposition and metrology methods; 2) The physical and chemical processes of wet and dry etching; 3) Cleanroom concepts and safety protocols; 4) Sequential micro-fabrication processes involved in the manufacture of microelectronic and photonic devices; 5) Metrology, imaging and characterization of micro- and nano-structures; and 6) Examples of practical existing and emerging micro- and nano-devices. Emphasis will be hands-on learning, and 50 % of the contact hours will lab sessions. Students divided in small groups will use the tools and equipment at the Toronto Nanofabrication Centre (TNFC) and the Open Centre for the Characterization of Advanced Materials (OCCAM).
TEP1701: Navigating Engineering Workplaces	The field of engineering is moving at a rapid pace, driven by advancements in technology, innovation, and global challenges. Coupling in-class learning with practical experience is demonstrated to be an invaluable tool in preparation for a professional career in engineering. In this graduate-level course, the emphasis is on students to gain a comprehensive understanding of engineering workplace strategies before diving into their co-op term, and building a personal legacy on authentic engineering education experiences. Through a combination of lectures, self-paced assignments, and collaborative group discussion, students will engage with their peers to understand course materials (including published literature), explore Canadian workplace contexts, and develop the skillset to conceptually design a narrative of experiential learning.

COURSE MODIFICATIONS

The following courses have had minor modifications approved by the Engineering Graduate Education Committee.

CHE1147: Chemical Data Science and Engineering	Course title change from “Data Mining in Engineering” to “Chemical Data Science and Engineering” to better reflect the contents of the course, and the specificity around Chemical Engineering applications.
CHE1148: Artificial Intelligence for Applied Chemistry and Chemical Engineering	Name change from “Data Process Analytics” to “Artificial Intelligence for Applied Chemistry and Chemical Engineering” to reflect increasing focus on AI.

MIE1076: AI & Robotics II	Remove the prerequisite MIE1075: AI & Robotics I. Courses are complementary but cover different applications, and MIE1076 does not require MIE1075 to be taken first.
MIE1624: Introduction to Data Science, Analytics and Artificial Intelligence	Name change from “Introduction to Data Science and Analytics” to “Introduction to Data Science, Analytics and Artificial Intelligence” to reflect the contents of the course.
MIE1402: Design and Analysis of Experiments	Name change from “Experimental Methods in Human Factors Research” to “Design and Analysis of Experiments.” The use of the term “Human Factors” in the course title is unnecessarily restrictive since the course covers the design and analysis of any experiments.

RECOMMENDATION FOR COUNCIL

For Information.

University of Toronto
Minor Modification Proposal

Change to an Existing Graduate Program or Collaborative Specialization

Creation of Emphasis in Semiconductor Fabrication and Inspection

This template was developed by the Office of the Vice-Provost, Academic Programs and updated on March 6, 2018. It should be used to bring forward all proposals for minor modifications to program or admissions requirements for existing graduate programs or collaborative specializations under the UTQAP.

Program/Collaborative Specialization being modified:	Master of Engineering (MEng) in Electrical and Computer Engineering Master of Engineering (MEng) in Materials Science & Engineering
Graduate unit:	Electrical & Computer Engineering (ECE) Materials Science & Engineering (MSE)
Faculty/academic division:	Applied Science & Engineering
Dean's office contact:	Prof. Julie Audet, Vice-Dean, Graduate Studies
Version date:	March 12, 2025

1. Summary

- *Check box for type(s) of change. Summarize what the change is, including details about any changes to FCEs.*

	Changing admission requirements		Renaming field, concentration or emphasis[1]
	Changing program requirements		Renaming of program or collaborative specialization (please notify VPAP before governance)
	Changing timing of program requirements	**X**	**Creating a new emphasis**
			Changes to programs affecting an MOA

[1] Anything with a changed/new name requires consultation with OVPAP prior to governance; if name change implies significant change to what is being offered or how it is being offered, this may be a major modification or new program.

MEng students in the departments of Electrical & Computer Engineering and Materials Science & Engineering can earn an emphasis in the area of **Semiconductor Fabrication and Inspection** by completing four courses from the lists described in Appendix A.

2. Effective Date of Change

September 1, 2025.

3. Academic Rationale

- *Describe the academic reasons for the change.*

In July 2024, Canadian government launched the $120M FABrIC initiative to secure Canada's future in semiconductors and advanced manufacturing. This five-year FABrIC program will help Canada to expand its semiconductor industry, develop new innovative Made-in-Canada semiconductor-based products. It is forecasted that the industry will require 40,000 well-trained labor force. In responding to the surge of industrial demand, leveraging the strength and world-class facilities of the Open Centre for the Characterization of Advanced Materials (OCCAM) and Toronto Nanofabrication Centre (TNFC), we will set up a new MEng Emphasis in **"Semiconductor Fabrication and Inspection".**

This new emphasis will provide an unprecedented experiential and interdisciplinary learning environment for semiconductor fabrication and inspection. Hands-on training will be carried out at the Toronto Nanofabrication Centre (TNFC), a Micro/ Nanotechnology research and training facility and the Open Center for the Characterisation of Advanced Materials (OCCAM). Students will get a chance to perform deposition, lithography and etching at TNFC's cleanroom and learn to measure the dimensions of the fine patterns formed on semiconductor wafers using OCCAM's state-of-the-art electron microscopes.

4. Impact on Students

- *Outline the expected impact on continuing and incoming students, if any, and how they will be accommodated.*

Students eligible for the emphasis can, at the beginning of their program, enrol the emphasis by requesting the notation on their transcripts to the FASE graduate office.

5. Consultation

- *Describe any consultation undertaken with the students, faculty, Dean and chair/director. Address any major issues discussed.*

Support from Industry

The Emphasis in Semiconductor Fabrication and Inspection has been developed with consultation from the FABrIC program and the CMC Microsystem, with the intention of connecting students to potential careers, and facilitating continuing education for industry practitioners. The CMC is a not-for-profit organization that accelerates research and innovation in advanced technologies including microelectronics, photonics, microelectromechanical systems (MEMS), Internet of Things (IoT), Artificial Intelligence (AI), and quantum software and hardware. To support the development of the Canadian semiconductor industry, the FABrIC has organized the Canadian Semiconductor Symposium in October 2024 in Markham, Ontario. Professors Wai Tung Ng and Jane Howe met with industrial leaders and the representatives of the local businesses and asked for their feedbacks and demand. The curriculum is being designed in close collaboration with the FABrIC and the CMC.

We are in the process of connecting with prospective students from industry. We will invite them to enroll in the new courses. It is estimated that roughly a dozen people will be strongly interested in enrolling the coming academic year.

Consultation with UofT students

A group of six current MEng students in MSE were consulted. They all gave positive feedbacks and expressed enthusiasm in having courses with industry connections, and further curricula on semiconductor fabrication and inspection.

Support from UofT Faculty

Prof. Antonio Liscidini, ECE Associate Chair, Graduate Studies is in favour of creating this new emphasis. Prof. Wai Tung Ng (ECE), Director of Toronto Nanofabrication Centre (TNFC), and Prof. Jane Howe (MSE), Co-Director of the Open Centre for the Characterization of Advanced Materials (OCCAM) and MSE Associate Chair, Graduate Studies, are spearheading its establishment. Prof. Naomi Matsuura, MSE Associate Chair, Research has also been fully supportive.

Prof. Hani Naguib, MSE Chair, and Prof. Deepa Kundur, ECE Chair, have also been consulted. Both are strongly in favour of establishing this new emphasis.

The Faculty's Vice-Dean, Graduate Studies and the Chief Financial Officer were consulted and support the establishment of the emphasis.

6. Resources

- *Describe any resource implications of the change(s) including, but not limited to, faculty complement, space, libraries and enrolment/admissions).*

The MEng students will be asked to declare the emphasis as soon as they enroll into the program. There are minimal resource implications as major increases in enrolment are not expected for any of the eligible courses listed given the significant number of them. A FASE-level administrator with access to ROSI will be responsible for verifying that students from the different participating units have completed the required courses and for adding the emphasis notation on their transcripts. It is intended that resources will be sought for both marketing and development of course material. Prof. Jane Howe intends to continue to oversee and guide the implementation process for at least the first five years of the program's life.

7. Governance Approval

Sign-off by Units	Prof. Antonio Liscidini (ECE) Prof. Jane Howe (MSE)
Sign off by Dean's Office	Prof. Julie Audet, Vice-Dean, Graduate Studies, March 5, 2025
Approval by FASE Engineering Graduate Education Committee (EGEC) **Receipt for Information by FASE Council**	March 13, 2025 April 29, 2025

Appendix A: Calendar Entry

Use track changes to indicate where changes have been made.

MEng students must successfully complete **four half courses (2.0 FCE), including** one core course. The remaining coursework may be taken from the following lists.

Core courses (Required)

JEM1068 Semiconductor Fabrication and Inspection. This new course will be taught jointly by ECE and MSE. It is a graduate-level technical course which can be used by M Eng, MASc, and PhD students towards their degree requirements in MSE and ECE. In addition to the lectures of theories, this course will include six bi-weekly 4-hour practical sessions of learning the fabrication process in TNFC and the inspection using OCCAM facility.

Electives - choose at least 3 of the following courses

ECE1398	VLSI Technology
MSE1026	Advanced Electron Microscopy
ECE1395H	Power Semiconductor Devices & Applications
MSE1066	Practical Aspects of Electron Microscopy
MSE1067	Materials Failure
MSE1031	Forensic Engineering
JTC 1135	Applied Surface & Interface Analysis
MSE1061	Engineered Ceramics
MSE1022	Special Topics in Materials Science I: Quantum Transport
MSE1065	Application of Artificial Intelligence in Materials Design
ECE1352	Analog Circuit Design I
ECE1396	Analog Signal Processing Circuits
ECE1336	Semiconductor Physics
ECE1390	Selected Topics in Circuits and Systems: Integrated Circuits for Sensors and Biomedical Devices
ECE1718	Special Topics in Computer Hardware Design: Advanced Computer Architecture
ECE1385	Selected Topics in VLSI Systems: VLSI-based Digital Signal Processing and AI Systems
ECE1777	Computer Methods for Circuit Simulation
ECE1387	CAD for Digital Circuit Synthesis & Layout
ECE1392	Integrated Circuits for Digital Communication