UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Report No. 3571 Revised

MEMORANDUM

To: Executive Committee of Faculty Council (November 20, 2017)
Faculty Council (December 12, 2017)

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

Date: November 24, 2017

Re: **EGEC Information Report**

REPORT CLASSIFICATION

This is a routine or minor policy matter that has been approved by the Engineering Graduate Education Committee on behalf of Faculty Council[1]. It will be considered by the Executive Committee for endorsing and forwarding to Faculty Council for information.

NEW COURSES APPROVED

APS1049	Management Consulting for Engineers
CHE1148	Process Data Analytics

MINOR MODIFICATIONS

Emphasis in Analytics	New emphasis created (see attached proposal)
Emphasis in Advanced Water Technologies and Process Design	Name changed to Emphasis in Advanced Water Technologies
MIE1613 – Discrete Event Simulation	Course name changed to MIE1613 - Stochastic Simulation; course description also changed

RECOMMENDATION FOR FACULTY COUNCIL

For information.

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

New Emphasis in Analytics

Minor Modification: Change to an Existing Graduate Program

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

Programs being Modified:	Chemical Engineering & Applied Chemistry, MEng Civil Engineering, MEng Electrical & Computer Engineering, MEng Mechanical & Industrial Engineering, MEng
Graduate Units:	Above four
Faculty / Academic Division:	Applied Science & Engineering
Dean's Office Contact:	Julie Audet (Vice-Dean, Graduate)
Version Date:	November 24, 2017

1 Summary

	Changing Admission Requirements		*Renaming Field, Concentration or Emphasis*
	Changing Program Requirements or Length		*Renaming of Program*
	Changing Timing of Program Requirements	X	*Creating a New Emphasis*
	Adding/Removing Option (i.e. part-time, flex-time)		*Changes to Programs Affecting an MOA*

Master of Engineering (MEng) students in graduate units in the departments of Chemical Engineering & Applied Chemistry, Civil Engineering, Electrical & Computer Engineering, and Mechanical & Industrial Engineering can earn an Emphasis in Analytics by successfully completing four courses from the two lists presented on the next page. At least one (1) course must be from the list of core courses. The other courses must be selected from the list of elective courses.

Core Courses

MIE 1624H: Introduction to Data Science and Analytics
ECE 1504H: Statistical Learning

Elective Courses

APS 502H: Financial Engineering
APS 1005H: Operations Research for Engineering Management
APS 1017H: Supply Chain Management and Logistics
APS 1022H: Financial Engineering II

CHE 507H: Data-based Modelling for Prediction and Control
CHE 1148H: Process Data Analytics
CHE 1434H: Six Sigma for Chemical Processes

CIV 1504H: Applied Probability and Statistics for Civil Engineering
CIV 1506H: Freight Transportation and ITS Applications
CIV 1507H: Public Transport
CIV 1532H: Fundamentals of ITS and Traffic Management
CIV 1538H: Transportation Demand Analysis

ECE 537H: Random Processes
ECE 1505H: Convex Optimization
ECE 1510H: Advanced Inference Algorithms
ECE 1657H: Game Theory and Evolutionary Games
ECE 1778H: Creative Applications for Mobile Devices
ECE 1779H: Introduction to Cloud Computing

MIE 562H: Scheduling
MIE 1413H: Statistical Models in Empirical Research
MIE 1501H: Knowledge Modelling and Management
MIE 1512H: Data Analytics
MIE 1513H: Decision Support Systems
MIE 1620H: Linear Programming and Network Flows
MIE 1621H: Non-Linear Optimization
MIE 1622H: Computational Finance and Risk Management
MIE 1623H: Introduction to Healthcare Engineering
MIE 1653H: Integer Programming Applications
MIE 1721H: Reliability
MIE 1723H: Engineering Asset Management
MIE 1727H: Statistical Methods of Quality Assurance

2 Effective Date of Change

January 1, 2018

3 Academic Rationale

Analytics is a rapidly growing field and career opportunities in applying analytics methodologies exist in many sectors, including technology, energy, healthcare, transportation, logistics, manufacturing, marketing, public policy, and sports, among others. U of T has established the Vector Institute earlier this year, and our Faculty has developed a major in Machine Intelligence in the Division of Engineering Science, and a corresponding undergraduate minor. Rotman's new Master of Management Analytics program will be offered in the fall of 2018, and other universities are introducing similar master's programs.

This emphasis was named "Analytics" since it covers a broader range of topics than machine learning (i.e. deep learning or artificial intelligence). Machine learning is focused on making predictions. In analytics, there is a strong optimization component which is referred to as prescriptive analytics. That is, making decisions or make prescriptive actions, which goes beyond making predictions. Therefore, an emphasis in Analytics better reflects the diversity of research activities and expertise in the Faculty. The emphasis was named "Analytics", rather than "Data analytics", partially because a significant part of analytics is on developing methodologies, which are data-independent.

Given the demand, educational offerings in analytics are rapidly proliferating. The proposed Emphasis in Analytics draws upon existing courses offered by the graduate units in the four departments listed above, plus several ELITE courses. The emphasis will serve to introduce students to these methods, and over the next few years as FASE continues to build expertise and interest in this area, it is anticipated that the list of associated courses (including core courses) will grow.

Finally, it is expected that the emphasis will help highlight FASE's strength in analytics research and education, and create new opportunities to establish industrial partnerships through education.

4 Impact on Students

There are more and more career opportunities in analytics and associated methods. Students are well aware of this field, and are asking how to learn about these methods. Analytics methodologies cover the spectrum from descriptive to predictive to prescriptive analytics, including topics such as statistics, data mining, machine learning, optimization, data storage, and large-scale computing. However, analytics methods and application areas are currently spread throughout different departments and courses in FASE. By creating this Emphasis, we are highlighting to students the availability of courses in this broad area within FASE and make it easier for MEng students to pursue a more coherent course of study in analytics. Additionally, given the growing demand of students with analytics training, the emphasis will enable our students to signal to prospective employers of their exposure to this topic.

5 Consultation

This proposal was prepared by faculty in the four participating departments: Chemical Engineering & Applied Chemistry, Civil Engineering, Electrical & Computer Engineering, and Mechanical & Industrial Engineering, together with the Vice-Dean, Graduate Studies, who administers these courses and this emphasis on behalf of all graduate units in FASE. Subsequently it was reviewed by the Engineering Graduate Education Committee (EGEC).

6 Resources

None that are not already allocated.

7 Governance Approval

Unit Sign-Off	Graduate Coordinators and Chairs of each of the graduate units (Nov 13, 2017)
Dean's Office Sign-Off	Julie Audet, Vice-Dean, Graduate Studies (Nov 13, 2017)
Faculty/Division Council Approval	Approved by the Engineering Graduate Education Committee (EGEC) on behalf of the Council of the Faculty of Applied Science & Engineering (Nov 13, 2017). Will be presented to the Council of the Faculty of Applied Science & Engineering for information (December 12, 2017)

Appendix A: Calendar Entry

Emphasis: Analytics

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

Core Courses

MIE 1624H
ECE 1504H

Elective Courses

APS 502H, APS 1005H, APS 1017H, APS 1022H

CHE 507H, CHE 1148H, CHE 1434H

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

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

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