UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Faculty Council Meeting

December 6, 2022 | 3:10-5:00 pm
Michael E Charles Council Chamber (GB202) & Zoom

AGENDA

1.	**Speaker's Welcome**	J Nogami
2.	**Approval of Agenda** For approval as a regular motion	J Nogami
3.	**Adoption of the Minutes of Previous Meeting** For approval as a regular motion	J Nogami
4.	**Memorial Tributes** Professors Emeriti F A De Lory (CivMin)* and Charles A Ward (MIE)	B Sleep G Jamieson
5.	**Report of the Dean** For information/discussion	C Yip
6.	**Proposed Certificate in Public Policy and Engineering** (Report 3728 Revised) For approval as a regular motion	D Aleman
7.	**Major Curriculum Changes for 2023-2024** (Report 3725 Revised) For approval as a regular motion	E Bentz
8.	**Change to Faculty Calendar regarding Transfer Credits** (Report 3727 Revised) For approval as a regular motion	E Bentz
9.	**Information Reports** For receipt for information	
	a) Engineering Graduate Education Committee Update (Report 3726)	M Hatzopoulou
	b) Admission Cycle 2022 (Report 3730)	A Goel
10.	**Other Business**	J Nogami
	a) Service Presentation Faculty Registrar Don MacMillan	C Yip
11.	**Learning to Teach, Teaching to Learn – Modern First-Year Math Education in Engineering** For information/discussion	S Cohen S Hendrickson C Karimian Pour F Parsch, S Uppal
12.	**Date of Next Meeting**	J Nogami
13.	**Adjournment**	J Nogami

*To be distributed
Rev. 11/22/2022 5:13 PM

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Council of the Faculty of Applied Science & Engineering
Minutes of the Meeting of October 13, 2022

MEMBERS: Jun Nogami (Speaker), Chris Yip (Dean), Ravi Adve, Dionne Aleman, Danita Allick, Cristina Amon, Philip Anderson, Philip Asare, Julie Audet, Jason Bazylak, Evan Bentz, Raymond Bhushan, Shlomo Bibas, Chris Bouwmeester, Markus Bussmann, Roger Carrick, Ariel Chan, Arthur Chan, Hay Shun Chan, Warren Chan, Heba Chehade, Jeff Chen, Alan Chong, Shai Cohen, Tom Coyle, Phil Cuvin, Stark Draper, Natalie Enright Jerger, Greg Evans, Jonathan Eyolfson, Saima Fancy, Jennifer Farmer, Ramin Farnood, Sam Gaskin, Ran Gong, Aidan Grenville, Michael Guerzhoy, Piyush Gupta, Sarah Haines, Mukund Hari, Marianne Hatzopoulou, Angela Henshilwood, Glenn Hibbard, Randa Higazy, Ken Hilton, Morgan Hooper, Jennifer Hsu, Greg Jamieson, Katherine Jia, Parker Johnston, Kyle Juliao, Andrew Kidd, Don Kirk, Deepa Kundur, Philippe Lavoie, Jennifer Lofgreen, Don MacMillan, Saf Mahmood, Tala Malkawi, Sam Mantenuto, Elham Marzi, Paul Milgram, Kasra Modares, Enid Montague, Javad Mostaghimi, Yang (Yuyang) Niu, Elodie Passeport, Prarthona Paul, Daniel Posen, Mark Rittinger, Jon Rocheleau, Nicole Ryk, Shamim Sheikh, David Song, Marisa Sterling, Micah Stickel, Kyla Tan, Kaitlyn Tran, Chris Twigge-Molecey, Oyku Ugur, Saskia van Beers, Tony Vanvari, Chirag Variawa, Carmela Versace, Julia Wagner, Elizabeth Whitmell, Bernard Wong, Sherry Zhang, Tobin Zheng

SECRETARIAT: Caroline Ziegler (Secretary), Alex Schroen (Moderator), Anna Limanni (Technical Support)

GUESTS: Olenka Baron, Irina Belaya, Helen Bright, Chris Brown, Maya Churbaji, Khuong Doan, Raysa Dyczok, Pierina Filippone, Roger Francis, Eric Fysh, Leslie Grife, Nadia Gulezko, Christina Heidorn, Andrea Luna Yong, Jess MacInnis, Teresa Miniaci, Don Newton, Shannon Osborne, Dan Pettigrew, Zeeshan Rayees, Frank Scornaienchi, Allison Van Beek, Audrey Wichert, Geoff Wichert

1. Speaker's Welcome

Speaker Jun Nogami called the first Faculty Council meeting of 2022-2023 to order at 12:10 pm. He welcomed members and guests, and reviewed protocols for the virtual meeting. There were no questions.

Before stating the land acknowledgment, the Speaker described the boundaries of the traditional lands of the Mississaugas of the Credit, and the unfairness of treaties and purchases the government made with Indigenous people. He mentioned a 1.3K by .5K tract of land nearby the University of British Columbia campus in Vancouver, about half the size of our St. George campus, which has been purchased by a consortium of three First Nations bands who will now have a say in how the land is developed.

2. Approval of Agenda

The agenda and reports were distributed on September 29, 2022. Agenda item 09(a), the Engineering Graduate Education Committee Update, was inadvertently listed as Report 3695 when it is actually Report 3722. It was proposed that the agenda be revised to reflect the correct report number.

On a regular motion duly moved, seconded and carried, the revised agenda was approved.

3. Introduction of New Faculty

New faculty members Roger Carrick and Enid Montague of MIE, Jonathan Eyolfson of ECE, Morgan Hooper of UTIAS, and Jennifer Lofgreen of ISTEP, were introduced by their respective chairs and directors.

4. Adoption of the Minutes of Previous Meetings

No errors or omissions were noted in the minutes of the April 27, 2022 Council meeting and on a regular motion duly moved, seconded and carried, the minutes were approved.

5. Memorial Tributes

(a) Sergei Dmitrevsky

Deepa Kundur, ECE chair, read the following memorial tribute in honour of Professor Emeritus Sergei Dmitrevsky.

Be it resolved –

> THAT the Council of the Faculty of Applied Science & Engineering record with deep regret the death on July 31, 2022 of Professor Sergei Dmitrevsky.

Professor Dmitrevsky arrived in Canada from Czechoslovakia in the early 1950s after two years at Prague Technical University. He completed his undergraduate education at the Faculty of Applied Science & Engineering at the University of Toronto in 1955 and spent two years working at Philips Electronics Industries Ltd. as a microwave engineer. After returning to receive his Masters at U of T Engineering, he obtained his PhD in quantum physics at Harvard University under the supervision of Professor Nicolaas Bloembergen, who later received the Nobel Prize for Physics in 1981.

Professor Dmitrevsky returned to U of T and joined the Edward S. Rogers Sr. Department of Electrical & Computer Engineering (then known as the Electrical Engineering Department) where he taught courses in electronics, electricity and magnetism, and quantum physics and helped to build the reputation of the electromagnetics and photonics groups here as world-class. He had an unbelievable depth of understanding of electromagnetics and quantum mechanics. He rarely taught from notes; rather he derived everything from first principles.

His approach to teaching was unique and memorable, and often won him departmental teaching awards. When interviewed for an alumni magazine, Dmitrevsky described his teaching style: “My first principle: I teach the particular scientific discipline. I do not [just] prepare students for examinations.” While he may not have intended to prepare students for examinations, he certainly provided his students with clearly explained complex concepts and theories with an unforgettable delivery.

His former student, TA and later colleague, Professor Micah Stickel remembers his impact on students: “Sergei was beloved by his students. He expected students to be on time (often late students would find a locked door), and if you fell asleep or stopped paying attention you might find yourself on the end of a well thrown piece of chalk. Yet, students admired and loved him as a person and a professor. He was always on the dance floor with students at the ECE Dinner Dances, and this deeply endeared him to generations of our students. I don’t know how many teaching awards he won, but it seemed like it happened every term!”

According to former student and current professor at the University of Alberta, Professor Ashwin Iyer: “Students were treated to a surreal, inspiring journey through electromagnetic theory, frequently annotated by witty, sometimes anachronistic, often wildly funny, and always enthralling anecdotes that served as mental anchor points for the challenging lecture material.”

Professor Dmitrevsky had very high expectations for his students. He wanted them to truly understand the concepts and was always available to help; for example, he ran all of his own tutorials. As a student in his fields and waves course in the late 90s Professor Iyer recalls “Professor Dmitrevsky established a review session the day before the final exam, during which any question could be asked, and all problems would be methodically re-explained and fully solved. The full-day session proceeded well into the evening, until there were no further questions, culminating in an ovation of applause like I'd never before, and never since, seen.”

Beyond academia, Professor Dmitrevsky was an accomplished pilot, and well into his later years he would still fly up north in the summer to camp and fish and as someone else recently shared he said: “My camp site was whatever lake I was able to land on.”

His passion for teaching kept him at the front of a classroom — with his bag of chalk in hand — until his nineties, teaching quantum mechanics to students born well after he had retired. Professor Dmitrevsky would have turned 100 at the end of the year.

Be it further resolved –

> THAT this tribute to Sergei Dmitrevsky be inscribed in the minutes of this Council meeting, and that copies be sent to his family as an expression of the respect and gratitude of the members of this Council.

(b) Hans Kunov

Professor Kundur then read the following memorial tribute in honour of Professor Emeritus Hans Kunov.

Be it resolved –

> THAT the Council of the Faculty of Applied Science & Engineering record with deep regret the death on June 4, 2022 of Professor Hans Kunov.

Hans Kunov was born in Copenhagen in 1938 and grew up in a town close by. His father passed away when he was only four years old and Hans was raised in the company of his mother and sister. The death of his father had a devastating effect on the family and likely shaped his outlook as a professor and as a mentor.

Hans grew up under several dominating influences at that time. There was of course the legacy left by Niels Bohr and atomic physics. This was however not to be Hans' calling. Instead, the influence of another famous Danish scientist by the name of Oersted (the discover of electromagnetic induction) would have a greater influence as it was Oersted who created the Technical University of Denmark where Hans did his degree in electrical engineering. The second major influence was of course Bruel and Kjaer which dictated the scientific norm of Denmark and gave it its prominence in the area of acoustics. It was this influence that Hans decided to pursue his master's thesis on measuring distortions in hearing aids.

Hans' association with acoustics soon ended when he decided to pursue something different for his PhD. He was greatly influenced by the work of Hodgkin and Huxley and instead decided to do modelling work in electroneurophysiology. Soon after his PhD, as with many Danish engineers, Hans wanted to go abroad. He received two job offers, one from UCLA and the other from Toronto but it was the Vietnam War that ultimately swayed his decision to come to Toronto.

After arriving in Toronto, Hans began what was to be his lifelong — and as it turns out — only job as a faculty member in biomedical and electrical engineering. He was hired by Norman F. Moody who was the founder and founding director of the Institute of Biomedical Engineering. At that time, Hans decided yet again to work on a different field, this time in ultrasound imaging or acoustic holography. In parallel, he continued his work in electroneurophysiology collaborating with people from the physiology department. In the 70's, Hans met a Danish expatriate by the name of Poul Madsen living in the Toronto area. Poul was an engineer working on biomedical instrumentation in the general area of hearing diagnosis. Hans' association with Poul began with some contract work, became a lasting friendship and finally turned Hans back into the area that he first started with — that of the acoustics of hearing and speech. With the help of Poul Madsen, Hans established a laboratory for hearing at the Institute of Biomedical Engineering. He later went on to study otoacoustic emissions which is useful in detecting problems in hearing in young infants and newborns, and started the company Vivosonic based on the same technology.

Hans was always interested in mentoring and teaching young people. Outside of the University he was very active in the Big Brothers program. Within the University, he made several significant contributions towards teaching and pedagogy. First, he conducted studies on whether audiovisual enhancements during lectures would aid in student engagement and performance. In experiments conducted in classes he taught, to his surprise he was not able to

demonstrate a significant change in test performance. Second, in the 90s Hans created a fourth year interdisciplinary ECE course on acoustics, the only course of its kind at U of T and is now the foundational course of the Engineering Music Minor at the Faculty of Applied Science and Engineering. Third, Hans was particularly enthusiastic in teaching design to undergraduate students and was actively engaged in the teaching of APS111/112 (Engineering Strategies & Practice I/II). Fourth, for over 15 years, Hans Kunov set the standard as both a supervisor and an administrator of ECE capstone projects in ECE496. He took such care in guiding and mentoring his students, and continued to supervise capstone teams up until his death. As an administrator, Hans was always the first to complete his marking; when Hans finally retired from the course, Phil Anderson pondered "who will be there to shame us into getting our reports marked now that Hans won't be reporting first?" Finally, he was the Dean's Designate on Academic Offences, a position he held until the very end. Vaughn Betz observed how Hans "turned difficult meetings into teaching moments, having compassion for the students and their situation but also eloquently explaining why engineers need to have integrity at their core." Hans shared a tremendous passion for working with young engineering students.

Hans was a great visionary, teacher, mentor, engineer, philosopher, friend, and above all a caring, critical, and fair human being. In the early 1990s when the Engineering Science students at the University of Toronto presented a petition (signed by 200 students) to start a biomedical engineering option in Engineering Science, he sprang into action, and approached colleagues Berj Bardakjian and Yu Ling Cheng to start working on developing such a program. They had many meetings in his “director’s office”, where they started charting their path. He left their deliberations on the blackboard of his office for a long time as they kept filling in the holes and improve the offering. It was a challenge like any “new” endeavor as this was the first undergraduate biomedical engineering program in Canada. It started with a bang as it became the most popular option, along with the Aerospace option, in the Engineering Science program. He was the “force field” pushing that program forward.

On the administrative front, Hans was Director of the Institute of Biomedical Engineering from 1989-1999, and its Associate Director from 1984-1986. Before that, he was also Associate Chair of the Division of Engineering Science. For his service, Hans was awarded the Queen’s Golden Jubilee Medal “for significant contribution to Canada, to the community, or to fellow Canadians” in 2003.

Hans is survived by his wife, Clare Lamb; his sons, Mads (Marie) and Niels (Daniella); and their mother, Helle; as well as his five beloved grandchildren and his sister, Else.

Be it further resolved –

> THAT this tribute to Hans Kunov be inscribed in the minutes of this Council meeting, and that copies be sent to his family as an expression of the respect and gratitude of the members of this Council.

The Speaker assumed concurrence with these resolutions and Council observed one minute of silence in honour of Professors Emeriti Dmitrevsky and Kunov.

6. Report of the Dean

Dean Chris Yip welcomed all to the Council meeting, in particular new faculty members, saying it is nice to see everyone back in person.

He thanked the Registrar and his team for their hard work in managing first year admissions, and congratulated the Engineering Society for rolling out a successful orientation for new students and some upper year students who missed orientation during Covid.

The dean referred to an in person meeting he had earlier that morning with the president of the Hong Kong Chapter of the Engineering Alumni Association, who was visiting Toronto. We are seeing a return to travel, and he looks forward to engaging with alumni in person around the globe.

He congratulated the chair of Civil & Mineral Engineering for opening up Gull Lake. Other departments and institutes, such as Electrical & Computer Engineering and Aerospace Studies, are interested in using the facility in a more fulsome manner.

Dean Yip stated that Fall convocation for engineering students is on November 10, and that we also look forward to welcoming back the classes of 2T0, 2T1, and PEY on December 2 for in person celebrations. The Registrar confirmed the Dean will preside over the ceremony for these recent graduates and that their names will be read. Many chairs and directors will be on stage and all are invited to attend.

The dean described the administrative activities underway, including new faculty and searches; SAP development; and our November move into the Experiential Learning Centre at 203 College Street. He also announced that a provostial review of the Faculty is being commissioned with an on-site visit planned for 2023-2024.

7. Appointments to the Academic Appeals Board (Undergraduate) and Standing Committees of Council, 2022-2023

The Speaker presented Report 3723, which lists the names of members appointed to the Faculty's Academic Appeals Board (Undergraduate) and standing committees of Council to date for this academic year. It is anticipated that the graduate student members will be appointed in October.

There were no questions and the report was received for information.

8. Annual Report of the Academic Appeals Board (Undergraduate), 2021-2022

Don Kirk, chair of the Academic Appeals Board (Undergraduate), presented Report 3724 regarding the number of appeals brought in the previous year and the disposition of those appeals. The report also describes updates, trends and observations within academic appeals. Professor Kirk thanked Board members, in particular student representatives, for their efforts and availability to attend hearings.

Council members discussed whether Covid had an effect on the number of hearings this past year. Professor Kirk said that the spike appears to be due to scheduling and timing, not the pandemic, but the number of students under extreme distress was greater than usual.

Members also discussed the impact of appeals decisions on students' continuing scholarships and awards. It was suggested that this information be included with the student information packages, and that the Scholarships and Awards Committee, Board, and Undergraduate Assessment Committee work together to lessen the impact on students.

The report was received for information.

9. Reports from Standing Committees of Council

The following standing committee report was approved by the Executive Committee of Council at its September 22, 2022 meeting.

(a) Engineering Graduate Education Committee Update

Marianne Hatzopoulou, chair of the Engineering Graduate Education Committee, presented Report 3722, which lists new courses approved in BME and MIE, and minor modifications to courses in MIE.

Professor Hatzopoulou noted that she is the first elected chair of EGEC, as the committee's chair has historically been the vice-dean, graduate studies, ex officio.

There were no questions and the report was received for information.

10. Service Presentation

Dean Yip acknowledged and thanked Javad Mostaghimi for his service as Speaker of Council from 2020-2022, and presented him with a token of the Faculty's appreciation.

11. Other Business

Further to the Speaker's earlier comments on traditional First Nations lands, a Council member commented on the decimation of the Wendat First Nation who were virtually wiped out by the small pox pandemics brought over by the colonial settlers, losing much of their population. Their weakened state led to attacks by the Haudenosaunee, who – backed by the English colonizers – defeated, disbursed or assimilated the Wendat.

Another member noted that the dean recently completed two marathons. The dean congratulated an MSE student who is running their first marathon this weekend.

12. Date of Next Meeting

The next Faculty Council meeting is on December 6, 2022.

13. Adjournment

The meeting was adjourned at 1:14 pm.

/cz

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Memorial Tribute to

FREDERIC ANTHONY DELORY

Professor Emeritus, Civil Engineering

December 6, 2022

Be it resolved –

> THAT the Council of the Faculty of Applied Science & Engineering record with sincere regret the death on Wednesday, September 28, 2022 of Professor Emeritus Frederic Anthony DeLory.

Professor DeLory was a Second World War Canadian Army Volunteer (1943-1945), rising from Private to Lieutenant. He graduated from McGill University with a Bachelor of Engineering (Civil) in 1948, after which he worked for the Consolidated Mining and Smelting Company, Ltd. in Trail, B.C. as a Junior Engineer (1948-1950). Professor DeLory then graduated from the University of Toronto with a Master of Applied Science in 1951 following which he worked for the Aluminum Company of Canada, Ltd. in Arvida, Quebec and Kitimat, B.C. as a soils engineer (1951-1953).

Fred was awarded an Athlone Fellowship which he held at the Imperial College of Science and Technology, London, England, graduating with a D.I.C. in 1953 and a Doctor of Philosophy from the University of London in 1957. On returning to Canada, he was employed by H.G. Acres and Company in Niagara Falls, Ont., as a design engineer (1957-1958).

Professor DeLory joined the faculty of the University of Toronto as Assistant Professor in 1958, was promoted to Associate Professor in 1962, and later to full Professor. Since 1990, he has been Professor Emeritus. He supervised numerous undergraduate, masters and doctoral students over this time and taught courses in engineering geology, soil properties and behaviour, foundations and earthworks, soil mechanics and associated laboratories. Fred was a member of the Canadian Geotechnical Society, Engineering Institute of Canada, American Society of Civil Engineers, and the International Society for Soil Mechanics and Foundation Engineering. He served as both Associate Editor and Editor of the Canadian Geotechnical Journal. From 1973 to 1988, Fred chaired the Division of Geological Engineering.

Professor DeLory was simply a kind and virtuous man who was often sought for his wise counsel by students and faculty colleagues alike. He had an infectious enthusiasm for engineering artifacts, particularly those related to steam. He kept an operable steam engine in his office about

which he would offer tutorials to those with interest. In the early 1970s, Fred restored a 60-year-old Connecticut steamboat which he could be found sailing in Toronto Harbour and the Trent Canal system. After retiring, among several other projects, he was a volunteer driver for Meals on Wheels for 17 years. He moved to Halifax in 2008.

Fred maintained a strong connection with his birthplace in Prince Edward Island and frequently entertained colleagues and friends with stories of growing up in that colourful location.

After a lengthy illness, Professor DeLory passed peacefully in Camp Hill Veterans' Memorial Building, QEII, Halifax, at age 97. Fred was born in Georgetown, PEI on June 7, 1925, the son of the late Frederick and Mary (Cullen) DeLory. He is survived by his devoted wife of 62 years, June (Garrett) DeLory; daughters, Kathryn (James) Steele and Deni DeLory (Dan Macadam); siblings, Cullen (Barbara) DeLory and Bernice (William) Melanson; niece, Nicole DeLory; as well as numerous other nieces and nephews. He is predeceased by brothers, John, Dr. Maurice (Mike), Richard, Stephen and sister, Sheila.

It is difficult to express adequately the admiration his students and colleagues had towards Professor DeLory for his willingness to serve, his wisdom, and his friendship.

Be it further resolved –

> THAT this tribute to Professor Emeritus Frederic Anthony DeLory be inscribed in the minutes of this Council meeting, and copies be sent to his family as an expression of the respect and gratitude of the members of Council.

Prepared by Professors Emeritus Barry Adams and Richard Soberman.

Presented at Faculty Council by Professor Brent Sleep,
Chair of the Department of Civil and Mineral Engineering.

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Memorial Tribute to

CHARLES ALBERT WARD

Professor Emeritus
Mechanical and Industrial Engineering

December 6, 2022

Be it resolved –

> THAT the Council of the Faculty of Applied Science & Engineering record with deep regret the death on October 12, 2022 of Professor Emeritus Charles Albert Ward.

Charles Albert Ward, born May 28, 1939, passed away on October 12, 2022, in Hennick Bridgepoint Hospital, Toronto. He leaves behind family members in Texas: brother, John and his wife, Cissy; nieces, Susan and Delinda; and nephews, David (Clara) and Johnny (Nell).

Charles was born in Bailey, Texas and after graduating from Magnolia High School he studied Mechanical Engineering at the University of Texas. He later earned his PhD from Northwestern University in 1967 at which time he embarked on his academic career. He first joined the Department of Mechanical Engineering at the University of Toronto on July 1, 1967. He became a full professor in the department in 1977. While on paper Charles retired in 2004, he remained active in the Department teaching graduate-level courses, including MIE1101 Advanced Classical Thermodynamics and MIE1107 Statistical Thermodynamics, and continued with his research for a number of years.

Charles was a renowned researcher in his field and the Director of the Thermodynamics and Kinetics Laboratory. The Statistical Rate Theory – a theory for predicting the rate of molecular transport across phase boundaries – developed in his lab has been cited in the open literature over 400 times. During his career he and his students published over one hundred papers in peer-reviewed journals. His studies of interfacial kinetics led to the measurement of a temperature discontinuity at the liquid-vapour interface during evaporation and to the measurement of a new property of water: the surface thermal capacity. This property defines the energy transport by surface-tension-driven flow.

Charles was recognized with many prestigious awards throughout his career including two Alexander von Humboldt Fellowships, the Canadian Society of Mechanical Engineering Robert W. Angus Medal and the Canadian Society for Mechanical Engineering Jules Stachiewicz Medal.

Outside of his academic career, Charles was a loving husband to his wife Barbara with whom he built a happy life in Toronto. They were known for hosting dinner parties, which showcased Barbara's excellent cooking skills and Charles' expert wine pairings. They enjoyed attending opera performances and visiting the Art Gallery of Ontario.

Greatly admired by students and colleagues alike, the Department remembers Charles as kind, thoughtful and well-spoken, and he will be dearly missed by all who knew him.

Be it further resolved –

> THAT this tribute to Charles Albert Ward be inscribed in the minutes of this Council meeting, and that copies be sent to his family as an expression of the respect and gratitude of the members of this Council.

Prepared by Lynsey Mellon with input from Professor Emeritus David F. James.

Presented at Faculty Council by Professor Emeritus David F. James
of the Department of Mechanical & Industrial Engineering.

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Report No. 3728 Revised

MEMORANDUM

To: Executive Committee of Faculty Council (November 15, 2022)
Faculty Council (December 6, 2022)

From: Professor Dionne Aleman
Associate Dean, Cross-Disciplinary Programs

Date: November 7, 2022; revised November 22, 2022

Re: **Proposed Certificate in Public Policy and Engineering**

REPORT CLASSIFICATION

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

BACKGROUND

Engineering decisions can and should reflect public policy concerns, and likewise, public policy decisions can benefit from engineering analysis. The two disciplines have strong historical connections, and engineers with training in public policy can mitigate contemporary social challenges by contributing to improved policy outcomes.

The impetus for this certificate came from a meeting with a group of current engineering students who were keen to find avenues to develop their knowledge of political science, governance and policy in a way that could be recognized on their transcript. The Munk School of Global Affairs and Public Policy at the University of Toronto is excited to work with the Faculty of Applied Science and Engineering to introduce public policy to engineering students and thus better prepare them for professional practice.

PROPOSED

A certificate in engineering and public policy is proposed to provide students in the Core-8 engineering programs and Engineering Science with training in the extensive intersections between the two disciplines. This program will offer an introduction to public policy that might also inspire Engineering's technological experts to pursue careers or graduate studies in policy-making.

CONSULTATIONS

This proposal was developed through discussions with the Munk School of Global Affairs and Public Policy and the Faculty of Arts and Science.

RECOMMENDATION FOR COUNCIL

THAT a Certificate in Public Policy and Engineering, as described in Report 3728 Revised, be approved effective September 2023.

University of Toronto
Proposal to Create a Certificate in Public Policy and Engineering

This is a for-credit certificate offered in conjunction with an undergraduate program (category 2) and is governed by the Policy for Certificates (For-Credit and Not-For-Credit).

Proposed certificate name:	**Certificate in Public Policy and Engineering**
Undergraduate degree(s) the certificate will be offered in conjuction with:	*Any Engineering Bachelor's Degree (BASc or BASc in Engineering Science)*
Faculty/academic division:	*Faculty of Applied Science and Engineering (FASE)*
Unit:	*Cross-Disciplinary Programs Office, FASE*
Dean's Office contact:	*Dionne Aleman, Associate Dean, Cross Disciplinary Programs* *Caroline Ziegler, Faculty Governance and Programs Officer*
Version date:	*November 22, 2022*

1 Summary

Engineering decisions can and should reflect public policy concerns, and likewise, public policy decisions can benefit from engineering analysis. The two disciplines have strong historical connections, and engineers with training in public policy can mitigate contemporary social challenges by contributing to improved policy outcomes. A certificate in engineering and public policy is proposed to provide students in the Core-8 engineering programs and Engineering Science with training in the extensive intersections between the two disciplines. This program will offer an introduction to public policy that might also inspire Engineering's technological experts to pursue careers or graduate studies in policy-making.

2 Effective Date

September 1, 2023

3 Academic Rationale

Engineering is a fundamentally public endeavour. Many foundational engineering projects – from bridges to waterworks to recent climate mitigation efforts – are undertaken with government partners. Private projects are similarly shaped by public regulations. Public policy training will enable engineers to build effective and informed collaborations with these public actors, from governments to regulatory agencies. This proficiency will also help engineers knowledgeably participate in policy making. Technological expertise is essential to public decision-making, and familiarity with public institutions and processes will facilitate engineers' contributions to the many issues facing an urbanizing, changing planet.

The Munk School of Global Affairs and Public Policy at the University of Toronto (an EDU:A within the Faculty of Arts and Science) is excited to work with the Faculty of Applied Science and Engineering (FASE) to introduce public policy to engineering students and thus better prepare them for professional practice. Notably, some engineers have already sought out graduate studies in public policy, and the synchronicity between the two fields is also evident in the number of degree programs which offer a dual concentration in engineering and public policy. As well, FASE already offers several courses which intersect with policy issues, such as classes on municipal engineering, environmental engineering, mine design and health care systems. This certificate is an opportunity for students to expand on that content, to learn more about how public policy intersects with their technological expertise and how to help shape better policy outcomes.

4 Need and Demand

The impetus for this certificate came from a meeting with a group of current engineering students who were keen to find avenues to develop their knowledge of political science, governance and policy in a way that could be recognized on their transcript. While the Faculty of Arts and Science (FAS) offers minors in these areas, the 4.0 FCE is a significant burden on engineering students, who typically have 2.0 FCE of elective spaces available for courses in these areas. In addition, some of these courses are highly popular within FAS and our students do not have priority access to the courses which adds to the difficulty in pursuing those credentials.

This certificate will be open to students in any engineering discipline. The courses in the program are classed as Complementary Studies (CS) or Humanities and Social Sciences (HSS) which will allow students from any discipline to pursue them in conjunction with their degree requirements. Those who do not have sufficient CS/HSS elective spaces can take the remaining course(s) as a Free Elective or an Extra credit.

FASE previously offered a graduate collaborative program in Engineering and Public Policy which closed after a few years due to low enrolment. However, we believe that since these courses will fit into the required CS/HSS elective course categories, there's a stronger likelihood of attracting students to these courses and to the program as a whole.

We anticipate an initial enrolment in the courses of about 20 students. The Munk School will offer these courses. Funding will be arranged with FAS via the FAS/FASE Interdivisional Teaching Agreement. The third course in the certificate, PPG402H1, may be co-taught as a 1000-level course graduate course for engineering.

Current plans are for the courses to only be available to Engineering students. In future years, the Munk School may make these courses or similar offerings available to students from other interested non-FAS/FASE faculties.

5 Admission Requirements

There are no admission requirements for engineering certificate programs. The certificate is open to all undergraduate students in any engineering discipline. Successful completion of the certificate by an eligible student will be recorded on the student's academic transcript as part of their undergraduate program.

6 Program Requirements

The certificate consists of three half-course requirements, totaling 1.5 FCE. The courses can be completed as part of the elective credits in a student's program or taken as Extra credits (not counting towards their degree requirements).

1. PPG201H1F Microeconomics for Engineers (new)
2. PPG302H1F Institutions and Public Policy for Engineers (new)
3. PPG402H1S Public Policy Analysis for Engineers (new)

The first course, PPG201H1, will provide an enhanced examination of microeconomics concepts which goes beyond the content that is already found in the typical engineering economics course. The course will have an emphasis on mathematical approaches, taking advantage of the strong math background required in first year engineering.

PPG302H1 will examine the role of institutions in making social change and policy through a study of historic and current policy and institutional practices and the relationship of institutions to democracy.

PPG201H1 and PPG302H1 will be offered in the Fall term and can be taken concurrently.

In the final course, PPG402H1, students will examine the theories of policy-making, the role of regulation and the policy process in action from proposal through development, consultation, implementation, and reform.

This course will be offered in the Winter term and requires PPG201H1 and PPG302H1 (or approval of the instructor) as pre-requisites.

These courses are currently being ushered through FAS governance processes by the Munk School (approval forthcoming in January) with the expectation that they all will be offered starting in the 2023-2024 academic year. The Munk School will be responsible for the course administration and will bear the costs (as well as benefits) of mounting them.

7 Consultation

This proposal was developed through discussions between FASE and the Munk School of Global Affairs and Public Policy, including:

Faculty of Applied Science and Engineering:

- Chris Yip – Dean
- Dionne Aleman – Associate Dean, Cross-Disciplinary Programs
- Daniel Posen – Assistant Professor, Civil and Mineral Engineering, Canada Research Chair in System-Scale Environmental Impacts of Energy and Transport Technologies
- Sharon Brown – Assistant Director, Cross-Disciplinary Programs Office

Munk School of Global Affairs and Public Policy:

- Peter Lowen – Director
- Alexandra Rahr – Director, Undergraduate Programs and Student Experience
- Shari Eli – Director, Undergraduate Program in Public Policy
- Ariana Bradford – Executive Director

The following from the **Faculty of Arts and Science** were also consulted:

- Alana Boland – Associate Dean, Curriculum and Learning
- Horatio Bot – Executive Director, Faculty Budget, Planning & Finance Office
- Gillian Hamilton – Acting Vice-Dean, Academic Operations

The proposal has been endorsed by the Munk School of Global Affairs and Public Policy (Prof. Peter Lowen); and the Faculty of Arts and Science Vice-Dean (Acting), Academic Operations (Prof. Gillian Hamilton).

8 Resources

Administration of the certificate program will be managed through the Cross-Disciplinary Programs Office as part of its regular activities. No additional resources will be required to offer the certificate.

Funding for the new courses will be developed as part of the existing IDT agreement between FAS and FASE.

9 Oversight & Accountability

Minors and certificates in the Faculty of Applied Science and Engineering are subject to periodic review in conjunction with the review of the Cross-Disciplinary Programs Office.

10 Summary of Process Steps & Approvals

Steps	**Dates**
Development/consultation within CDPO	July-October 2022
Endorsement by Undergraduate Curriculum Committee	October 28, 2022
Consultation with Dean's Office	October-November 2022

Steps	**Dates**
Endorsement by Munk School of Global Affairs and Public Policy	November 10, 2022
Endorsement by Faculty of Arts & Science	November 2022 (courses to be approved January 27, 2023)
Consultation with VPAP	November 14, 2022
Approval of FASE Council	December 6, 2022
Submission to VPAP upon approval	December 6, 2022
Reported by VPAP to AP&P	June 2023

Appendix A: Proposed Learning Outcomes and Undergraduate Degree-Level Expectations

The Faculty of Applied Science and Engineering aims to provide all of its undergraduate students with an education that will encourage them to be leaders in society in developing solutions to its most pressing problems. In order to achieve this, each graduate will have achieved the Undergraduate Degree-Level Expectations for the BASc described below.

Engineering minors and certificates are designed to recognize students for focusing their degree-program electives in a particular area of study. They are optional structures above and beyond a student's degree requirements and are therefore enhancements to existing rigorous degree-level expectations for engineering programs.

The certificate is structured around a broad, interdisciplinary introduction to the field of public policy and its constituent elements.

The first course, PPG201H1, will provide an enhanced examination of microeconomics concepts which goes beyond the content that is already found in the typical engineering economics course. The course will have an emphasis on mathematical approaches, taking advantage of the strong math background required in first year engineering.

PPG302H1 will examine the role of institutions in making social change and policy through a study of historic and current policy and institutional practices and the relationship of institutions to democracy.

In the final course, PPG402H1, students will examine the theories of policy-making, the role of regulation and the policy process in action from proposal through development, consultation, implementation, and reform.

In addition to the following Undergraduate Degree-Level Expectations, upon completion of the certificate program, students will be able to:

1. Recognise and critically assess public policy dimensions of current and proposed engineering activities;
2. Use their understanding of the policy process and the role of institutions to enable effective dialogue in multidisciplinary collaboration; and
3. Transfer engineering knowledge to public policy related challenges and applications.

Degree Level Expectations for Graduates Receiving the Degree of Bachelor of Applied Science

Faculty of Applied Science and Engineering University of Toronto

1. Degree Learning Objectives and Requirements

Overall Learning Objectives

The Faculty of Applied Science and Engineering aims to provide all of its undergraduate students with an education that will allow them to be leaders in society in developing solutions to its most pressing problems. Our graduates will be able and inspired to:

- be leading practitioners of engineering and engineering design
- be known for their technical literacy as well as their knowledge of mathematics and the basic sciences and the role of technology in society
- be able to formulate and solve problems in complex systems independently and in teams
- pursue independent lifelong learning within their field of study and more broadly
- be prepared for careers, including graduate programs, that build upon their advanced technical knowledge
- participate meaningfully as leaders in society

In order to achieve this, each graduate will have achieved the following general learning objectives:

a. Depth of knowledge that cultivates critical understanding and intellectual rigour in at least one engineering discipline.
b. Competencies in learning and applying knowledge to solve problems facing society and that are fundamental to responsible and effective participation in the workplace, in the community, in scholarly activity, and in personal life:
    i. Critical and Creative Thinking
    ii. Oral and Written Communication
    iii. Quantitative Reasoning
    iv. Teamwork
    v. Information Literacy
    vi. Ethical Thinking and Decision-Making
c. Breadth of knowledge across mathematics, basic sciences, engineering sciences, engineering economics and engineering design that cut across the engineering disciplines and across a range of nontechnical areas including the humanities and social sciences and an awareness of the impact of technology on society.
d. Integration of skills and knowledge developed in a student's course of study through a capstone experience in the upper years.

2. Requirements to Graduate

In order to graduate with a BASc degree, each student in the Faculty of Applied Science and Engineering will have completed a full undergraduate program as outlined in the Faculty Calendar within nine calendar years of first registration, exclusive of mandatory absences from his/her program. Current programs include: Chemical, Civil, Computer, Electrical, Industrial, Mineral, Materials and Mechanical Engineering as well as the BASc in Engineering Science.

The practice of engineering is regulated, by statute, in all Canadian provinces and territories. To become a Professional Engineer (PEng), an individual must satisfy the requirements of the licensing bodies.

These requirements include a degree from an accredited program, successful completion of a professional practice examination in engineering law and ethics, and suitable experience. At present, all programs in the Faculty of Applied Science and Engineering are accredited and evaluated regularly by the Canadian Engineering Accreditation Board (CEAB) of the Canadian Council of Professional Engineers. Therefore, graduation from the Faculty may lead to registration in the provincial Associations of Professional Engineers, in accordance with individual policies. No student will be permitted to graduate who does not meet these requirements.

The criteria set out by the CEAB are designed to ensure that each graduate has a foundation in Mathematics and Basic Sciences, a broad preparation in Engineering Sciences and Engineering Design and an exposure to non-technical subjects (Complementary Studies) that complement the technical aspects of the curriculum. Basic Sciences must include physics and chemistry and also may include elements of life sciences and earth sciences; they impart an understanding of natural phenomena. Engineering Sciences normally involve Mathematics and Basic Sciences but carry knowledge further to creative applications. Complementary Studies include the humanities, social sciences, arts, management, engineering economics and communication skills.

Each program in the Faculty consists of a technical component and complementary studies component. The curriculum for students in their early years forms a basis in the fundamental subjects prior to subsequent specialization in the various engineering disciplines. Students are able to choose from a range of technical electives in their senior years. In the senior years, all programs contain a capstone experience through a design project, which integrates their skills and knowledge and provides students with the opportunity to carry out original work in their chosen fields of study.

There are a set of common requirements, described below, that cut across all programs in the following categories: Coursework, Promotion, English Proficiency, and Practical Experience. In this context, a course is defined as one half-course equivalent, which may consist of a half course (“S,” “F” or “H”) or half of a full-year “Y” course.

1. **Coursework:** Each program will have courses that provide the following:
    a. Complementary Studies Electives
    b. A basic knowledge of Engineering Economics
    c. Technical Electives
    d. Courses with substantial design content in Years 1, 2 and/or 3

e. Capstone course(s) in Years 3 and/or 4 with strong integrative, design and independent work elements
f. Across all four years, programs will provide sufficient opportunities for the development of professional awareness and practice.

2. **Promotion:** All undergraduate programs will consist of eight Fall and Winter Sessions taken in order.

    a. To gain credit for a session a student must:
        i. satisfy the academic regulations to proceed to the succeeding session as described in the calendar and
        ii. not be subsequently required to repeat the session for which credit is to be gained, and
        iii. achieve a course mark of 50% or greater in every course taken as part of the academic load in a session, and
        iv. not have any outstanding designations of 'standing deferred,' 'incomplete' or 'No Grade Available' for any course in any session.

    b. To be eligible to graduate, each student must attain a weighted Session Average of 60% or greater in the final session of their program. Any student who does not achieve a weighted Session Average of 60% in their final session (4W), but has attained a weighted Session Average that allows them to proceed to the next session on probation, shall repeat the final session and achieve a weighted Session Average of 60% or greater to graduate.

3. **English Proficiency:** Each student must show an ability to write English coherently and correctly. Every student will also take at least one course that includes a written communication component within their curriculum. Satisfactory completion of the course or courses is required for graduation.

4. **Practical Experience:** The Faculty requires that all students complete a minimum of 600 hours of practical work before graduation.

3. Degree Level Expectations for the Bachelor of Applied Science

1.1. Depth and Breadth of Knowledge

The Faculty ensures that a student has mastered a body of knowledge with appropriate depth by requiring that each student completes the requirements of one of the degree Programs of Study (POSt) as described in the Faculty Calendar. The curriculum for students in First Year forms a common basis in the fundamental subjects, including the natural sciences and mathematics, prior to a subsequent specialization in the various engineering disciplines. Each program consists of a technical component and a complementary studies component.

Critical analysis and thinking and analytical skills are emphasized through the student's exposure to an increasingly sophisticated understanding of their program of study. Specialization within the discipline is developed through technical electives taken in the 3rd and 4th years of study. A detailed knowledge of and experience in design is ensured through the Design Course requirements, beginning with courses in the first three years as well as the

Capstone course(s) in each program. Opportunity to further develop these skills is provided through a research thesis that is available in most POSts.

The Faculty assures that students have breadth of knowledge in a number of ways. Breadth across engineering is assured through a First Year of study that prepares a student for any of the programs of study. Breadth beyond engineering is developed through the Complementary Studies Electives as well as the Engineering Economics requirement.

1.2. Knowledge of Methodologies

Every POSt has requirements which demonstrates a student's understanding of the methods of engineering design. Students in all engineering programs must successfully complete courses with substantial design in their first three years and a Capstone design course in their senior years. These courses require students to evaluate the appropriateness of various approaches to analyze and solve the design problem and also to devise and sustain arguments for their design. In most POSts, students have the opportunity to participate in a research thesis course that familiarizes them with the specific methodologies currently in use in the development of knowledge in their discipline.

1.3. Application of Knowledge

The application of science and mathematics to solve problems is fundamental to all programs in Engineering and therefore is required in many of the courses within all POSt. A minimum level of instruction in Engineering Science and Engineering Design is required, both of which directly involve the application of knowledge.

1.4. Communication Skills

The Faculty requires students to communicate information, arguments and analysis accurately and reliably, orally and in writing, to specialist and non-specialists audiences. The requirement for courses with substantial engineering design that are required across all programs require a series of technical reports and presentations with direct involvement with our Engineering Communication Program. In addition, our Capstone Design Courses and research theses all involve a written report and most involve oral presentations. The course requirements for instruction in Complementary Studies also adds to the education our students receive in communication skills. Also, the English Proficiency requirement insures a minimum level of writing ability for all graduates.

1.5. Awareness of Limits of Knowledge

Each POSt develops, through a sequence of courses starting at the 100-series or 200-series and culminating at the 300-series or 400-series or 500-series of courses, an understanding of a discipline as it is currently appreciated by educators who are at the same time involved in original scholarship in the subject area. The course content at the upper series level is designed, in part, to provide students with an appreciation of the uncertainties, ambiguities and limitations of knowledge in the specific area.

1.6. Autonomy and Professional Capacity

The development of an awareness and understanding of professional practice is required for all POSt. The required design courses require students to work in teams and also accept responsibility for their own contributions. Students are required to make their own decisions for their own learning through selection of their technical and nontechnical electives. Finally, in completing their course requirements, the Faculty expects strict adherence by students to

the Code of Behaviour on Academic Matters, which requires students to not tolerate or encourage the creation of an environment of cheating, misrepresentation or unfairness.

1.7. Other Degree Level Expectations

The Faculty requires all students to have developed competency in several areas of learning and applying knowledge not identified explicitly in the previous sections. In particular, the Faculty requires students to have developed competencies in quantitative reasoning and in information literacy.

Quantitative reasoning is considered the ability to identify, assemble and interpret quantitative information and make and test hypotheses based on such data. Development of this competency is an explicit part of all POSts offered by the Faculty.

The Faculty requires all students to develop an advanced understanding of how to obtain information, manipulate and evaluate it and bring diverse sources together to develop a comprehensive understanding of specific issues, solve problems or apply the scientific method to create further knowledge in the discipline. These advanced information literacy skills are developed through the studies in their concentration(s) and are demonstrated in the advanced courses required in each POSt.

Appendix B: Proposed Calendar Copy

Course Requirements for the Certificate in Public Policy and Engineering

Engineering is a fundamentally public endeavour. Many foundational engineering projects – from bridges to waterworks to recent climate mitigation efforts - are undertaken with government partners. Private projects are similarly shaped by public regulations. Public policy training will enable engineers to build effective and informed collaborations with these public actors, from governments to regulatory agencies. This proficiency will also help engineers knowledgeably participate in policy making. Technological expertise is essential to public decision-making, and familiarity with public institutions and processes will facilitate engineers' contributions to the many issues facing an urbanizing, changing planet.

All undergraduate Engineering students are eligible to participate in this certificate program. Students who complete the requirements of the Certificate will receive a notation on their transcript upon graduation.

The requirements for the Certificate are the successful completion of the following courses:

1. PPG201H1F: Microeconomics for Engineers
2. PPG302H1F: Institutions and Public Policy for Engineers
3. PPG402H1S: Public Policy Analysis for Engineers

Note: Availability of the courses for timetabling purposes is not guaranteed; the onus is on the student to ensure compatibility with their timetable.

Courses	Term	Lec	Lab	Tut	Wgt
Fall Courses					
PPG201H1 – Microeconomics for Engineers	F	2		1	0.5
PPG302H1 – Institutions and Public Policy for Engineers	F	2			0.5
Winter Courses					
PPG402H1 – Public Policy Analysis for Engineers	S	2			0.5

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Report No. 3725 Revised

MEMORANDUM

To: Executive Committee of Faculty Council (November 15, 2022)
Faculty Council (December 6, 2022)

From: Professor Evan Bentz
Chair, Undergraduate Curriculum Committee

Date: November 3, 2022; revised November 21, 2022

Re: Major Curriculum Changes for the 2023-2024 Academic Year

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 Undergraduate Curriculum Committee is tasked with managing the curriculum change process for the Faculty. This report summarizes course changes proposed for the 2023-2024 academic year.

PROCESS AND CONSULTATION

These changes have been reviewed and approved by the Undergraduate Curriculum Committee, which is comprised of teaching staff representatives from the Faculty's departments and institutes; undergraduate student representatives; the Vice-Dean, Undergraduate; the Vice-Dean, First Year; the Director, First Year Curriculum; the Associate Dean, Cross-Disciplinary Programs; the Assistant Dean and Director, Diversity, Inclusion and Professionalism; and the Faculty Registrar. The Committee meets regularly to review and approve proposed changes to the undergraduate curriculum. The impact of these changes on students in the relevant programs has been considered.

RECOMMENDATION FOR COUNCIL

THAT the proposed curriculum changes for the 2023-2024 academic year, as described in Report 3725 Revised, be approved.

PROPOSED CURRICULUM CHANGES

1. MECHANICAL ENGINEERING

1.1. Update course description for **MIE519: Advanced Manufacturing Technologies**

CURRENT: This course is designed to provide an integrated multidisciplinary approach to Advanced Manufacturing Engineering, and provide a strong foundation including fundamentals and applications of advanced manufacturing AM. Topics include: additive manufacturing, 3D printing, micro and nanomanufacturing, intelligent manufacturing, Advanced Materials, lean manufacturing, AM in machine design and product development, process control technologies. New applications of AM in sectors such as automotive, aerospace, biomedical, electronic, food processing.

PROPOSED: This course is designed to provide an integrated multidisciplinary approach to Advanced Manufacturing Engineering, and provide a strong foundation including fundamentals and applications of advanced manufacturing (AM). Topics include: additive manufacturing, 3D printing, micro- and nano-manufacturing, continuous & precision manufacturing, green and biological manufacturing. New applications of AM in sectors such as automotive, aerospace, biomedical, and electronics.

- *The proposed course description better reflects the course content. New topics include continuous & precision manufacturing, and green and biological manufacturing. Topics removed include intelligent manufacturing, Advanced Materials, lean manufacturing, AM in machine design and product development, process control technologies.*

1.2. Update prerequisites for **MIE441: Design Optimization**

CURRENT: MIE341H1, MIE222H1 or equivalents

PROPOSED: MIE243H1, MIE222H1 or equivalents

- *MIE341 is no longer offered. The new course code is MIE243.*

1.3. Update program for the listing of **BME595: Medical Imaging**

CURRENT: Technical elective for the Winter Session - Year 4

PROPOSED: Technical elective for the Fall Session - Year 4

- *BME595 is offered in the Fall, not Winter.*

1.4. Update program for the listing of **BME440: Biomedical Engineering Technology and Investigation**

CURRENT: *Listing does not include BME440*

PROPOSED: Add BME440 to the list of approved technical electives for MEC (Fall Session - Year 4)

- *BME440H1 is taken by quite a number of MEC students as a technical elective substitute (MEC students make up about 20% of the class). Adding BME440H1 to the list of approved technical electives will ensure that it gets captured via the scheduling and enrolment process. This way, students who request it via pre-registration will not be excluded from the batch enrolment, and will not need to seek approval from the Department for a technical elective substitute.*

1.5. Update course title and description for **MIE563: Engineering Analysis II**

CURRENT: **Engineering Analysis II**
This course explores exact solution techniques for common engineering Partial Differential Equations (PDEs), such as separation of variables, superposition, eigenfunctions, orthogonal functions, complex functions. Other topics include: derivation of common engineering PDEs, introduction to methods of weighted residuals for deriving finite element formulations and limitations of exact solutions relative to approximate solutions.

PROPOSED: **Analytic and Numerical Solution of Engineering PDEs**
This course explores analytic and numerical solution techniques for heat/mass diffusion and vibration/wave equations. Emphasis is placed on intuitive derivation of these equations, and analytic solution techniques like separation of variations, eigenfunction expansions, Fourier analysis, integral transforms, coordinate transforms, and special functions. Numerical solutions are introduced via finite difference methods. A key learning outcome of this course is understanding the central role that analytic solutions play in developing intuition about engineering physics, and how this is a fundamental step in learning to verify, validate, and properly use advanced computational modelling tools.

- *There is a decline in enrolment over the past 2-3 years, and the MIE563 students themselves strongly encouraged the instructor to change the title of the course. Course material has not changed much, but instructor notes he is emphasizing more the connection to engineering practice and intuition, and some students won't be aware of that from the current title and description.*

1.6. Update program and course for thesis enrolment requirements for **MIE498H/Y1: Research Thesis**

CURRENT: Overall B average in second and third years

PROPOSED: 2.7 CGPA

- *Calendar will better reflect current practice.*

1.7. Move technical elective **MSE443: Composite Materials Engineering** from Winter to Fall session.

CURRENT: Winter Session - Year 4

PROPOSED: Fall Session - Year 4

- *MSE443 is offered in the Fall, not Winter*

2. ELECTRICAL & COMPUTER ENGINEERING

2.1. Add **ECE441: Interfacing and Modulating the Nervous System**

PROPOSED session: Fall 2023

PROPOSED instructors: Professor Xilin Liu and Professor Ervin Sejdic

PROPOSED course description: Provides an overview of the fundamental principles and clinical applications of neuromodulation. Topics include (i) overview of the human nervous system & neural oscillations, (ii) introduction to electrical-neural interfaces, (iii) fundamentals of neural recording, neural stimulation & signal processing as well as (iv) instrumentation and clinical applications of commonly used neuromodalities including Electroencephalography (EEG), Deep brain stimulation (DBS), Transcranial magnetic stimulation (TMS) and Functional electrical stimulation (FES).

- *Updated to match current content of course.*

2.2. Update math/science electives for ECE

CURRENT: *Electives do not include PHY365*

PROPOSED elective: **PHY365: Quantum Information**

PROPOSED course description: Introduction to quantum computing and other quantum information topics; Quantum states of multi-particle systems; Entanglement, Bell inequalities and Teleportation; Quantum Key Distribution; Quantum Computing Algorithms; Quantum Information Processing Technologies; other applications to metrology and illumination.

PROPOSED pre-requisites: PHY256H1/PHY294H1/CHM223H1/ECE330H1

PROPOSED co-requisites: None

PROPOSED Exclusions: None

PROPOSED recommended preparations: MAT223H1/MAT240H1

2.3. Update course description for **ECE244: Programming Fundamentals**

CURRENT: Provides a foundation in programming using an object-oriented programming language. Topics include: classes and objects, inheritance, exception handling, basic data structures (lists, tree, etc.), big-O complexity analysis, and testing and debugging. The laboratory assignments emphasize the use of object - oriented programming constructs in the design and implementation of reasonably large programs.

PROPOSED: Provides a foundation in programming using an object-oriented programming language. Topics include: classes and objects, inheritance, basic data structures (linked lists, binary trees, and hash tables), big-O complexity analysis, and testing and debugging. The laboratory assignments emphasize the use of object - oriented programming constructs in the design and implementation of reasonably large programs.

- *Updated to match current content of course.*

2.4. Update title and course description for **ECE411: Real-time computer control**

CURRENT**: ECE411: Real-time computer control**
Digital Control analysis and design by state-space methods. Introduction to scheduling of control tasks using fixed-priority protocols. Labs include control design using MATLAB and Simulink, and computer control of the inverted pendulum using a PC with real-time software.

PROPOSED**: ECE411: Adaptive Control and Reinforcement Learning**
An introduction to adaptive control and reinforcement learning for discrete-time deterministic linear systems. Topics include: discrete-time state space models; stability of discrete time systems; parameter adaptation laws; error models in adaptive control; persistent excitation; controllability and pole placement; observability and observers; classical regulation in discrete-time; adaptive regulation; dynamic programming; Rescorla-Wagner model; value iteration methods; Q-learning; temporal difference learning.

- *Updated to match current content of course.*

2.5. Update course description for **ECE212: Circuit Analysis**

CURRENT: Nodal and loop analysis and network theorems. Natural and forced response of RL, RC, and RLC circuits. Sinusoidal steady-state analysis. Frequency

response; resonance phenomena; poles and zeros; applications of the Laplace transform.

PROPOSED: Methods for the analysis and design of electrical circuits. Resistive circuits, KCL and KVL, nodal analysis and mesh analysis, circuit linearity and superposition, equivalent circuits, Thevenin and Norton theorems. Ideal operational amplifier analysis, review of differential equations, and dynamic RLC circuit analysis. For sinusoidal steady state analysis, topics include phasor analysis, impedance and admittance, induction and coupled inductors, ideal transformers, real and reactive power, power factor, complex power and power flow analysis. Frequency domain analysis, including the Laplace transform, poles and zeros, s-domain analysis, transfer functions, convolution, frequency response, Bode diagrams, low-pass, high-pass, bandpass, and bandstop filters.

- *Provides deeper explanation of the topics that are currently taught in the course; aiding students to understand the context and technical material.*

2.6. Update course description for **ECE231: Introductory Electronics**

CURRENT: An introduction to electronic circuits using operational amplifiers, diodes, bipolar junction transistors and field-effect transistors.

PROPOSED: Provides methods for the analysis and design of electrical circuits based on semiconductor non-linear components (diodes, bipolar junction transistors and field effect transistors) and operational amplifiers. The course discusses basic physical operation of semiconductor devices, current-voltage characteristics, operating regions, DC modeling, small-signal modelling and biasing. Fundamental circuits are covered, such as rectifiers, limiting and clamping circuits and transistors amplifiers. Finally, operational amplifier non-idealities are addressed, including the impact on circuit applications.

- *Provides deeper explanation of the topics that are currently taught in the course; aiding students to understand the context and technical material.*

2.7. Update course description for **ECE331: Analog Electronics**

CURRENT: Transistor amplifiers, including: differential and multistage amplifiers, integrated circuit biasing techniques, output stage design and IC amplifier building blocks. Frequency response of amplifiers at low, medium and high frequencies. Feedback amplifier analysis. Stability and compensation techniques for amplifiers using negative feedback.

PROPOSED: Transistor amplifiers with an emphasis on integrated circuit (IC) design. Building blocks include differential and multistage amplifiers, IC biasing techniques, and output stage design. Frequency response of amplifiers at low, medium and high frequencies. Feedback amplifier analysis. Stability and compensation techniques for amplifiers using negative feedback.

3. *Provides deeper explanation of the topics that are currently taught in the course; aiding students to understand the context and technical material.*

4. ENGINEERING SCIENCE

4.1. Update BMS course requirements

CURRENT: **MIE439: Cellular and Tissue Biomechanics, core**

PROPOSED: One of **MIE439: Cellular and Tissue Biomechanics** or **BME530: Human Whole Body Biomechanics**

CURRENT calendar:

Fall Session Year 4
ESC499Y1
BME428H1
BME489H1
MIE439H1
CS/HSS Technical elective

Winter Session Year 4
ESC499Y1
CS/HSS Technical elective
CS/HSS Technical elective
CS/HSS Technical elective
CS/HSS Technical elective

PROPOSED calendar:

Fall Session Year 4
ESC499Y1
BME428H1
BME489H1
CS/HSS Technical elective

Winter Session Year 4
ESC499Y1
CS/HSS Technical elective
CS/HSS Technical elective
CS/HSS Technical elective
CS/HSS Technical elective

Students Must Also Take One of:
Fall Session Year 4
MIE439H1

Winter Session Year 4
BME530H1

Remove:
Note 1: Students who completed MIE439H1 in Year 3 are required to take a Technical Elective

- *MIE439 permanently moved from winter to fall term. This left only 1 fall elective and 4 winter electives in 4th year. Allowing BME530 as a substitution provides a better balance. Rodrigo suggested BME530 as the appropriate core substitution. Remove note as it is not adding useful information.*

4.2. Move **PHY484: Relativity Theory II** to Group B elective grouping and update Group A courses

CURRENT: **PHY484H1: Relativity Theory II** in Group A electives

PROPOSED: **PHY484H1: Relativity Theory II** in Group B electives.

Add the following to Group A electives:
APS360 (Applied Fundamentals of Deep Learning)
ECE358 (Foundations of Computing)
ECE421(Introduction to Machine Learning)
CSC384 (Introduction to Artificial Intelligence)
CSC413(Neural Networks and Deep Learning)

- *Machine learning/computing courses have been approved in the past for the physics major and it makes sense to add those courses given their use in many fields of physics (for example machine learning is used extensively in experimental particle physics).*

4.3. Update course description for **AER210: Vector Calculus and Fluid Mechanics**

CURRENT: The first part of this course covers multiple integrals and vector calculus. Topics covered include: double and triple integrals, derivatives of definite integrals, surface area, cylindrical and spherical coordinates, general coordinate transformations (Jacobians), Taylor series in two variables, line and surface integrals, parametric surfaces, Green's theorem, the divergence and gradient theorems, Stokes's theorem. The second part of the course provides a general introduction to the principles of continuum fluid mechanics. The basic conservation laws are derived in both differential and integral form, and the link between the two is demonstrated. Applications covered include hydrostatics, incompressible and compressible frictionless flow, the speed of sound, the momentum theorem, viscous flows, and selected examples of real fluid flows

PROPOSED: The first part covers multiple integrals and vector calculus. Topics covered include: double and triple integrals, surface area, multiple integrals in polar, cylindrical

and spherical coordinates, general coordinate transformations (Jacobians), Taylor series in two variables, line and surface integrals, parametric surfaces, Green's theorem, the divergence and Stokes's theorems. The second part of the course provides a general introduction to the principles of continuum fluid mechanics. The basic conservation laws are derived in both differential and integral forms using different fluid models, and the link between the two is demonstrated. Applications covered include: dimensional analysis, hydrostatics, flow visualization, incompressible and compressible frictionless flows, the speed of sound, the momentum principle, viscous flows and selected examples of real fluid flows. The students conduct two hands-on laboratory experiments involving microfluidics and flow visualization, which complement the fluid mechanics lectures and experience technical report writing.

- *More aligned with the material currently delivered.*

4.4. Update course description for **AER310: Gasdynamics**

CURRENT: Basic introduction to compressible gasdynamics. Includes some fundamental thermodynamics, thermal and caloric equations of state, derivation of Euler's equations by control volume approach. Also, includes the theory of steady flows in ducts with area changes, adiabatic frictional flows, duct flows with heat transfer, normal and oblique shock waves, Prandtl-Meyer expansion wave, moving shock and rarefaction waves, shock tubes, and wind tunnels. The lectures are supplemented by problem sets. Reference book: Anderson, J.D., Modern Compressible Flow with Historical Perspective.

PROPOSED: Fundamental thermodynamics for calorically perfect gases and derivation of Navier-Stokes and Euler equations by control volume approach. Also includes the theory of steady quasi-one-dimensional (1D) flows in flow tubes, pipes, and ducts with area variation, friction and drag, body forces, heat addition, and external work, reviewing isentropic flow and Fanno and Rayleigh lines solutions. Also covers the Rankine-Hugoniot equations and solutions for both steady normal shock waves and moving shocks and introduces theory of unsteady 1D constant-area flows and solutions for unsteady isentropic expansion and compression waves via characteristic analysis. Concludes with theory of steady two-dimensional (2D) supersonic flow including Prandtl-Meyer theory and solutions for oblique shock, expansion, and compression waves. The lectures are supplemented by problem sets.

- *More aligned with the material currently delivered.*

4.5. Update course description for **ROB501: Computer Vision for Robotics**

CURRENT: An introduction to aspects of computer vision specifically relevant to robotics applications. Topics include the geometry of image formation, basic image processing operations, camera models and calibration methods, image feature detection and matching, stereo vision, structure from motion and 3D reconstruction. Discussion of moving object identification and tracking as time permits.

PROPOSED: An introduction to aspects of computer vision specifically relevant to robotics applications. Topics include the geometry of image formation, image processing operations, camera models and calibration methods, image feature detection and matching, stereo vision, structure from motion and 3D reconstruction. Discussion of the growing role of machine learning and deep neural networks in robotic vision, for tasks such as segmentation, object detection, and tracking. The course includes case studies of several successful robotic vision systems.

- *More aligned with the material currently delivered.*

Program Changes

4.6. Addition of **MIE5XXH1: Data Mining** to technical electives list (Machine Intelligence major)

- *Course is a good fit and useful addition to Machine Intelligence major technical electives list.*

5. CHEMICAL ENGINEERING & APPLIED CHEMISTRY

5.1. Update course description for **CHE204: Chemical Engineering and Applied Chemistry – Laboratory I**

CURRENT: This laboratory course will survey aspects of inorganic, organic and analytical chemistry from a practical point of view in a comprehensive laboratory experience. Theory, where applicable, will be interwoven within the laboratories or given as self-taught modules. Topics to be covered are inorganic and organic synthesis and analysis and will include elements of process and industrial chemistry and practice (including Green Chemistry).

PROPOSED: This laboratory course surveys aspects of inorganic and analytical chemistry from a practical point of view in a comprehensive laboratory experience. In this course, students learn how to analyze known and unknown samples using qualitative and quantitative analysis. Emphasis is placed on primary standards, instrumental techniques (e.g., spectroscopy), classical volumetric techniques (e.g., titration), statistical treatment of data, and reliability and repeatability (i.e., accuracy and precision). The course includes elements of process and industrial chemistry and practice. Theory, where applicable, is interwoven within the laboratories or given as self-taught modules.

- *Better reflects what is currently being taught in this course.*

5.2. Update course description for **CHE205: Chemical Engineering and Applied Chemistry – Laboratory II**

CURRENT: This laboratory course will survey aspects of inorganic, organic and analytical chemistry from a practical point of view in a comprehensive laboratory experience. Theory, where applicable, will be interwoven within the laboratories or given as self-taught modules. Topics to be covered are inorganic and organic synthesis and analysis and will include elements of process and industrial chemistry and practice (including Green Chemistry).

PROPOSED: This laboratory course surveys aspects of organic chemistry from a practical point of view in a comprehensive laboratory experience. In this course, students explore the syntheses of different chemical reactions (substitution, elimination, condensation and hydrolysis), analyzing and characterizing the intermediates and major products formed using established processes and laboratory techniques (e.g., IR, RI, GC, TLC). The course includes elements of process and industrial chemistry and practice (including Green Chemistry).

- *Better reflects what is currently being taught in this course.*

5.3. Update course description for **CHE221: Calculus III**

CURRENT: Introduces concepts used in developing mathematical models of common chemical engineering processes, concepts of process dynamics and methods for analyzing the process response to different perturbations, and the numerical methods required for solving and analyzing the mathematical models. The course will also introduce applications of modeling to biochemical engineering.

PROPOSED: This course introduces the basic concepts of multivariable calculus (partial derivatives, gradients, multiple integrals and vector analysis, etc.) and methods of solution of ordinary differential equations. The course places a strong emphasis on the application of these concepts to practical design and modeling problems in chemical engineering.

- *Better reflects what is currently being taught in this course.*

6. CIVIL & MINERAL ENGINEERING

Civil Program

6.1. Add a new **5XX** course: **Building Energy Performance Simulation**

PROPOSED timing: 2 Lecture, 2 Practical

PROPOSED calendar description: Building performance simulation (BPS) is the process of imitating/predicting aspects of building performance with computational building models. The models draw heavily upon the disciplines of heat and mass transfer,

thermodynamics, fluid mechanics, light transmission, and occupant behaviour. BPS allows improving the design and operation of buildings through quantitative analyses. This course will provide students with theoretical knowledge and practical skills to effectively apply BPS tools in design and analysis contexts focusing on building heating and cooling loads, building HVAC systems, and whole-building HVAC energy consumption. In addition, various building science research methodologies and examples based on BPS will be presented. As the course project, students will be required to either perform building thermal/energy analysis of real buildings with BPS or conduct research on building science topics with BPS.

Mineral Program

6.2. Add a new course at the start of 2nd year Mineral

PROPOSED title: **Mineral Engineering Field Excursion**

PROPOSED timing: Field based course during frosh week, start of second year 2-4 days long depending on how far away mine is.

PROPOSED calendar description: A field-based course introducing students to mineral engineering activities in open pit and underground mines, and mineral processing plants. The course will provide essential contextual experience for later courses in years 2 to 4 of the program, as well as highlight the key role of mineral engineers in developing safe, economical, and sustainable solutions for extracting and processing natural mineral resources. A mine operation in Ontario will be visited which, depending on the site location, will require one or two overnight stays in the nearest town/city. The mine operation will provide all personal protective equipment (PPE), and will ensure that students receive comprehensive safety induction training before entering the operation. The course will run in the first week of September immediately following Labour Day.

6.3. Update course code for **MIN450: Mineral Economics** and remove from 4th year options

CURRENT: **MIN450: Mineral Economics**

PROPOSED: **MIN350: Mineral Economics**

- *Current course MIN450 is now taken in 3rd year.*

7. INSTITUTE FOR STUDIES IN TRANSDISCIPLINARY ENGINEERING EDUCATION & PRACTICE

7.1. Update title and calendar description for **TEP321: Representing Science and Technology in Popular Media**

CURRENT: **TEP321: Representing Science and Technology in Popular Media**

This course analyzes popular scientific communication critically, starting by establishing a historical and theoretical foundation for understanding the complex relationship between science and the public. We apply this theoretical foundation to contemporary case studies in multiple media (mis)representations of climate, environmental, and biomedical sciences, as well as breakthroughs in engineering. We develop rhetorical strategies for delivering technical information to non-technical readers, including narrative and metaphor.

PROPOSED: **TEP321: Introduction to Science Communication**
This course introduces students to the history, theory and practice of communicating science to the public. We first establish a theoretical foundation for understanding the complex relationship between science and the public, closely examining techniques and strategies for communicating about science to non-technical readers with a variety of backgrounds and ideological perspectives. We apply these concepts to contemporary case studies in multiple media, focusing on (mis)representations of climate, environmental, and biomedical sciences, as well as breakthroughs in engineering. In doing so, we explore how the shift from traditional news to new media – including videos, podcasts, and social media – has changed how science is communicated to the public, as well as the implications of this shift for scientists and engineers.

- *Better represents how the course is currently taught.*

7.2. Remove enrolment cap in the **TEP444: Positive Psychology for Engineers** calendar description

CURRENT: Many disciplines have explored happiness - philosophy, anthropology, psychology, sociology, neurobiology, film, art and literature - to name a few. Why not engineering? During the first part of the course, we will play catch-up, examining the scholarly and creative ways that people have attempted to understand what makes for a happy life. Then we turn our attention to our own domain-expertise, applying engineering concepts like "balance", "flow", "amplitude", "dynamic equilibrium", "momentum" and others to explore the ways that your technical knowledge can contribute to a deep understanding of happiness. This course is designed to challenge you academically as we analyze texts from a variety of disciplines, but it is also designed to challenge you personally to explore happiness as it relates to yourself, your own personal development and your success and fulfillment as an engineer.

If the number of students electing to take the course exceeds the class size limit, selection of the final group will be made on the basis of an in-class assessment completed during the first class.

PROPOSED: Many disciplines have explored happiness - philosophy, anthropology, psychology, sociology, neurobiology, film, art and literature - to name a few. Why not engineering? During the first part of the course, we will play catch-up, examining the scholarly and creative ways that people have attempted to understand what makes for a happy life. Then we turn our attention to our own domain-expertise, applying

engineering concepts like "balance", "flow", "amplitude", "dynamic equilibrium", "momentum" and others to explore the ways that your technical knowledge can contribute to a deep understanding of happiness. This course is designed to challenge you academically as we analyze texts from a variety of disciplines, but it is also designed to challenge you personally to explore happiness as it relates to yourself, your own personal development and your success and fulfillment as an engineer.

8. MATERIALS SCIENCE & ENGINEERING

8.1. Update pre-requisites for **MSE431: Forensic Engineering**

CURRENT: MSE101H1/APS104H1/MSE260H1 or MSE160H1

PROPOSED: Remove all pre-requisites

- *Current pre-requisites are not only outdated, but the course has evolved over the years to be less focused on materials and pre-requisites in MSE courses are no longer required.*

8.2. Update MSE graduation requirements on program calendar

CURRENT: Unclear requirements

PROPOSED: Include statement “MSE students are required to complete 5 Technical Electives between Years 3 and 4. Of the 5 Technical Electives, at least 2 must be from the 400-/500- level.”

8.3. *This is currently not stated in the calendar and given the breadth of electives available to MSE students, we would like to ensure that students are taking some electives in the upper year/advanced categories.*

8.4. Remove courses no longer offered from MSE calendar

Remove:
MSE235: Materials Physics
MSE250: Materials Selection in Design I
MSE298: Communications
MSE342: Nanomaterials
MSE421: Solid State Processing and Surface Treatment
MSE451: Advanced Physical Properties of Structural Nanomaterials
MSE390: Communications II
MSE398: Materials Manufacturing and Design
MSE450: Plant and Process Design
MSE478: Materials Manufacturing and Design Laboratory II
MSE488: Entrepreneurship and Business for Engineers

MSE558: Nanotechnology in Alternate Energy Systems
MSE550: Advanced Physical Properties of Structural Nanomaterials

- *No longer offered by department.*

8.5. Update title for **MSE440: Biomaterial Processing and Properties**

CURRENT: **MSE440: Biomaterial Processing and Properties**

PROPOSED: **MSE440: Biomaterial Processing and Properties**

- *This is a typo on the calendar entry.*

8.6. Update Winter Session Year 3 Curriculum table

CURRENT:

Winter Session – Year 3		Lect.	Lab.	Tut.	Wgt.
MSE332H1: Heat and Mass Transfer for Materials Processing	S	3	–	2	0.50
MSE335H1: Materials Physics	S	3	–	1	0.50
MSE355H1: Materials Production	S	3	–	1	0.50
MSE397H1: Materials Manufacturing and Design II	S	3	1	2	0.50
CS/HSS or Technical Elective	S	–	–	–	1.00

PROPOSED:

Winter Session – Year 3		Lect.	Lab.	Tut.	Wgt.
MSE332H1: Heat and Mass Transfer for Materials Processing	S	3	–	2	0.50
MSE335H1: Materials Physics	S	3	–	1	0.50
MSE355H1: Materials Production	S	3	–	1	0.50
MSE397H1: Materials Manufacturing and Design II	S	3	1	2	0.50
CS/HSS or Technical Elective	S	–	–	–	0.50
CS/HSS or Technical Elective	S	–	–	–	0.50

8.7. Update course description for **MSE294: Communications I**

CURRENT: This is part I of two laboratory, tutorial, and lecture courses building on the communication principles students learned in first year. Students will work in teams on open-ended design projects, and scaffolded assignments will provide students the opportunity to report on their projects in written reports, podium presentations, and poster presentations. The projects in this course are supported by laboratory exercises and tutorial activities designed to help students build engineering drawing skills with an emphasis on the SolidWorks package.

PROPOSED: This is part I of two laboratory, tutorial, and lecture courses building on the communication principles students learned in first year. Students will work in teams on open-ended design projects, and scaffolded assignments will provide students the

opportunity to report on their projects in written reports, podium presentations, and poster presentations. The projects in this course are supported by laboratory exercises and tutorial activities.

- *Better reflects content of the course. SolidWorks is not necessarily the best fit in the communications course.*

8.8. Update course description for **MSE295: Communications II**

CURRENT: This is part II of two laboratory, tutorial, and lecture courses building on the communication principles students learned in first year. Students will work in teams on open-ended design projects, and scaffolded assignments will provide students the opportunity to report on their projects in written reports, podium presentations, and poster presentations. The projects in this course are supported by laboratory exercises and tutorial activities designed to help students build engineering drawing skills with an emphasis on the SolidWorks package.

PROPOSED: This is part II of two laboratory, tutorial, and lecture courses building on the communication principles students learned in first year. Students will work in teams on open-ended design projects, and scaffolded assignments will provide students the opportunity to report on their projects in written reports, podium presentations, and poster presentations. The projects in this course are supported by laboratory exercises and tutorial activities.

- *The updated description better reflects content of the course as SolidWorks is not necessarily the best fit in the communications course.*

9. CROSS-DISCIPLINARY PROGRAMS

9.1. Add new course **APS5XX: Building Organizations: An Engineer's Business Toolkit (Engineering Business Minor)**

PROPOSED course description: This course develops simple, powerful tools and strategies for designing, starting, growing, managing, changing, fixing and evolving successful organisations in the engineering industry. It is highly practical, develops a model for analysing an organisation and then applies it in clear simple steps. The curriculum is designed for Engineers looking to lead organisations, commercialise product ideas or manage change in existing institutions.

9.2. Add new course **APS3XX: Interdisciplinary Studies for Sustainability & Innovation (Environmental Eng Minor, Global Eng Certificate)**

PROPOSED course description: This is an interdisciplinary and multi-university project-based course focused on positively impacting the complex sustainability challenges

faced by real-world communities around the world. Throughout this course, students work in small (three to five person) interdisciplinary and multi-university teams in order to (1) identify and understand a well-defined sustainability (social and/or environmental) problem faced by a real-world community, and then (2) devise, design and propose an implementable idea for positively impacting that problem. During the course, students are provided with multiple facilitated and structured opportunities to: engage directly with local stakeholders from the community their team is focused on; receive mentorship from a global network of experienced sustainability and innovation experts; and collaborate with a diverse array of students from other disciplines and institutions working on similar sustainability problems with other communities around the world.

9.3. Remove Complementary Studies course flag for **APS470: Engineering and Public Health**

9.4. Update course flag and description for **JRE420H1: People Management and Organizational Behaviour**

CURRENT course flag: CS

PROPOSED course flag: HSS

- *This was approved years ago but missed the update in the calendar text***.**

CURRENT course description: This module spans three inter-related topics: leadership, people management and organization behaviour. It provides students with both the theory and practice in how to design, lead and manage organizations. Topics include theories of leadership, strategy, ethics, designing organizations for rapid change and differing cultural environments, communication, job design, managing and motivating people, fostering creativity, and team work. In addition to traditional lectures, exercises and case studies will be used throughout.

PROPOSED course description: This course spans three inter-related topics within organizational behavior and human resources: individual behavior, group behaviour, and leadership. It provides students with both the theory and practice of how to work, lead, and thrive in organizations. Topics include theories of personality, learning, power, decision making, ethics, culture, communication, leadership, teamwork, and motivation teamwork. These topics are taught in three ways:

1. Case studies, role play & simulation exercises followed by class discussion
2. Surveys of Personality & Skills
3. Lectures, discussions, and readings based on the current research on the topic

<u>Minor/Certificate Updates</u>

Engineering Business Minor

9.5. Add new course **APS5XX: Building Organisations: An Engineer's Business Toolkit to electives**

Advanced Manufacturing Minor

9.6. Add **MIE243: Mechanical Engineering Design** as an Introductory Elective (for 3rd year MSE students only)

AI Engineering Minor

9.7. Change **MIE335H1** to **MIE2XXH1(S): Data Structures and Algorithms** in Requirement 2

9.8. Add **MIE5XXH1: Data Mining** to Requirement 5

9.9. Add **MIE567H1: Dynamic & Distributed Decision Making** to Requirement 5

9.10. Add **CME538H1: Intro. To Data Science for Civil and Min. Engineering** to Requirement 5

9.11. Add **CHE408H1: Data Analytics for Prediction, Control, and Optimization of Chemical Processes** to Requirement 5

9.12. Add **MSE403H1: Data Sciences and Analytics for Materials Engineers** to Requirement 5

9.13. Add **MSE465H1: Application of Artificial Intelligence in Materials Design** to Requirement 5

Sustainable Energy Minor

9.14. Add **MIE550H1: Advanced Momentum, Heat and Mass Transfer** as Advanced Elective

9.15. Add **CIV5XX: Building Energy Performance Simulation** as Advanced Elective

Bioengineering Minor

9.16. Update course code for **BCH441: Bioinformatics** to **MGY441: Bioinformatics**

9.17. Add **ECE441: Interfacing & Modulating the Nervous System** to Clinical Pathway electives (new ECE course)

Environmental Engineering Minor

9.18. Add **APS3XX**: **Interdisciplinary Studies for Sustainability & Innovation** as Introductory Elective

Robotics and Mechatronics Minor

9.19. Add **CSC263: Data Structures and Analysis** to Introductory Electives

Global Engineering Certificate

9.20. Add **APS3XX: Interdisciplinary Studies for Sustainability & Innovation**

10. BIOMEDICAL ENGINEERING

10.1. Remove **BME499Y: Applied Research in Biomedical Engineering** from calendar

- *Removed as course not needed for new bioengineering minor.*

11. INDUSTRIAL ENGINEERING

Industrial Engineering is currently implementing a new curriculum renewal and this set of changes represents the start of a multi-year set of changes to implement this.

11.1. Add new course **MAT2XXH1: Differential Equations and Discrete Math**

PROPOSED year and term: 2F

PROPOSED course description: Ordinary differential equations. Equations of first order and first degree. Linear equations of order n. Systems of simultaneous equations. Difference equations. Forecasting. Business dynamics. Basic Set Theory. Counting, Cartesian Product, Combinations, Permutations. Basic Propositional Logic and Proofs. Throughout the course: formulating and analysing differential equation, difference equation, and discrete mathematical models for real-world problems.

PROPOSED learning objectives:

1. Understand the basic principles of differential and difference equations including how to represent them and solve them.

2. Understand the basic principles of discrete mathematics including counting, combinatorics, and logic.

3. Understand how to apply all principles taught in the course to model real-world applications and problems in Industrial Engineering.

PROPOSED Textbooks:

1. Differential Equations – An introduction to Modern Methods and Applications, 2nd Edition, by Brannan & Boyce, Wiley (2011).
2. Discrete Mathematics and its Applications, sixth edition, by Kenneth H. Rosen (2007).

PROPOSED AUs: 75% Mathematics and Natural Science / 25% Eng Science

PROPOSED timing: 3 hours / Lab: 0 hours / Tutorial: 2 hours

PROPOSED prerequisites: None

PROPOSED exclusions: None

PROPOSED short course name: Diff Eq and Discrete Math

PROPOSED room requirements: Standard lecture and tutorial rooms

- *Both differential equations and discrete math are important mathematical foundations of our IE curriculum, but the existing curriculum lacks any discrete math component. Rather than introduce an entirely new course for discrete math, it has been determined that the necessary foundational material for both differential equations and discrete math can be provided in a single course that is divided into two distinct sections.*

11.2. Add new course **MIE2XXH1: Data Science**

PROPOSED year and term: 2S

PROPOSED course description: Introduction to the methods of Data Science. Exploratory data analysis and visualization; tools for reproducible analysis. Principles and tools for data collection; awareness of bias in collection methods. Data cleaning. Descriptive statistics and feature analysis. Assessment of data with respect to scientific theories. Data interpretation fallacies. Geographical data representation and manipulation. Text processing, the natural language processing pipeline, and sentiment analysis. Fundamentals of social network analysis and centrality measures. Cloud-based data processing.

PROPOSED learning objectives:

1. Understand the role of the scientific method in analyzing and interpreting data.

2. Understand the role of exploratory data analysis and visualization in data science methodology.

3. Understand sources of bias and error in data collection and data science methodology.

4. Become proficient in tools (local machine and cloud-based) that facilitate reproducible analysis.

5. Become proficient in methodology and tools for working with a variety of data formats (tabular, time series, geospatial, text, network) and application domains (public health, ecommerce, social media).

PROPOSED Textbook: None (online readings provided)

PROPOSED AUs: 25% Natural Science / 75% Eng Science

PROPOSED timing: 3 hours / Lab: 2 hours / Tutorial: 0 hours

PROPOSED prerequisites: APS105H1/APS106H1 or equivalent; MIE236H1/ECE286H1/ECE302H1 or equivalent

PROPOSED exclusions: None

PROPOSED short course name: Data Science

PROPOSED room requirements: Windows or Linux Computer Lab for lab component

- *This new course is foundational to the data science component of our new curriculum to provide exposure to a variety of types of data and how to work with them to solve practical problems in the modern organization.*

11.3. Add new course **MIE5XXH1: Data Mining**

PROPOSED year and term: 4F

PROPOSED course description: Introduction to data mining and machine learning algorithms for very large datasets; Emphasis on creating scalable algorithms using MapReduce and Spark, as well as modern machine learning frameworks. Algorithms for high-dimensional data. Data mining and machine learning with large-scale graph data. Handling infinite data streams. Modern applications of scalable data mining and machine learning algorithms.

PROPOSED learning objectives:

1. To understand the role of modern distributed computing and machine learning frameworks in creating scalable algorithms for large datasets.
2. To understand the algorithmic principles behind popular scalable data mining and machine learning approaches.
3. To be familiar with widely used, real-world applications of such approaches.
4. To become proficient in tools that support the development of scalable data mining and machine learning algorithms (MapReduce, Spark, and modern machine learning frameworks).
5. To become proficient in the methodology and tools for working with different types of data (high-dimensional, graph data, infinite data streams).

PROPOSED Textbook:

1. Mining of Massive Datasets 3rd Edition. Leskovec, Rajaraman, and Ullman. Cambridge University Press. 2020.

PROPOSED AUs: 75% ES / 25% ED

PROPOSED timing: 3 hours / Lab: 2 hours / Tutorial: 0 hours

PROPOSED prerequisites: MIE350 or equivalent; MIE236H1/ECE286H1/ECE302H1 or equivalent; MIE2XX (Data Structures and Algorithms) or equivalent

PROPOSED exclusions: None

PROPOSED short course name: Data Mining

PROPOSED room requirements: Windows or Linux Computer Lab

- *This new course will provide students with critical knowledge and skills to successfully apply data mining and machine learning techniques on large real-world datasets.*

11.4. Add new course **MIE5XXH1: Electrification Through Electricity Markets**

PROPOSED year and term: 4S

PROPOSED course description: Challenges of Meeting Net-Zero, Fundamentals of Markets, Structures and Participants, Spot Markets, Economic Dispatch, Day-Ahead Markets, Optimal Unit Commitment, Forward Markets, Settlement Process, Storage

and Demand Management, Renewable and Distributed Energy Resources, Trading over Transmission Networks, Nodal Pricing, Reliability Resources, Generation and Transmission Capacity Investment Models, Capacity Markets.

PROPOSED textbook:

1. Fundamentals of Power System Economics, 2nd Edition by Daniel S. Kirschen and Goran Strbac. 2018. Wiley. ISBN: 978-1-119-21324-6.

PROPOSED software: https://pesd.fsi.stanford.edu/research/energy-market-game

PROPOSED AUs: 100% ES

PROPOSED timing: 3 hours / Lab: 1 hour / Tutorial: 1 hour

PROPOSED prerequisites: MIE358 or equivalent

PROPOSED exclusions: None

PROPOSED short course name: Electrification Through Markets

PROPOSED room requirements: ECF Lab

- *Increased Electrification and Net Zero targets are driving significant increases in electrical supply. This course addresses the market mechanisms in place to allow the private sector to invest in satisfying this demand, within net zero constraints. It complements the new EV minor program.*

11.5. Remove **MAT231H1: Modelling with Differential and Difference Equation**

- *This course is being replaced by MAT2XX which provides more foundation for the computational and optimization aspects of the program.*

11.6. Remove **MIE253H1: Data Modeling**

- *This course is being replaced by MAT3XX that will be introduced in 2024-25.*

11.7. Update course description for **MIE236H1: Probability**

CURRENT course description: Introduction to probability (the role of probability, exploratory data analysis and basic graphical methods). Sample space and events, Venn diagram. Definitions of probability. Axiomatic definition and basic rules. Conditional probability and Bayes' rule. Concept of random variables. Discrete, continuous, and joint distributions. Probability mass functions, density function, cumulative distribution function. Expectation, variance, and covariance. Important

discrete and continuous distributions. Multivariate normal distribution. Functions of random variables. Moment Generating functions. Central limit theorem, laws of large numbers, Markov and Chebyshev's inequalities, types of convergence. Fundamental sampling distributions, Chi-square, t, and F distributions. One sample estimation and hypothesis testing.

PROPOSED course description: Introduction to probability (the role of probability and data in engineering; concepts of population vs. sample). Sample space and events. Definitions of probability. Conditional probability and Bayes' rule. Concept of random variables. Discrete, continuous, and joint distributions. Statistical independence. Expectation, variance, covariance, and correlation. Important discrete and continuous distributions that explain engineering-related phenomena. Brief introduction to the homogeneous Poisson process and related distributions. How to derive distributions. Transformation of random variables. Fundamental sampling distributions, Chi-square, t, and F distributions. Central limit theorem, laws of large numbers. One sample estimation (methods of maximum likelihood, bootstrapping, and jackknife) and hypothesis testing.

- *No major changes. The new description flows better than the older description and follows the syllabus more closely. It also highlights where content will be briefly covered so not to significantly overlap with other courses in the program and introduces new estimation techniques of bootstrapping and jackknife.*

11.8. Update course description for **MIE237H1: Statistics**

CURRENT course description: Two sample estimation and hypothesis testing. Least squares estimation. Simple linear regression and correlation. Multiple linear regression. Linear models. Model building and model assessment. Design and analysis of single and multi-factor experiments. Analysis of variance. Randomization and blocking. Fixed and random effects models. Multiple comparisons. Sample size calculations.

PROPOSED course description: Data gathering motivation and methods (observational vs. experimental). Modeling for inference vs. prediction. Data visualizations. Two sample estimation and hypothesis testing. Choice of sample size. Fitting distributions to data. Goodness of fit tests. Simple linear regression and correlation. Multiple linear regression. Model building and model assessment. Design and analysis of single and multi-factor experiments. Analysis of variance. Fixed and random effects models. Multiple comparisons.

- *No major changes. The new description flows better than the older description and follows the syllabus more closely. It also highlights the importance of an introduction to data gathering motivation and method.*

11.9. Update title and course description for **MIE240H1: Human Centred Systems Design**

CURRENT: **MIE240H1: Human Centred Systems Design**
Introduction to principles, methods, and tools for the analysis, design, and evaluation of human-centred systems. Consideration of impacts of human physical, physiological, perceptual, and cognitive factors on the design and use of engineered systems. Basic concepts of anthropometrics, work-related hazards, shiftwork, workload, human error and reliability, and human factors standards. The human-centred systems design process, including task analysis, user requirements generation, prototyping, and usability evaluation. Design of work/rest schedules, procedures, displays and controls, and training systems; design for error prevention and human-computer interaction; design for aging populations.

PROPOSED: **MIE240H1: Human Factors Engineering**
Introduction to principles, methods, and tools for the analysis, design, and evaluation of human-centred systems. Consideration of impacts of human physical, physiological, perceptual, and cognitive factors on the design and use of engineered systems. Basic concepts of anthropometrics, work-related hazards, shiftwork, workload, human error and reliability, system complexity, and human factors standards. The human-centred systems design process, including task analysis, user requirements generation, prototyping, and usability evaluation. Design of work/rest schedules, procedures, displays and controls, and information and training systems; design for error prevention and human-computer interaction; design for accessibility and aging populations.

- *Minor changes reflecting change in emphasis in the discipline.*

11.10. Update title and course description for **MIE242H1: Psychology for Engineers**

CURRENT: **MIE242H1: Psychology for Engineers**
Introduction to neuroanatomy and processes that are core to perception, cognition, language, decision making, and action. Use of experiments to test hypotheses concerning brain activities and computations. Conducting and reporting experimental research, use of elementary statistics, and satisfaction of research ethics requirements.

PROPOSED: **MIE242H1: Foundations of Cognitive Psychology**
Introduction to neuroanatomy and processes that are core to perception, memory, executive functions, language, decision making, and action. Introduction to stress and emotions, regulation of thought and behaviour, and reward processing. Case studies in Addiction, Depression, Dementia, ADHD, and Dyslexia. Role of neuroimaging and brain

lesions in demonstrating the functioning of different pathways and regions of interest within the brain. Use of experiments to test hypotheses concerning brain activities and computations. Conducting a literature review and reporting experimental research, use of elementary statistics, and satisfaction of research ethics requirements.

- *Expanded description to reflect evolution in course content over 12 years since introduction.*

11.11. Update course description for **MIE250H1: Fundamentals of Object-Oriented Programming**

CURRENT course description: Introduction to object-oriented programming using the Java programming language with heavy emphasis on practical application; variable types; console and file input/output; arithmetic; logical expressions; control structures; arrays; modularity; functions; classes and objects; access modifiers; inheritance; polymorphism; fundamental data structures; design and implementation of programs relevant to industrial engineering needs according to strict specifications.

PROPOSED course description: Introduction to object-oriented programming using the Java programming language with heavy emphasis on practical application; variable types; console and file input/output; arithmetic; logical expressions; control structures; arrays; modularity; functions; classes and objects; access modifiers; inheritance; polymorphism; common data structures; regular expressions; GitHub; Java Swing; unit testing; introduction to complexity analysis; introduction to parallel computing; design and implementation of programs relevant to industrial engineering needs according to strict specifications.

- *Explicit inclusion of current course content (common data structures, regular expressions, complexity, parallel computing); addition of new content (GitHub, Java Swing, unit testing) to provide real-world implementation experience.*

11.12. Update title course description, and term for **MIE262H1: OR I: Deterministic OR**

CURRENT: **MIE262H1: OR I: Deterministic OR**
Introduction to deterministic operations research. Formulations of mathematical models to improve decision making; linear and integer programming; the simplex method; the revised simplex method; branch-and-bound methods; sensitivity analysis; duality; network models; network simplex method; Dijkstra's algorithm; basic graph theory; and deterministic dynamic programming.

CURRENT year and term: 2S

PROPOSED: **MIE262H1: Deterministic Operations Research**
Introduction to deterministic operations research. Formulations of mathematical models to improve decision making; linear and integer programming; the simplex method; the revised simplex method; branch-and-bound methods; sensitivity analysis; duality; network models; network simplex method; Dijkstra's algorithm; Prim's and Kruskal's algorithms; deterministic dynamic programming; applications of deterministic OR in machine learning; common metaheuristics.

PROPOSED year and term: 2F

- *Explicit inclusion of current course content (Prim's and Kruskal's algorithms); addition of new content (deterministic OR in ML, common metaheuristics) to demonstrate interaction of optimization and ML.*

11.13. Update title and course description for **MIE263H1: OR II: Stochastic OR**

CURRENT: **MIE263H1: OR II: Stochastic OR**
Modeling and analysis of systems subject to uncertainty using probabilistic methods. Introduction to decision analysis. Derivation and application of Bernoulli and Poisson processes, Markov chains, and queuing models. Stochastic optimization and extensions. Applications to engineering, games of chance, health care, and management.

PROPOSED: **MIE263H1: Stochastic Operations Research**
Modeling and analysis of systems subject to uncertainty using probabilistic methods. Derivation and application of Bernoulli and Poisson processes, Markov chains, Markov decision processes, Monte Carlo simulation, and queuing models. Applications to engineering, health care, finance, and management.

- *Removed decision analysis and added Markov decision processes.*

11.14. Update title course description, and term for **MIE335H1: Algorithms & Numerical Methods**

CURRENT: **MIE335H1: Algorithms & Numerical Methods**
Algorithmic analysis, big-O asymptotic analysis; numerical linear algebra, solution techniques for linear and non-linear systems of equations; matrix factorization, LU and Cholesky factorization, factorization in the revised simplex method; Newton's method, Gale-Shapley method, greedy methods for combinatorial optimization, branch-and-bound search methods; graph theory and graph theoretic algorithms; design and implementation of algorithms to optimize mathematical models.

CURRENT year and term: 3S

PROPOSED: **MIE2XXH1: Data Structures and Algorithms**
Introduction to algorithms (principles involved in designing, analyzing, and implementing algorithms). Basic data structures (lists, sets, maps, stacks, queues). Graphs and graph search. Decision algorithms (greedy methods and approximation algorithms). Sorting, divide-and-conquer, and recursive algorithms. Trees, heaps, and priority queues. Hashing and hash tables. Algorithmic analysis: big-O complexity. Numerical methods as examples of algorithms and big-O analysis (matrix inversion, matrix decomposition, solving linear system of equations).

PROPOSED year and term: 2S

- *Data structures allow efficient storage of and access to data. Moreover, they are crucial in efficient implementation of algorithms. Therefore, the data structure component is added to the course. This integration will not only help students to learn the true power of algorithms but also help them grasp better the algorithm design process as well as efficiency analysis also taking the appropriate choice of data structures into account. In order to be able to accommodate this major change, the following topics are removed: (i) NP-hard problems: This is in fact an advanced topic, as such had been only introduced at a very high level in the course. After learning about algorithmic complexity, students will already develop an idea about difficult problems. Without going into details, they would not benefit much from an NP-hardness discussion, nor gain skills to apply the relevant concepts themselves. (ii) Modular arithmetic and RSA encryption: The former was mostly introduced for the sake of the latter which is a nice application area for algorithms. In the revised course, the main algorithms used in this application (namely the Extended Euclidean algorithm and the modular exponentiation algorithm) will be nevertheless used as fitting examples of recursive algorithms. (iii) Unconstrained optimization (steepest descent method, and Newton's method): They had been used as applications of numerical methods. As the motivation of numerical methods is already clear, and high-level classification of the examples has been provided regardless, this particular application had been adding a very marginal value to the course.*

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Report 3727 Revised

MEMORANDUM

To: Executive Committee of Faculty Council (November 15, 2022)
Faculty Council (December 6, 2022)

From: Professor Evan Bentz
Chair, Undergraduate Curriculum Committee

Date: November 3, 2022; revised November 21, 2022

Re: **Change to Faculty Calendar regarding Transfer Credits**

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).

BACKGROUND

In recent years, there has been an increase in requests from students to complete courses at international institutions during the summer as HS/CSS credits or as credits toward a business minor. The majority of the requests are courses offered by international summer programs affiliated with post-secondary institutions; many of these courses are taught by visiting faculty and are not part of the regular curriculum of the host institution.

In the section regarding Post-Admission Transfer Credit, the Faculty Calendar currently states: “Courses should be academically rigorous and include a written examination or a significant component of closely supervised work. Students who wish to take a course at an institution outside of Canada should note that the course will be closely examined to ensure it is comparable to the academic standards of the University of Toronto. Online courses will be subject to a special review to ensure they meet the expectations of the University of Toronto.”

Given the nature of these summer programs, accurately examining the rigor and academic standards of the courses presents a challenge for transfer credit assessment.

Therefore, it is proposed that the calendar be amended to include the statement: “With the exception of official University of Toronto exchange partners, transfer credit requests will not be considered for courses taken through international summer programs attached to post-

secondary institutions outside of Canada except with the special permission from the Associate Registrar, Director of Admissions. Students interested in participating in an international exchange should contact the Centre for International Experience and their academic advisor."

CURRENT CALENDAR ENTRY

Post-Admission Transfer Credits

Post-Admission Transfer Credits are credits awarded for courses completed at another institution during the time a student is enrolled at U of T Engineering, where a Letter of Permission was not first obtained.

Courses should be academically rigorous and include a written examination or a significant component of closely supervised work. Students who wish to take a course at an institution outside of Canada should note that the course will be closely examined to ensure it is comparable to the academic standards of the University of Toronto. Online courses will be subject to a special review to ensure they meet the expectations of the University of Toronto. Post-Admission Transfer Credits are usually not awarded for core courses. Students should speak to their academic advisor prior to submitting a request for a Post-Admission Transfer Credit for a core course.

The Post-Admission Transfer Credit request form can be obtained by emailing the Registrar's Office at registrar@engineering.utoronto.ca. Students will be required to submit an official transcript and a course syllabus that contains the following information: length of the course; number of hours; grading scheme; number of essays, tests, and examinations; reading list; course instructor(s); and method of instruction (online, in-person, hybrid, etc.). A non-refundable processing fee of $40 per institution will be charged.

Post-Admission Transfer Credit requests must be submitted to the Registrar's Office no later than the term following the course's completion.

PROPOSED CALENDAR ENTRY

Post-Admission Transfer Credits

Post-Admission Transfer Credits are credits awarded for courses completed at another institution during the time a student is enrolled at U of T Engineering, where a Letter of Permission was not first obtained.

Courses should be academically rigorous and include a written examination or a significant component of closely supervised work. Students who wish to take a course at an institution outside of Canada should note that the course will be closely examined to ensure it is comparable to the academic standards of the University of Toronto. Online courses will be subject to a special review to ensure they meet the expectations of the University of Toronto. With the exception of official University of Toronto exchange partners, transfer credit requests will not be considered for courses taken through international summer programs attached to

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PROCESS AND CONSULTATION

The domain of the Undergraduate Curriculum Committee includes curriculum change and curriculum quality control. This recommendation has been reviewed and approved by the committee, which is comprised of teaching staff representatives from the Faculty's departments and institutes; undergraduate student representatives; the Vice-Dean, Undergraduate; the Vice-Dean, First Year; the Director, First Year Curriculum; the Associate Dean, Cross-Disciplinary Programs; the Assistant Dean and Director, Diversity, Inclusion and Professionalism; and the Faculty Registrar.

RECOMMENDATION FOR COUNCIL

> THAT the FASE calendar be amended regarding transfer credits, as described in Report 3727 Revised, effective immediately.

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Report No. 3726

MEMORANDUM

To: Executive Committee of Faculty Council (November 15, 2022)
Faculty Council (December 6, 2022)

From: Professor Marianne Hatzopoulou
Chair, Engineering Graduate Education Committee (EGEC)

Date: October 28, 2022

Re: **EGEC Information Update**

REPORT CLASSIFICATION

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

NEW COURSES APPROVED

BME 1550	Regenerative Medicine: Science, Manufacturing and Regulations
MIE 1770	Artificial Intelligence in Automotive and Manufacturing Applications
ROB 1830	Collaborative Specialization in Robotics Seminar Series[1]

RECOMMENDATION FOR FACULTY COUNCIL

For information.

[1] Core course for the new Collaborative Specialization in Robotics that was launched September 2022

Please contact governance.fase@utoronto.ca for Report 3730: Admissions Cycle 2022.

LEARNING TO TEACH
TEACHING TO LEARN

Modern First-Year Math Education in Engineering

We welcome all questions. Our specialties are listed below, but please do not hesitate to contact any of us.

Sa'diyya Hendrickson - sadiyya.parnell.hendrickson@mail.utoronto.ca - Learning to Learn

Shai Cohen – sh.cohen@utoronto.ca - Extracurricular resources, T-program

Fabian Parsch - fabian.parsch@utoronto.ca - Active Learning Cycle (PCEs and Teamwork)

Camelia Karimian Pour - camelia.karimian@utoronto.ca - Linear Algebra, MATLAB:

Sean Uppal - sean.uppal@utoronto.ca - Calculus I

Purpose Of This Presentation

We are …

… teachers and coordinators of the first year math courses for Core 8

… from the Department of Mathematics and ISTEP

We wish to …

...make the faculty more aware of the changes in the first-year mathematics courses in FASE over the past decade and demonstrate what additional resources would further support student learning in this new framework.

...showcase the most recent changes and the direction in which they lead.

...begin discussions about what other courses, in first year and in later years, feel has worked and what they think can be done to improve our efforts.

The Setting

Course code	Course title	Semester	Enrollment
APS 162	Calculus I	Summer	~150
APS 163	Calculus II	Fall	~60
MAT 186	Calculus I	Fall	~850
MAT 188	Linear Algebra	Fall	~1000
MAT 187	Calculus II	Winter	~950
MAT 186T	Calculus I	Winter	~50
MAT 188T	Linear Algebra	Winter	~50
MAT 187T	Calculus II	Summer	~80

Student Context

We are teaching students …

… with diverse mathematical background

… with very different lived experiences

Rather frequently, we encounter …

… less mathematical maturity

… the idea that math is about “plug and chug” and following recipes

… ingrained passive learning practices

… lack of learning skills

… feelings of anxiety and being overwhelmed

Program Wide Changes

Concepts over computations

- **Qualitative results over quantitative results**
- Mathematical modeling and problem-solving

Multiple paths to success

- Less “tentpole” assignments with heavy weight
- **Regular engagement with material**
- Standard- and attribute-based grading

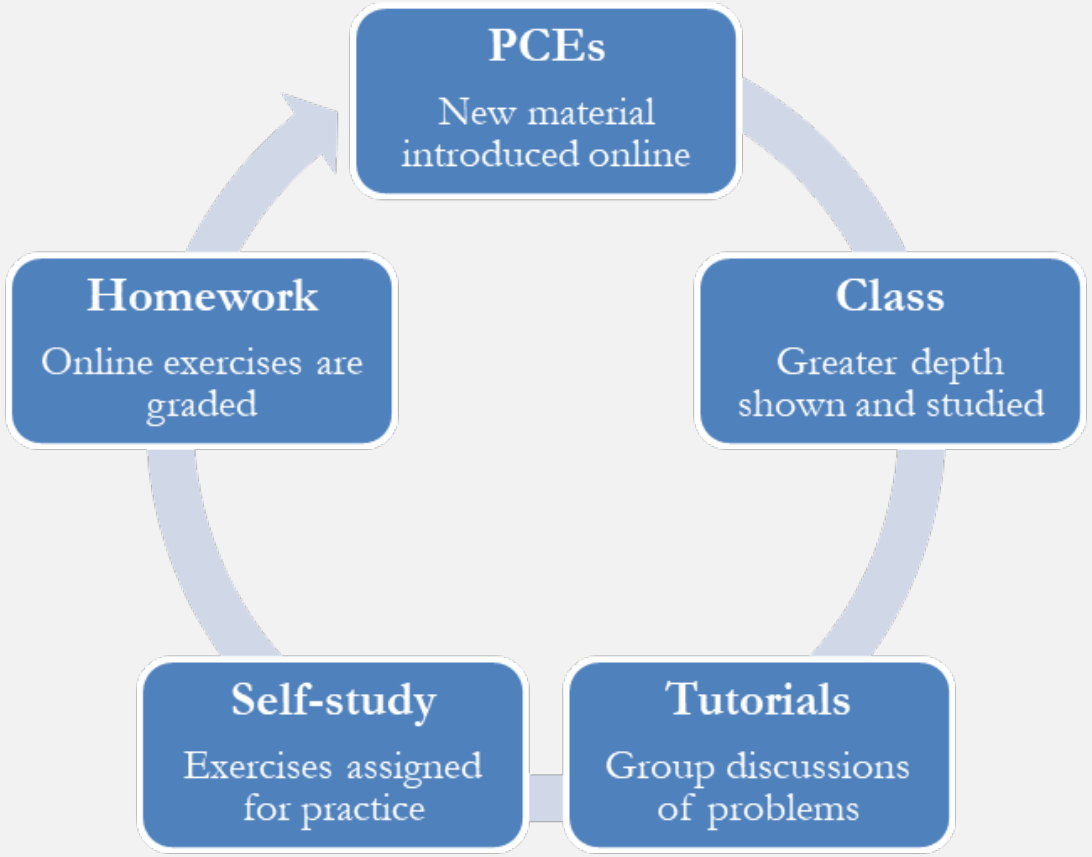
Resources added

- **Better TA/student ratio**
- Math Success Program
- Math self-assessment
- ePUMP (Preparing for University Math Program)

Collaboration and communication

- **Teamwork**
- Writing mathematics
- Math as a language
- **Assigned seating in MY150**

The Active Learning Cycle



Note: PCE = Pre-Class Essentials

Calculus II

A quote from the syllabus:

We want to train you in the art of teamwork and communication. As future engineers, you will serve an important role at the boundary between science and its applications.

You will have to talk to business partners, manufacturers, designers, construction workers, investors.

You will need to be able not just to arrive at correct mathematical answers but make others understand you, believe you, and trust you.

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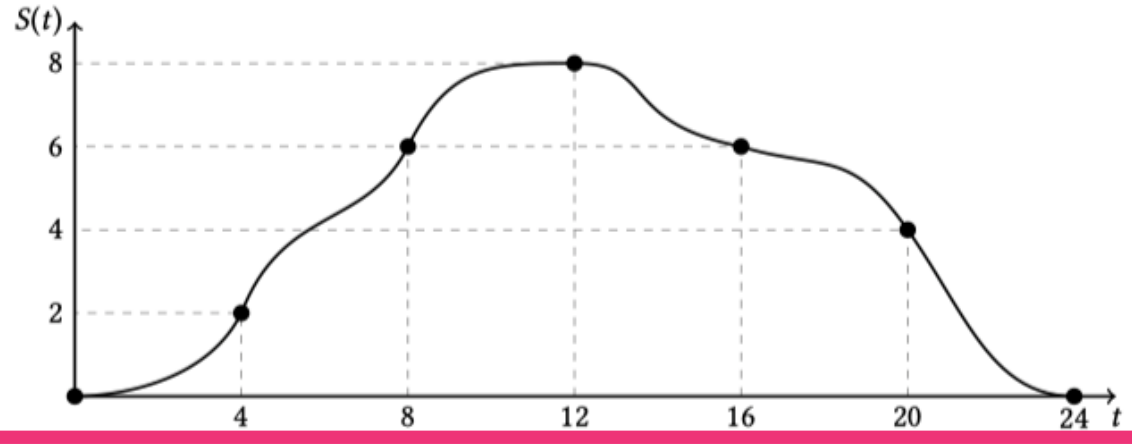
2022 Term Test 1 - Numerical integration

9. (4 marks) You a working on a risk assessment regarding the radiation experienced by astronauts on a space station. Radiation doses are measured in microsievert (μSv). Radiation is dangerous and possibly deadly to the astronauts.

Based on guidelines regarding maximal exposure and the number of days that the astronauts will be on the space station, the maximum acceptable dosage is 130 μSv in 24 hours.

The graph below shows the radiation at the station over the course of 24 hours. The radiation fluctuates due to the changing position of the station. t is given in hours and $S(t)$ is the radiation in μSv per hour.



The question is: "Is this station safe for astronauts?". Remember that the lives of these astronauts depend on you, so make sure that you can give a confident yes or no answer that is **justified**.

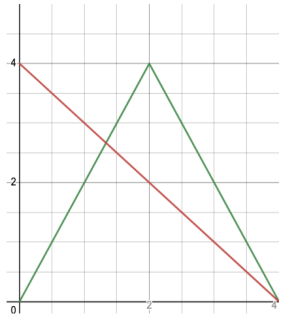
*You can use value readings from the graph, but you can **only** use values at points marked with a dot. You can also use the general behaviour of the graph between dots.*

Calculus I

Lecture: Chain Rule:

Consider the graphs of $f(x)$ and $g(x)$ pictured below. Which of the following derivatives exist? Evaluate those that do.

- $(f \circ g)'(1)$
- $(g \circ f)'(1)$
- $(f \circ g)'(2)$
- $(g \circ f)'(2)$



Assignment 3: Modelling with Differential Equations

Deer we go again.

Let $P(t)$ represent the population of deer, measured in thousands, in West Grey Bruce County (WGBC) at time t, measured in years. Suppose that the population of deer satisfies

$$\frac{dP}{dt} = aP - bP^2$$

where a and b are positive constants.

(c) If hunters in WGBC harvest exactly D_{MSY} deer per year, is it possible for the deer population survive over time? If so, under what conditions? Do you think it is a good idea for hunters to harvest D_{MSY} per year in practice? Explain.

(d) Suppose hunters in WGBC harvest deer at a rate is greater than D_{MSY} per year. By considering the graph of P versus t, explain why once the population of deer is below the inflection point, WGBC conservation officials should take immediate action to save the deer population.

Linear Algebra

Instructor support

- Lecture tasks
- Learning standards

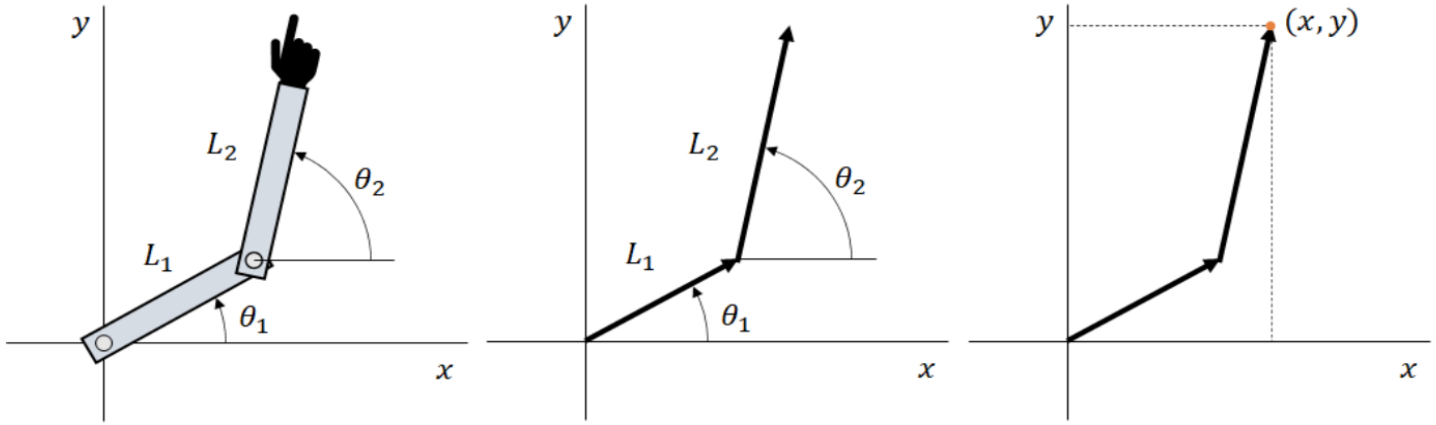
Mastery-based grading

- Standard grading in tutorials
- Online gateway exams

MATLAB projects

(project 2, Fall 2022)

You will be given the lengths of the links L_1 and L_2, as well as their angles relative to the horizontal axis θ_1 and θ_2. Using this information, the goal is to calculate the x,y-coordinates of the hand at the end of the second link as shown in Figure 1c.



Concerns And Requests

Assessments

- We aim to teach skills and virtues that are not easy to assess via traditional exams
- Modern assessments (Gateway exams, standard-based grading) requires resources and flexible policies

Workload concerns

- Not enough time to properly treat the concepts and no time to learn to retain
- For example, in Linear Algebra: from vectors in 2D to singular value decomposition + MATLAB in one term

Possible solutions

- Linear Algebra I and II + MATLAB
- A year-long separate course on MATLAB

The Counterpart: Teaching To Learn

The **teaching** of the courses has been improved, but we can also show the students how to become improved learners.

Learning how to learn

Through open and explicit communication, we can:

- Foster a **productive disposition** – the understanding that math is a learned skill and is fundamental to becoming a better engineer.
- Help students become **self-regulated learners**

This is already happening in subtle ways in our courses, but there is great benefit in making Learning How to Learn an explicit part of our course structures.

Examples

Fostering productive disposition:

- Providing materials that address:
  - students' experiences and mental health
  - university resources
  - the nature of math and how to learn it
  - active learning and its benefits

Supporting self-regulated learners:

- Offering resources that include:
  - math-specific learning strategies
  - pre-class, in-class, and after-class training checklists
  - **Learning How to Learn (LHL) corner** in lecture slides
  - how to get math help outside of class
  - tutorials that reinforce active learning practices

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Let's Play! (Pre-Class Question)

2. Suppose we need to approximate the amount of water in a 10 meter long section of creek. A cross section of the creek has depth (measured in meters) given by the function $f(x) = x^2 - 1$, for $-1 \leq x \leq 1$. Approximate the amount of water in this 10 meter long section by finding an upper and lower bound on the cross section $f(x)$.

   Hint: Begin by searching for a constant c and a function $h(x)$ such that $c \leq f(x) \leq h(x)$ for $-1 \leq x \leq 1$. Then try to improve the lower bound by finding a function $l(x)$ such that $c \leq l(x) \leq f(x) \leq h(x)$ for $-1 \leq x \leq 1$.

Need support? *Check out Page(s) 21-22 in the* ***LHL*** *(Learning How to Learn)* ***Corner*** *of these slides.*

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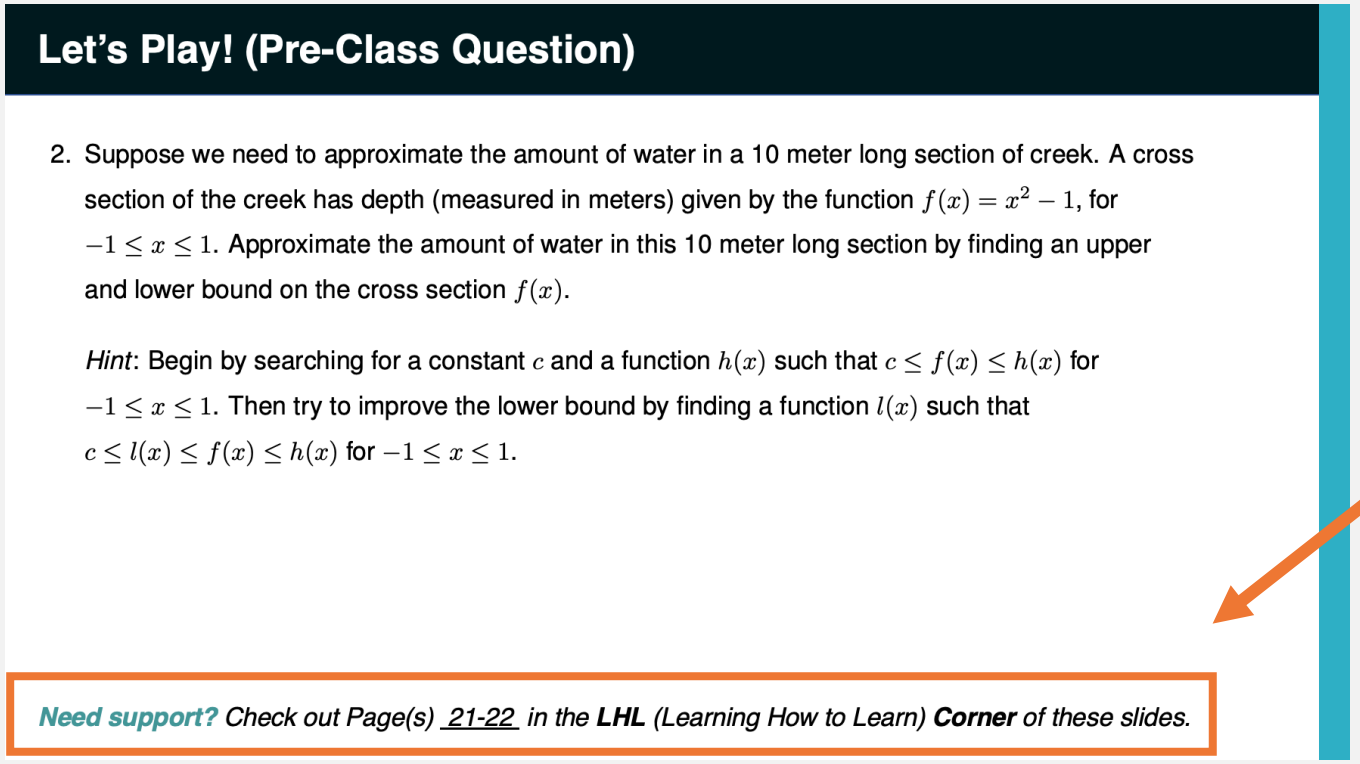

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Toolbox Checklist for #2: Building Blocks

- ❑ Utilizing General **Problem-Solving Strategies** (see Page 22)
- ❑ Understanding the *definition* of **cross section**.
- ❑ Knowledge and understanding of **popular functions** and their **graphs**.
- ❑ Understanding of the *definitions* of **upper** and **lower bounds**.

Need index cards?

Next steps: some conversation starters

- Help students prepare for the university learning experience by integrating in-class support of learning skills, existing and additional external resources, and peer support groups.

- Adopt new policies on grades that strengthen incentives for struggling students to find and use available resources.

- Create a *dialogue* with students across their courses that discusses active learning, aiming to reduce their frustration and resistance.

LEARNING TO TEACH
TEACHING TO LEARN

Modern First-Year Math Education in Engineering

Thank you!

Camelia Karimian Pour Shai Cohen Sa'diyya Hendrickson
Fabian Parsch Sean Uppal