



MEMORANDUM

To: Executive Committee of Faculty Council (February 5, 2019)
 Faculty Council (February 27, 2019)

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

Date: February 8, 2019

Re: **EGEC Information Update**

REPORT CLASSIFICATION

This is a routine or minor policy matter that has been approved by the Engineering Graduate Education Committee on behalf of Faculty Council¹. It will be considered by the Executive Committee for endorsing and forwarding to Faculty Council for information.

NEW COURSES APPROVED

AER1604H	Air Accident Investigation
APS1070H	Foundations of Data Analytics and Machine Learning
CIV1302H	Low Impact Development and Stormwater Systems

MINOR MODIFICATIONS

BME1450 Bioengineering Science (required course in the MHSc, MASc and PhD programs in BME)	Course code and name changed to BME1477 Biomedical Engineering Project Design and Execution. The learning outcomes of the course remain similar.
ECE1094H Mathematical Methods in Power Systems	Course name changed to Power System Operations and Economics. The revised name is a better reflection of the course contents.

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

MINOR MODIFICATIONS, continued

Emphasis in Analytics (MEng CIV, ECE, CHE, MIE)	Students interested in pursuing the emphasis must successfully complete a new pre-requisite course APS1070H (above) before taking any one of the two core courses required for the emphasis (MIE1624, ECE1513). (See Appendix 1, Minor Modification proposal)
Collaborative Master's and Doctoral Specialization in Psychology and Engineering	Added master's (MAsc) and doctoral (PhD) degree programs in Civil Engineering and Electrical and Computer Engineering. (See Appendix 2, Minor Modification proposal)

MAJOR MODIFICATIONS

Doctoral program in Aerospace Engineering	Add direct-entry option. (See Appendix 3, Major Modification proposal)
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RECOMMENDATION FOR FACULTY COUNCIL

For information.

APPENDIX 1

University of Toronto

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

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

Program/Collaborative Specialization being modified:	Chemical Engineering & Applied Chemistry, MEng Civil Engineering, MEng Electrical & Computer Engineering, MEng Mechanical & Industrial Engineering, MEng
Graduate unit:	Above four
Faculty/academic division:	Applied Science & Engineering
Dean's office contact:	Julie Audet, Vice-Dean, Graduate Studies
Version date:	January 28, 2019

1 Summary

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

Master of Engineering (MEng) students in graduate units in the departments of Chemical Engineering & Applied Chemistry, Civil & Mineral Engineering, Electrical & Computer Engineering, and Mechanical & Industrial Engineering can earn an Emphasis in Analytics by successfully completing four courses from the two lists presented on the in Appendix A. At least one course must be from the list of core courses. The other courses must be selected from the list of elective courses.

Herein, we propose to add a pre-requisite course for both core courses for the emphasis. Therefore, to be admitted in the emphasis in analytics, MEng students must first successfully complete a prerequisite course (APS1070H: Foundations of Data Analytics and Machine Learning). Subsequently, to earn the emphasis, students must successfully complete four additional half-courses from the list of core courses or elective courses. These must include at least one core course; the remaining courses must be selected from the list of elective courses. Students must have completed the prerequisite course APS1070H before taking any of the core courses.

2 Effective Date of Change

September 1, 2019. The new requirement will apply to MEng students who have started their program in September 2019 and afterwards.

3 Academic Rationale

Shortly after the emphasis was launched last year (2018), registration in the core courses (ECE1513, MIE1624) dramatically increased. Since the emphasis in Analytics is available to MEng students in ECE, MIE, CHE and CIV, the extremely varied background of the students taking these courses caused serious challenges in class. Specifically, a large number of students had not had sufficient exposure to programming/coding, linear algebra, optimization, probability and statistics to succeed in the graduate-level core courses. Moreover, because of the novelty of the field, most students had only a vague appreciation of the practical applications of analytics. Therefore, a pre-requisite “gateway” course (APS1070) was designed to address these issues and to ensure that students get some introduction to data analytics and AI before they make their decision to pursue further specialization in this area.

4 Impact on Students

MEng students interested in earning the emphasis in Analytics (in particular those that are full-time in the program) should complete the pre-requisite course APS1070 during their first semester. APS1070 will be offered both in the fall and winter to accommodate students who will start their program in the winter session. In subsequent semesters, students can take at least one of the two core courses (MIE1624 or ECE1513) as long as they have successfully completed APS1070. The elective courses for the emphasis can be taken at any time of the MEng program, when they are offered. One of the core courses, ECE1513, is currently only offered in the winter, therefore may not be accessible for students who started their program in the winter semester. However, the core course MIE1624 is normally offered both in the fall and winter, therefore students who started their program in the winter will be able to take this core course during the fall semester of the same year.

Since APS1070 will rely significantly on graduate-level programming projects, it will be distinct from any other undergraduate course currently offered in FASE. Therefore, MEng students will not normally be eligible to be excluded from this requirement based on their undergraduate studies.

Offer letters for admission in the MEng program in the four graduate units will be modified to ensure applicants are aware that there is no guarantee that they will be able to earn a specific emphasis. A sentence such as “students are not guaranteed the option of taking a specific emphasis or core courses required to earn an emphasis” will be added to the letters.

5 Consultation

A committee was organized to assess the situation for the emphasis in Analytics within the Faculty and proposed this program change as a solution. The committee was composed of faculty members representing the four participating graduate units (Prof. Will Cluett from CHE, Prof. Sean Hum from ECE, Prof. Scott Sanner from MIE, Prof. Khandker Nurul Habib from CIV). The committee was chaired by Prof. Julie Audet, Vice-Dean, Graduate Studies. The modifications were discussed with Prof. Markus Bussmann, chair of MIE and Prof. Grant Allen, chair of CHE, as well as Prof. Jason Anderson (ECE) and Prof. Radhakrishnan Mahadevan (CHE). The contents of the prerequisite course APS1070 was also discussed, as well as the issue of excluding or not some students from this requirement based on the nature of their previous undergraduate studies.

6 Resources

N/A

7 Governance Approval

Unit sign-off	Analytics Curriculum Committee: January 15, 2019
Dean’s office sign-off	Julie Audet, Vice-Dean, Graduate Studies: January 15, 2019
Faculty/division council approval (or delegated body) if applicable	Approved by the Engineering Graduate Education Committee (EGEC) on behalf of the Council of the Faculty of Applied Science & Engineering: January 21, 2019

Appendix A: Calendar Entry (Revised)

To be admitted in the emphasis in analytics, MEng students must first successfully complete a prerequisite course APS 1070H (0.5 full-course equivalents [FCEs]). Subsequently, to earn the emphasis, students must successfully complete four additional half courses (2.0 FCE) from the list of core courses or elective courses. These must include at least one core course; the remaining courses must be selected from the list of elective courses. Students must have completed the prerequisite course APS1070H before taking any of the core courses.

Prerequisite Course

APS 1070H Foundations of Data Analytics and Machine Learning

Core Courses

MIE 1624H Introduction to Data Science and Analytics

ECE 1513H Introduction to Machine Learning (exclusion for ECE 1504H)

Elective Courses

APS 502H, APS 1005H, APS 1017H, APS 1022H, APS 1052H, APS 1040H, APS 1050H, APS 1051H, APS 1052H

CHE 507H, CHE 1108H, CHE 1147H, CHE 1148H, CHE 1434H

~~CIV 1499H~~, CIV 1504H, CIV 1506H, CIV 1507H, CIV 1532H, CIV 1538H

ECE 537H, ECE 1504H (exclusion for ECE 1513H), ECE 1505H, ECE 1510H, ECE 1657H, ECE 1778H, ECE 1779H,

MIE 562H, MIE 1413H, MIE 1501H, MIE 1512H, MIE 1513H, MIE 1620H, MIE 1621H, MIE 1622H, MIE 1623H, MIE 1628H, MIE 1653H, MIE 1721H, MIE 1723H, MIE 1727H

Appendix A: Calendar Entry (Previous Revised Version)

Emphasis: Analytics

MEng students must successfully complete four courses. These must include at least one core course and the remaining courses must be selected from the list of elective courses.

Core Courses

MIE 1624H

~~ECE1504H~~ ECE1513H

Elective Courses

APS 502H, APS 1005H, APS 1017H, APS 1022H, ~~APS1052H~~

CHE 507H, ~~CHE 1108H~~, ~~CHE1147H~~, CHE 1148H, CHE 1434H

CIV 1499H, CIV 1504H, CIV 1506H, CIV 1507H, CIV 1532H, CIV 1538H

ECE 537H, ECE 1505H, ECE 1510H, ECE 1657H, ECE 1778H, ECE 1779H

MIE 562H, MIE 1413H, MIE 1501H, MIE 1512H, MIE 1513H, MIE 1620H, MIE 1621H, MIE 1622H, MIE 1623H, ~~MIE 1628H~~, MIE 1653H, MIE 1721H, MIE 1723H, MIE 1727H

APPENDIX 2

University of Toronto

Minor Modification Proposal Participation in a Collaborative Specialization

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

Collaborative specialization:	Collaborative Master's and Doctoral Specialization in Psychology and Engineering
Collaborative specialization director:	Prof. Li Shu, Department of Mechanical & Industrial Engineering
Lead Faculty:	Applied Science & Engineering
Degree program(s) being added:	Master's (MAsc) and Doctoral (PhD), Civil Engineering Master's (MAsc) and Doctoral (PhD), Electrical and Computer Engineering
Unit offering above degree program(s):	Department of Civil and Mineral Engineering Department of Electrical and Computer Engineering
Dean's office contact:	Prof. Julie Audet, Vice-Dean, Graduate Studies
Version date:	February 8, 2019
Effective date:	September 1, 2019

Core Graduate Faculty Research Synopses

Core faculty members are those who are eligible to teach and/or supervise in the collaborative specialization, as appropriate. Core faculty members must hold graduate faculty membership in one of the participating degree programs. The process of identifying a graduate faculty member as a collaborative specialization core faculty member is initiated by the faculty member or the collaborative specialization director. Both the faculty member's home unit chair/director and the collaborative specialization director must agree, as well as the faculty member involved.

The collaborative specialization director is responsible for maintaining records of agreements concerning assignment of core faculty members to the collaborative specialization. Formal graduate faculty memberships in the collaborative specialization supporting units are not required for core faculty members.

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

Prof. Jeffrey Siegel

Department of Civil and Mineral Engineering

Research focus: Indoor air and psychology

Publications: (list two recent publications relevant to the focus of the collaborative specialization)

1. Vakalis D, Touchie M, Tzekova E, MacLean HL, Siegel JA (2019) Indoor Environmental Quality Perceptions of Social Housing Residents. Accepted to Building and Environment.

2. Diaz Lozano Patilîã E, Vakalis D, Touchie, M, Tzekova, E, Siegel JA (2018) Thermal Comfort in Multi-Unit Social Housing Buildings. Building and Environment, 144, 230-237. DOI: 10.1016/j.buildenv.2018.08.024.

Graduate course (suitable for non-engineering students):

CIV1320H: Indoor Air Quality – Contaminants in indoor air have enormous impact on human health, productivity, building energy use and sustainability. This course focuses on important contaminants, fundamental tools and methodologies to measure and model the indoor environment, and on engineering solutions to improve indoor air quality. The course covers a rationale and motivation for the investigation of indoor contaminants, important contaminants and sources, the use of mass balances to assess indoor concentrations, fundamental transport and transformation processes that occur indoors, indoor exposure assessment, and methodologies to assess costs and benefits for technologies and techniques to improve indoor air. The course explicitly links the air inside of buildings to building materials, energy use, outdoor air quality, and human health.

Prof. Jonathan Rose

Department of Electrical and Computer Engineering

Research focus: Software and technologies to support measurement and therapy for mental health

Publications: (list two recent publications relevant to the focus of the collaborative specialization)

1. Di Matteo D, Fine A, Fotinos K, Rose J, Katzman M (2018) Patient Willingness to Consent to Mobile Phone Data Collection for Mental Health Apps: Structured Questionnaire, in JMIR Mental Health. 5/3:e56

2. V. Patel, L. Shen, J. Rose, and A. Feinstein, "Taking the tester out of the SDMT: A proof of concept fully automated approach to assessing processing speed in people with MS" in Multiple Sclerosis Journal, published August, 2018.

Graduate course (suitable for non-engineering students):

ECE1778: Creative Applications for Mobile Devices – Mobile and wearable devices, combined with web-based software, have given rise to an explosion in creativity over the past several years. There have been exciting, inspiring and incredibly useful software apps in the areas of medicine,

music, psychology, senior support, banking, cooking, global health, exploring, travel, shopping, games and many more.

These applications have only just scratched the surface of the potential of mobile devices and software. As our understanding of how mobile technology evolves, combined with the web and perhaps machine learning, many new possibilities will occur to each of us. As new sensors and other capabilities are added to the phones and made available as wearable devices, ever-more clever ways of advancing knowledge and capability will be created.

The purpose of this course is to create new inter-disciplinary applications of mobile devices and software in general. Graduate students from all disciplines at the University of Toronto are invited to take the course for credit.

Prof. Willy Wong

Department of Electrical and Computer Engineering

Research foci: Neural engineering, biomedical signal processing and on sensory physics, with particular emphasis on characterizing brain electrical activity, elucidating underlying mechanisms and building associated medical devices

Publications: (list two recent publications relevant to the focus of the collaborative specialization)

1. Wong W (2013) "On the Asymptotic, Near-Equilibrium Sensory Response," Quantitative Biology, Neurons and Cognition, arXiv preprint <https://arxiv.org/abs/1307.6445>.
2. Mori S, Kikuchi Y, Hirose N, LePage H, Wong W, Biol Cybern (2018) Auditory gap detection: psychometric functions and insights into the underlying neural activity, Biological Cybernetics, 112:6/575-584. <https://doi.org/10.1007/s00422-018-0786-6>.

Graduate course (suitable for engineering students only):

ECE1774H: Sensory Cybernetics – This course covers the application of electrical engineering techniques to the study of the human senses. More and more engineers find it important to include the human user as part of the design process, hence the need for a proper understanding of the human perceptual process. Examples include multimedia, human-computer interaction and medical devices. We will cover the application of information theory and signal detection theory to the study of the human senses. Other topics include sensorineural engineering, the measurement of human performance, as well as an introduction to the requisite physiology and psychology. Course work will involve a research project and a final examination.

Prof. Berj L. Bardakjian

Department of Electrical and Computer Engineering

Research foci: Neural engineering, biological and artificial neural networks, electrical rhythmic activities of the brain, prediction and control of epileptic seizures, modeling of nonlinear physiological systems, biological clocks, signal processing of nonstationary electrical signals from the brain

Publications: (list two recent publications relevant to the focus of the collaborative specialization)

1. Jacobs D, Hilton T, Del Campo M, Carlen PL, Bardakjian BL (2018) Classification of Pre-Clinical Seizure States Using Scalp EEG Cross-Frequency Coupling Features, IEEE Transactions on Biomedical Engineering. 65/11(Nov) Article 8269341, pp. 2440-2449.
2. Grigorovsky V, Bardakjian BL (2018), Neuro-Glial Network Model of Postictal Generalized EEG Suppression (PGES), Proc. 40th Ann. Int. Conf. IEEE Engineering in Medicine and Biology Society EMBC 2018 July 18-21 Honolulu HI, Article no. 8512661, pp. 2044-2047.

Graduate course (suitable for engineering students only):

JEB1444H: Neural Engineering – General perspective of neural engineering and neurobiology; biological neural networks; parametric neural models using rate processes; nonparametric neural models, using the Volterra-Wiener approach; artificial neural networks as nonparametric neural models.

Prof. Joyce Poon

Department of Electrical and Computer Engineering
PsychEng-Relevant Research: Light, brain and computing

Publications: (list two recent publications relevant to the focus of the collaborative specialization)

1. WD Sacher, JC Mikkelsen, Y Huang, JCC Mak, Z Yong, X Luo, Y Li, P Dumais, J Jiang, D Goodwill, E Bernier, PG-Q. Lo, JKS Poon. Monolithically integrated multilayer silicon nitride-on-silicon waveguide platforms for 3-D photonic circuits and devices. Proceedings of the IEEE, 106(12): 2232-2245, 2018.
2. WD Sacher, JC Mikkelsen, P Dumais, J Jiang, D Goodwill, X Luo, Y Huang, Y Yang, A Bois, P GQ Lo, E Bernier, JKS Poon. Tri-layer silicon nitride-on-silicon photonic platform for ultra-low-loss crossings and interlayer transitions, Optics express 25 (25), 30862-30875, 2017.

Calendar Copy

CALENDAR ENTRY [\[Updates highlighted\]](#)

Psychology and Engineering

Lead Faculty

Faculty of Applied Science & Engineering

Participating Degree Programs

[Civil Engineering – MASC and PhD](#)

[Electrical and Computer Engineering – MASC and PhD](#)

Mechanical and Industrial Engineering – MASC and PhD

Psychology – MA and PhD

Supporting Unit

Department of Mechanical & Industrial Engineering

Overview

The Collaborative Specialization in Psychology and Engineering (PsychEng) is between the Departments of Mechanical & Industrial Engineering (MIE), [Civil and Mineral Engineering \(CIVMIN\)](#) and [Electrical and Computer Engineering \(ECE\)](#) in the Faculty of Applied Science & Engineering (FASE), and the Department of Psychology (PSY) in the Faculty of Arts & Science (FAS). Engineering involves the creative application of science to the design of systems, processes, structures and technologies. Psychology is a science that focuses on the mind and behavior of people and animals to understand individuals and groups across all levels of analyses, from the cellular to the cultural. The Psychology and Engineering Collaborative Specialization supports graduate students and faculty interested in contributing to the growing interdisciplinary scholarship at the nexus of psychology and

engineering. Fields of study that may benefit from this collaborative specialization include, but are not limited to: human factors, design theory and methodology, artificial intelligence and information engineering, operations research, and robotics. This specialization strengthens ties between the two departments, and may propel research of interest to both beyond what is possible individually.

Upon successful completion of the master's and/or doctoral degree requirements of the home department and the collaborative specialization, students receive the notation "Completed Collaborative Specialization in Psychology and Engineering" on their transcript and parchment.

Contact and Address

Web: <http://gradstudies.engineering.utoronto.ca/collaborative-specialization-psychology-engineering-psycheng/>

Email: psych_eng@mie.utoronto.ca

Telephone: (416) 946-3028

Fax: (416) 978-7753

Collaborative Specialization in Psychology and Engineering
Department of Mechanical and Industrial Engineering
5 King's College Road
Toronto, Ontario M5S 3G8
Canada

Master's Level

Admission Requirements

- Applicants to the collaborative specialization must first apply to and be admitted to a master's-level graduate degree program in one of the collaborative departments. Next, application to the collaborative specialization requires:
 - Applicant statement of purpose that describes background experience relating to Psychology and Engineering, and motivation for pursuing graduate studies in PsychEng.
 - Supervisor letter of recommendation in support of student's application to PsychEng.

Specialization Requirements

- Two (2) terms of APS1305 PsychEng Seminar Series (Master's level).
- Two (2) half courses (1.0 FCE). Students must take two (2) PsychEng electives, one (1) of which must be from the ~~non-home department~~ **other discipline. Students from either discipline (psychology or engineering) should first consult with the instructor before registering for a course in the other discipline to ensure adequate fit in terms of interest and preparation.**
- Thesis focused on a topic in the area of the Collaborative Specialization.

Completion of Specialization Requirements

All students enrolled in the Collaborative Specialization must complete the requirements of the Collaborative Specialization, in addition to those requirements for the degree program in their home graduate unit. The Collaborative Specialization Director and/or Specialization Committee is/are responsible for certifying the completion of the Collaborative Specialization requirements. The home graduate unit is solely responsible for the approval of the student's home degree requirements.

Doctoral Level

Admission Requirements

- Applicants to the collaborative specialization must first apply to and be admitted to a doctoral-

level graduate degree program in one of the collaborative departments. Next, application to the collaborative specialization requires:

- Applicant statement of purpose that describes background experience relating to Psychology and Engineering, and motivation for pursuing graduate studies in PsychEng.
- Supervisor letter of recommendation in support of student’s application to PsychEng.

Specialization Requirements

- Two (2) terms of APS1308 PsychEng Seminar Series (PhD level).
- Two (2) half courses (1.0 FCE). Students must take two (2) PsychEng electives, one (1) of which must be from the ~~non-home department~~ **other discipline. Students from either discipline (psychology or engineering) should first consult with the instructor before registering for a course in the other discipline to ensure adequate fit in terms of interest and preparation.**
- Thesis focused on a topic in the area of the Collaborative Specialization.
- Students who have completed the PsychEng Collaborative Specialization at the master’s level will take the core seminar course at the PhD level, which requires a higher level of participation, (i.e., present more frequently and/or take a leadership role in seminar activities such as the discussion of research papers), and take two (2) further (different) PsychEng electives during their doctoral program, and their research will be at a level appropriate to a PhD degree.

Completion of Specialization Requirements

All students enrolled in the Collaborative Specialization must complete the requirements of the Collaborative Specialization, in addition to those requirements for the degree program in their home graduate unit. The Collaborative Specialization Director and/or Specialization Committee is/are responsible for certifying the completion of the Collaborative Specialization requirements. The home graduate unit is solely responsible for the approval of the student’s home degree requirements.

Core Course

Two terms of one of following:	
APS1305	PsychEng Seminar Series – Master’s level (Credit/No Credit)
APS1308	PsychEng Seminar Series – PhD level (Credit/No Credit)

Elective Courses

Civil Engineering

CIV1320H	Indoor Air Quality
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Electrical and Computer Engineering

ECE1778H	Creative Applications for Mobile Devices
ECE1774H	Sensory Cybernetics (suitable for Engineering students only)
JEB1444H	Neural Engineering (suitable for Engineering students only)

Mechanical and Industrial Engineering

MIE 1070H	Intelligent Robots for Society
MIE 1402H	Experimental Methods in Human Factors Research
MIE 1403H	Analytical Methods in Human Factors Research
MIE 1412H	Human-Automation Interaction
MIE 1415H	Analysis and Design of Cognitive Work
MIE 1505H	Enterprise Modelling
MIE 1510H	Formal Techniques in Ontology Engineering
MIE 1720H	Creativity in Conceptual Design
KMD 2001H	Human-Centred Design

Psychology

PSY 1000H	Directed Studies
Department of Psychology courses offered in the 5000 series (contact the department for exclusions)	

Governance Process for a Minor Modification

Steps	Dates
Development of proposal	Nov 2018
Consultation <ul style="list-style-type: none"> • Department of Civil & Mineral Engineering • Department of Electrical & Computer Engineering • Department of Psychology • Dean's Office, Faculty of Applied Science & Engineering • Dean's Office, Faculty of Arts & Science • Office of the Vice-Provost, Academic Programs 	Nov 2018 - Jan 2019
Approval of FASE Engineering Graduate Education Committee	Jan 2019
Approval of Council of the Faculty of Applied Science & Engineering	Feb 27, 2019
Report to the Committee on Academic Policy & Programs for	Mar 2019

Steps	Dates
information	
Report to Ontario Quality Council for information	Jun 2019

APPENDIX 3

University of Toronto

Major Modification Proposal: Adding Direct Entry to PhD (Aerospace Science and Engineering)

This template should be used to bring forward all proposals for major modifications to existing graduate and undergraduate programs for governance approval under the UTQAP.

Program being modified:	Doctor of Philosophy in Aerospace Science and Engineering
Proposed major modification:	Adding Direct Entry option to existing PhD program
Department/unit:	University of Toronto Institute for Aerospace Studies (UTIAS)
Faculty/academic division:	Faculty of Applied Science & Engineering (FASE)
Dean's office contact:	Professor Julie Audet, Vice-Dean, Graduate Studies
Proponent:	Professor Craig Steeves, Associate Director, Graduate Studies (UTIAS)
Version date:	January 29, 2019

1 Summary

The proposed change is the addition of a Direct Entry option to the PhD program. This would allow students without the equivalent of the Master of Applied Science (MAsc) degree to apply for and be accepted to the PhD program.

2 Effective Date

Students will be admitted to begin their studies in the program after 1 September 2019.

3 Academic Rationale

Frequently, students with very strong undergraduate qualifications apply to the University of Toronto Institute for Aerospace Studies (UTIAS) graduate programs. At present, their only option is to enter the MAsc program. Several major American and British aerospace engineering departments offer a direct entry option to the PhD program (for example, California Institute of Technology, University of Michigan, Cambridge University, Stanford University), and UTIAS has lost exceptional students because we could not offer equivalent entrance options. The purpose of this modification is to attract more high-quality students to UTIAS; it is anticipated that this will increase the enrolment of PhD students at UTIAS by one to four per year.

4 Description of the Proposed Major Modification

The proposed change is exclusively to the program enrolment options, specifically to add a Direct Entry option. Students will be enabled to enrol in the UTIAS PhD program without previously enrolling in an MASc program.

UTIAS currently offers a Transfer option, whereby a strong student can transfer directly from the MASc program to the PhD program after one year in the MASc program and having completed 2.5 FCEs in coursework. It is expected that the academic progress of the Direct Entry and Transfer students will be very similar. Both programs will require 3.5 FCEs plus a thesis; the primary difference is that 0.5 FCEs of the Transfer program are composed of an MASc Research Seminar (AER 1800H), which will not be available to Direct Entry students.

The admission and program requirements for the Direct Entry option are described in the Proposed Calendar Copy, Appendix B.

5 Impact of the Change on Students

This program modification will not have any impact on existing students. A very small number of future students will enter the PhD program through the Direct Entry process. This may result in some students with a lower level of preparedness for the academic independence required for the PhD program, but because the students to be admitted under this option will be individually selected by the Institute, and not self-identified, it is expected that this effect will be mitigated because UTIAS will be selecting students with very strong background preparation. It is expected that the academic excellence of the students admitted under the Direct Entry option will enable them to catch up quickly to their peers in the regular PhD option. As well, the admission requirements for the Direct Entry option, an A- at the undergraduate level, is higher than the requirement for the regular PhD admission, a B+ in the qualifying MASc degree. Furthermore, the Direct Entry program coursework requirements, 3.5 FCEs, is greater than for the regular PhD program, which requires 2.0 FCEs of coursework.

6 Consultation

This program modification will not have any impact on other units. The UTIAS Curriculum Committee, the Faculty's Engineering Graduate Education Committee, and the Vice-Provost, Academic Programs were consulted during the development of this proposal.

7 Resources

No additional resources will be required.

8 Governance Process

The UTQAP pathway is summarized in the table below.

Steps	Dates
Development/consultation within unit	Jul 2018 - Oct 2018
Approval by unit, as appropriate	10 Oct 2018
Consultation with offices of FASE Dean and Vice-Provost, Academic	Oct 2018 - Dec 2018
Approval of FASE Engineering Graduate Education Committee	29 Nov 2018
Approval by FASE Council	27 Feb 2019
Submission to office of Vice-Provost, Academic	27 Feb 2019
Reported to the Provost and included in annual report to Committee on Academic Policy & Programs	Per Governing Council calendar
Reported annually to Ontario Quality Council	Jun 2019

Appendix A: Current Learning Outcomes, and Degree-Level Expectations

The design, structure, requirements and delivery of the Direct Entry option support the PhD program learning outcomes and degree-level expectations as highlighted below.

Doctoral (PhD) Degree-Level Expectations	Program Learning Outcomes	How the Program Design/Structure Supports the Degree-Level Expectations
<p>EXPECTATIONS: This PhD is awarded to students who have demonstrated:</p>		
<p>1. Depth and Breadth of Knowledge</p> <p>A thorough understanding of a substantial body of engineering or applied science knowledge that is at the forefront of their discipline including, where appropriate, relevant knowledge outside the field.</p>	<p>Depth and breadth of knowledge are understood in the doctoral (PhD) in Aerospace Science and Engineering program as the ability to undertake a major research thesis in a field related to aerospace engineering, and as fluency in subjects related to this field.</p> <p>This is reflected in students who are able to apply research, analysis and design skills within the field of aerospace engineering to develop and implement leading-edge technologies in industry and academia.</p>	<p>The program design and requirement elements that ensure these student outcomes for (1) depth and (2) breadth of knowledge are (1) the production of a thesis consisting primarily of significant original research and (2) the completion of course work that covers the academic field of the student more broadly and attendance at research seminars to supplement the coursework. The Direct Entry PhD program requires 3.5 FCEs, while the regular PhD program requires only 2.0 FCEs.</p>
<p>2. Research and Scholarship</p> <p>The ability to:</p> <p>(a) Conceptualize, design, and implement research for the generation of new knowledge, applications, or understanding at the forefront of the discipline, and to adjust the research design or methodology in the light of unforeseen problems;</p> <p>(b) Make informed judgments on complex issues in specialist fields, sometimes requiring new methods; and</p> <p>(c) Produce original research, or other advanced scholarship, of a quality to satisfy peer review, and to merit publication.</p>	<p>Research and scholarship is understood in the doctoral (PhD) program as demonstration of an understanding and ability to implement established techniques of research and inquiry to create and interpret knowledge related to aerospace engineering, to evaluate critically current research and scholarship in aerospace engineering.</p> <p>On the basis of that competence and through their dissertation, PhD students further demonstrate the development and support of a sustained argument in written form, and originality in the application of scientific knowledge.</p>	<p>Preparing the PhD thesis enables students to gain conceptual understanding and methodological competence. These are evaluated by supervisory committee meetings, review of the thesis, and the final oral examination.</p>

Doctoral (PhD) Degree-Level Expectations	Program Learning Outcomes	How the Program Design/Structure Supports the Degree-Level Expectations
	<p>This is reflected in students who are able to:</p> <ol style="list-style-type: none"> 1. Articulate a clear hypothesis or overall goal for their PhD research project (for example, solve a specific problem, develop a new technology, challenge a current paradigm or practice, address a critical bottleneck in the field). 2. Plan and design critical experiments or simulations to prove or disprove hypotheses or to achieve the overall goal stated in the PhD proposal. 3. Interpret analytical, numerical and experimental data and outcomes and appreciate the limitations of the approaches used. 4. Acquire in depth knowledge of the relevant literature and understand scientific and engineering concepts relevant to their PhD. 	
<p>3. Level of Application of Knowledge</p> <p>The capacity to:</p> <ol style="list-style-type: none"> (a) Undertake pure and/or applied research at an advanced level; and (b) Contribute to the development of academic or professional skills, techniques, tools, practices, ideas, theories, approaches, and/or materials. 	<p>Level of application of knowledge is understood in the doctoral (PhD) in Aerospace Science and Engineering program as competence in and understanding of the field of aerospace science beyond that of the undergraduate level, attained through coursework, plus competence in research, attained by creating knowledge or capabilities through the production of a thesis.</p> <p>This is reflected in students who are able to plan and execute an original and conclusive scientific investigation that develops into a full PhD thesis and results in publication of peer-reviewed papers.</p>	<p>The program design and requirement elements that ensure these student outcomes for level of application of knowledge are the coursework and the thesis, monitored by the supervisory committee and the final oral exam committee. The Direct Entry PhD program requires 3.5 FCEs, while the regular PhD program requires only 2.0 FCEs.</p>

Doctoral (PhD) Degree-Level Expectations	Program Learning Outcomes	How the Program Design/Structure Supports the Degree-Level Expectations
<p>4. Professional Capacity/Autonomy</p> <p>(a) The qualities and transferable skills necessary for employment requiring the exercise of personal responsibility and largely autonomous initiative in complex situations;</p> <p>(b) The intellectual independence to be academically and professionally engaged and current;</p> <p>(c) The ethical behavior consistent with academic integrity and the use of appropriate guidelines and procedures for responsible conduct of research; and</p> <p>(d) The ability to evaluate the broader implications of applying knowledge to particular contexts.</p>	<p>Professional capacity/autonomy is understood in the doctoral (PhD) program in Aerospace Science and Engineering as personal responsibility, integrity, independent decision-making and accountability related to the academic process of doctoral research.</p> <p>This is reflected in students who are able to conduct research and complete a PhD thesis.</p>	<p>The program design and requirement elements that ensure these student outcomes for professional capacity/autonomy are contained within the coursework, where students must demonstrate their capacity for independent, responsible work, and within the thesis requirements, where students must exhibit integrity and responsibility in research and the reporting of research results. In addition, all students must complete a mandatory “Ethics in Research” seminar.</p>
<p>5. Level of Communications Skills</p> <p>The ability to communicate complex and/or ambiguous ideas, issues and conclusions clearly and effectively.</p>	<p>Level of communications skills is understood in the doctoral (PhD) program as the ability to communicate, both verbally and in written form, results of research and the methodologies employed to produce the results.</p> <p>This is reflected in students who are able to write a full PhD thesis, academic papers, and to present research in an oral format.</p>	<p>The program design and requirement elements that ensure these student outcomes are the annual meetings of the supervisory committee, for which students must prepare a written report and at which they must deliver an oral presentation, the production of the PhD thesis and its defence at the final oral exam, conference and other presentations given during the course of the program, and academic papers prepared.</p>
<p>6. Awareness of Limits of Knowledge</p> <p>An appreciation of the limitations of one’s own work and discipline, of the complexity of knowledge, and of the potential contributions of other</p>	<p>Awareness of limits of knowledge is understood in the doctoral (PhD) program in Aerospace Science and Engineering as a cognizance of the complexity and multidisciplinary of the knowledge associated with aerospace engineering and its application. This is reinforced by an</p>	<p>The program design and requirement elements that ensure these student outcomes for awareness of limits of knowledge are the coursework and seminar requirements, to provide breadth of knowledge, the “Ethics in Research” seminar, and the annual supervisory committee meetings.</p>

Doctoral (PhD) Degree-Level Expectations	Program Learning Outcomes	How the Program Design/Structure Supports the Degree-Level Expectations
interpretations, methods, and disciplines.	<p>understanding of the responsibility associated with the technology and design of aerospace systems.</p> <p>This is reflected in students who are able to design and implement research projects that prove or disprove a hypothesis, and interpret results with an appreciation for the limits of the methods used.</p>	

Appendix B: Proposed Calendar Copy

PhD Program (Direct Entry)

Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy the University of Toronto Institute for Aerospace Studies' admission requirements stated below.
- Applicants must have a four-year undergraduate degree in engineering, mathematics, physics or chemistry.
- Applicants are expected to have achieved grades averaging the equivalent of a University of Toronto A- or better in their last full year of study.

Program Requirements

- Students must maintain **full-time, continuous registration** for every session, including the Summer session, until all degree requirements are completed.
 - Students must spend a minimum of three years in the Direct Entry PhD program.
 - Students are expected to complete the Direct Entry PhD program in less than five years.
- **Coursework.** Students must complete a total of **3.5 full-course equivalents (FCEs)**.
 - At least half of the required FCEs must be courses with AER or ROB designators.
 - Students must achieve at least a B- average to be in good academic standing. Failure in any course taken for credit may result in termination of the student's registration.
 - All required courses must be completed in the first two years of the program.
 - All courses must be technical.
- Students must complete the non-credit course JDE 1000H *Ethics in Research (half-day workshop)*.
- Students must attend a total of **24 approved seminars**.
- Students must undertake a program of research under the guidance of a Doctoral Examination Committee (DEC), which includes the student's supervisor and two other UTIAS professors. The DEC shall:
 - ascertain the suitability of the student for advanced research

- assess the thesis topic
 - conduct formal reviews of the student’s thesis progress at least once per year; unsatisfactory progress may result in the termination of the student’s registration
 - determine whether a student qualifies as a candidate for the PhD degree at the second DEC meeting (qualifying DEC meeting), approximately 1.5 years after program start
 - provide the first assessment of the PhD thesis.
- Students must present the thesis work at the UTIAS **Departmental Doctoral Seminar (DDS)**.
 - Students must defend the thesis at the **Doctoral Final Oral Examination** pursuant to the [SGS Degree Regulations](#).
 - Students must prepare at least **one formal manuscript for publication** in a refereed journal or refereed conference proceedings.
 - Students have the option of completing an emphasis in Aerial Robotics, Robotics and Mechatronics, Sustainable Aviation, or Sustainable Energy as part of their degree program. Please see details in the Aerospace Science and Engineering MAsc, MEng, PhD Emphases section.

Program Length

5 years

Time Limit

7 years