UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Report No. 3403 Revised

MEMORANDUM

To: Executive Committee of Faculty Council

From: Dr. Graeme Norval
Chair, Undergraduate Curriculum Committee

Date: November 14, 2013 for December 11, 2013 Faculty Council Meeting

Re: Minor Curriculum Changes for 2014-2015 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).

BACKGROUND

The Undergraduate Curriculum Committee is tasked with managing the curriculum change process for the Faculty. This report summarizes the program course changes for the upcoming academic year.

STRUCTURE

First Year Program

Merging MAT186F/MAT196F as well as MAT187S/MAT197S

When the two calculus streams were originally created more than 14 years ago, the intent was to provide FASE students with a basic applied stream (MAT186/187) and a more rigorous theoretical stream (MAT196/197). Originally, students within the Core 8 programs chose the stream that they would like to take, but eventually, the more advanced stream only became available to ECE and TrackOne students. At the time, the ECE program had one of the highest entering admissions averages, so it was reasonable to provide a more challenging calculus stream for these students.

Over the past eight years, these two calculus streams have slowly merged such that they are now both teaching the same core mathematical concepts and the current course descriptions are no longer valid. The primary reason for this convergence is the fact that all Core 8 departments are now admitting very high quality students and there is no longer the same discrepancy in the departmental entering admissions averages as there once was. Currently

these two course streams use two different textbooks and are coordinated by different instructors. By merging these streams, there will be a more consistent delivery of this core calculus content through a single coordinator (for each course) and one textbook, which can then be used in upper-year departmental calculus courses.

The proposed changes to the course descriptions are:

MAT186 – Calculus I – Current Course Description
Topics include: limits, differentiation, maximum and minimum problems, definite and indefinite integrals, application of integration in geometry, mechanics and other engineering problems.

MAT196 – Calculus A – Current Course Description
Topics include: limits and continuity, differentiation, maximum and minimum problems, definite and indefinite integrals, application of integration to geometry, mechanics and other engineering problems as well as an introduction to first order differential equations.

MAT186 – Calculus I – New Course Description (with MAT196 removed from the calendar)
Topics include: limits and continuity; differentiation; applications of the derivative – related rates problems, curve sketching, optimization problems, L'Hopital's rule; definite and indefinite integrals; the Fundamental Theorem of Calculus; applications of integration in geometry, mechanics and other engineering problems.

MAT187 – Calculus II – Current Course Description
Topics include: techniques of integration, an introduction to differential equations, vector differentiation, partial differentiation, series and application to mechanics and other engineering problems.

MAT197 – Calculus B – Current Course Description
Topics include: techniques of integration, introduction to second order differential equations, sequences and series, vector-valued functions, functions of several variables, partial differentiation and applications to mechanics and other engineering problems.

MAT187 – Calculus II – New Course Description (with MAT197 removed from the calendar)
Topics include: techniques of integration, an introduction to mathematical modeling with differential equations, infinite sequences and series, Taylor series, parametric and polar curves, vector-valued functions, partial differentiation, and application to mechanics and other engineering problems.

Subsequent changes to the calendar include:

The removal of MAT196 and MAT197 from the calendar will result in the following required changes within the FASE calendar:

1. The TrackOne program description and the first-year Electrical Engineering and Computer Engineering program descriptions would need to be updated.
2. The exclusions for APS162/163 would need to be changed.

It is proposed to change the course description for MAT188 as follows:

MAT188 – Linear Algebra – Current Course Description
This course covers systems of linear equations, matrices, determinants, vectors, lines and planes in three dimensions, Rn, vector spaces, eigenvalues and eigenvectors as well as an introduction to products and applications.

MAT188 – Linear Algebra – Proposed New Course Description
This course covers systems of linear equations and Gaussian elimination, applications; vectors in Rn, independent sets and spanning sets; linear transformations, matrices, inverses; subspaces in Rn, basis and dimension; determinants; eigenvalues and diagonalization; systems of differential equations; dot products and orthogonal sets in Rn; projections and the Gram-Schmidt process; diagonalizing symmetric matrices; least squares approximation.

Cross-Disciplinary Programs

Several changes to the approved course lists for the Minors are proposed.

Environmental Engineering Minor:
- Add CHE460 – Environmental Pathways and Impact Assessment to list of core credits (two from a selection of five courses). This will provide students with an alternative to CIV440 which has had challenges with waitlists and instructors.

Engineering Business Minor:
- Add HPS321 – Understanding Engineering Practice: From Design to Entrepreneurship, as an elective. This course has been "on the books" but not offered by HPS for a number of years; they are interested in reviving now as an elective for the minor. This is an FAS course, which will be targeted to Engineering, but open to students from both faculties.
- Add APS 4XX (1) – Positive Psychology for Engineers, created for the Leadership Certificate, as an elective.
- Add APS4XX (2) – The Power of Story, created for the Leadership Certificate, as an elective.

Robotics and Mechatronics Minor:
- Add AER5XX – Mobile Robotics and Perception, a new course for Engineering Science, as an advanced elective.

Bioengineering Minor:
- Add BME2XX (1) – Biomedical Design and BME2XX (2) – Biostatistics, created to support the Biomedical Engineering Minor, to the Bioengineering Minor as introductory electives.

- Remove BME510 since the course is only officially open to students in Engineering Science's Biomedical Systems Engineering Option. Any students outside this Option who receive special permission from the instructor to take the course can still request to have it count towards the minor.

Engineering Science

The proposed changes impact the upper years only.

ESC301 – Engineering Science Option Seminar will have a modified course description indicating that issues such as safety, professionalism and ethics will be included; further, the course weighting will be enhanced (0.25 rather than 0.1). There will also be common lectures for all students.

The course AER334F – Numerical Methods is being cancelled as it has not been offered for several years. The course AER310F – Gasdynamics will have the prerequisite (AER202 – Fluid Mechanics) removed as the pre-requisite is no longer offered. A new course, AER5XXS – Mobile Robotics and Perception is proposed and the set of electives will be modified to accommodate the new elective. (The course addresses fundamentals of mobile robotics and sensor-based perception for applications such as space exploration, search and rescue, mining, self-driving cars, unmanned aerial vehicles, autonomous underwater vehicles, etc. Topics include sensors and their principles, state estimation, computer vision, control architectures, localization, mapping, planning, path tracking, and software frameworks. Laboratories will be conducted using both simulations and hardware kits.)

The Biomedical Engineering Option will be removed from the calendar; all remaining students will be in the Biomedical Systems Engineering Option.

The course BME350F – Biomedical Systems Engineering 1: Organ Systems will have a modified delivery (3/1/2 rather than the current 3/4/0), and a modified course description ("An introduction to human anatomy and physiology with selected focus on the nervous, cardiovascular, respiratory, renal, and endocrine systems. The structures and mechanisms responsible for proper function of these complex systems will be examined in the healthy and diseased human body. The integration of different organ systems will be stressed, with a specific focus on the structure-function relationship. Application of biomedical engineering technologies in maintaining homeostasis will also be discussed.").

The course BME428F – Biomedical Systems Engineering IV: Computational Systems Biology will have a modified delivery (3/3/1 rather than the current 3/0/2), and a modified course description ("Through systematic mathematical analysis of biological networks, this course derives design principles that are cornerstones for the understanding of complex natural biological systems and the engineering of synthetic biological systems. Course material includes: transcriptional networks, autoregulation, feed-forward loops, global network structure, protein networks, robustness, kinetic proofreading and optimality. After completion of the course, students should be able to use quantitative reasoning to analyze biological systems and construct mathematical models to describe biological systems.").

A new elective is proposed: ECE3XXF/S – Communication Systems with a description of "An introductory course in analog and digital communication systems. Analog and digital signals. Probability and random processes. Energy and power spectral densities; bandwidth. Distortionless analog communication; amplitude, frequency and phase modulation systems; frequency division multiplexing. Sampling, quantization and pulse code modulation (PCM). Baseband digital communication; intersymbol interference (ISI); Nyquist's ISI criterion; eye diagrams. Passband digital communications; amplitude-, phase- and frequency-shift keying; signal constellations. Performance analysis of analog modulation schemes in the presence of noise. Performance analysis of PCM in noise." The course ECE455F – Digital Signal Processing, will move from core to elective, and the descriptions of the allowable electives will be adjusted.

The course CIV359S will have a name change to "Road Transportation Performance" and a modified course description ("A deep understanding of the behaviour and performance of road systems is fundamental to transportation engineering and planning. This course provides an in-depth exploration of the performance characteristics of highway and street systems that provides the basis for the design of road networks and operating systems, including Intelligent Transportation Systems for real-time control of roadways. Theoretical principles and practical applications concerning roadway performance are discussed, including facility capacity, speed-flow relationships, operational control, measurement of performance and safety. Driver behaviour and route choice and the demand-supply relationship between driver behaviour and system performance are examined in detail. Non-motorized (walking and cycling) system performance is also introduced.").

The Infrastructure Option will eliminate the explicit listing of 1000-level courses, as the listing of the course in the undergraduate calendar is not consistent with SGS policy. A note will be added to indicate that students are allowed to take courses that are not explicitly listed, with approval (which is current FASE policy and consistent with SGS policy). A footnote will be added that explains that students may take a half-year thesis in the winter term if they shift a Specialty Elective to the fall term.

Electrical and Computer Engineering

Three core second-year courses will have a change in contact hours; the next change is one additional scheduled tutorial.

ECE216H1 S Signals and Systems	3/-/2/0.50	to	3/1/2/0.50
ECE221H1 S Electric and Magnetic Fields	3/1/1/0.50	to	3/1/2/0.50
ECE297H1 S Communication and Design	2/3/2/0.50	to	2/2/2/0.50

Currently, students in ECE216S have simulation assignments that are not conducted under close supervision. The added 12 hours (four labs) does not reflect additional work for the student while reflecting the AU properly.

One additional tutorial hour will be added to ECE221S, allowing the tutorial to be delivered more effectively.

One lab hour is removed from ECE297S. This course has traditionally been criticized for having an extremely heavy workload. ECE has steadily reduced the amount of workload in the past few years. An internal student survey in 2013S term indicates that students are still spending and average of 35% of their time on this course. The reduction of the lab hour is a more accurate reflection of the actual delivery of the course. At the same time, the Committee hopes that second-year ECE students can make better judgement on their time management using the listed contact hours for each course.

The course ECE510F – Introduction to Lighting Systems will have the pre-requisite of ECE314F removed, as it is no longer required.

The course ECE524F – Microwave Circuits will have the prerequisite of ECE320F removed, as it is no longer required.

The course ECE512F – Analog Signal Processing Circuits will have a modified course description ("An overview of analog signal processing in both continuous-time and discrete-time. The design of analog filters including transfer function specification and circuit implementation. The partitioning and specification of mixed analog-digital systems including filters, data converters (analog-to-digital and digital-to-analog), and clocking. Prerequisite: ECE331H1 or ECE354H1."). The course ECE530S – Analog Integrate Circuits with have a modified course description ("Review of MOSFET semiconductor device equations. Noise in electronic devices. Review of single-stage amplifiers and frequency response, including noise analysis. Basic CMOS op amp. Op amp compensation. Advanced op amp circuits: telescopic and folded-cascode op amps. Fully-differential op amps. Common mode feedback. Prerequisite: ECE331H1 or ECE354H1."). The course content will be redistributed between these courses.

Materials Science and Engineering

The course MSE330F – Introduction to Polymer Engineering will be renumbered as MSE432S – Macromolecular Materials Engineering; the exclusion to CHE562F will be removed.

Mechanical and Industrial Engineering

The course MIE241 – Mechanical Engineering Design will have a modified course description ("Introduction to basic mechanical parts and mechanisms: gears, cams, bearings, linkages, actuators and motors, chain and belt drives, brakes and clutches, hydraulics and pneumatics. Tutorials on engineering drawing, sketching, and CAD/CAM in SolidWorks: views and drawing types, 2D sketching, 3D modeling and engineering drawing generation, modeling of assembly and motion analysis/animation.").

Several new elective courses are proposed:

MIE5XXS – Advanced Momentum, Heat and Mass Transfer ("Conservation of mass, momentum, energy and species; Diffusive momentum, heat and mass transfer; Dimensionless equations and numbers; Laminar boundary layers; Drag, heat transfer and mass transfer coefficients; Transport analogies; Simultaneous heat and mass transfer; Evaporative cooling, Droplet evaporation, Diffusion flames.").

MIE5XX – Computational Fluid Dynamics ("The course is designed for Students with no or little CFD knowledge who want to learn CFD application to solve engineering problems. The course will provide a general perspective to the CFD and its application to fluid flow and heat transfer and it will teach the use of some of the popular CFD packages and provides them with the necessary tool to use CFD in specific applications. Students will also learn basics of CFD and will use that basic knowledge to learn Fluent Ansys CFD software. Most CFD packages have a variety of modules to deal with a specific type of flow. Students will be introduced to different modules and their specific applications. They will then be able to utilize the CFD package to simulate any particular problem. Ansys software will be the commercial package that will be used in this course. Ansys Fluent is the most common commercial CFD code available and most of the engineering companies use this code for their research & development and product analysis.").

MIE5XX – Engineering Analysis ("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. Prerequisites: MIE230, MAT234, MIE 334.").

It is proposed that the course APS1002 – Financial Engineering be renumbered to APS502, so that it is available to fourth-year students.

Mineral Engineering

In March 2013, in order to address issues raised by the CEAB program visitor, MIN401H1S – Mineral Reserve and Mineral Resource Estimation and MIN470H1S – Ventilation and Occupational Health became core courses. Due to this change (previously approved by Faculty Council), all courses for fourth-year winter for the MIN program became core, resulting in no technical elective choices for the students in term 4W.

In order to rectify this, MIN401H1S will move to term 3W, and be renumbered, resulting in students having six courses in term 3W (five core and one HSS/CS) rather than in term 4W. Term 4W will become three core courses: one HSS/CS and one technical elective.

The recent CEAB accreditation report identified a lack of Rock Mechanics laboratories in the curriculum. Student will perform four laboratories of three hours each. The program has developed content for the laboratory as follows:

A: Stress measurement
Stress, strain and in situ stress are covered in lecture sessions 1, 2 and 3. By loading a block of rock containing a CSIRO Hollow Inclusion cell within an inclined hole, students will learn how to apply 3D Hooke's law and undertake the calculations necessary to determine the applied stress state.

B: Core logging
Geometric characterization of rock masses (i.e. linear discontinuity frequency, rock quality designation) and discontinuity surface characteristics are introduced in lecture sessions 5 and 7. Students will learn how to determine these characteristics from direct measurement of core, and will come to fully appreciate the difficulty involved in obtaining these key data.

C: Uniaxial compression testing of anisotropic rock
The strength of rock is introduced in sessions 6 and 7. Through testing of samples containing anisotropic fabric at various orientations, students will confirm the effect of anisotropy on rock strength and stiffness.

D: Index testing
Index testing is introduced in lecture session 8 in the context of accuracy and precision, and heterogeneity of rock masses. This laboratory session will expose students to Pundit ultrasonic testing on rocks of different properties and at different states (e.g. water content and applied stress), Schmidt Rebound Hammer and Point Load testing. As a result, students will appreciate the variability of index properties and the value of index testing in rock engineering.

E: Direct shear testing of rock discontinuities
The shear strength of discontinuities is introduced in session 7. Each group will test a specimen at a specific normal stress and shearing direction to learn the effect of shearing on a discontinuity surface; results from all groups will be combined to allow understanding of effect of stress/orientation on behaviour.

The MIN429 – Engineering Rock Mechanics course will be modified by inclusion of the laboratory and a change to the course description ("This course introduces students to the fundamental concepts of rock mechanics and their application to rock engineering. The following rock mechanics topics are covered: stress and strain; in situ stress; intact rock strength; discontinuity geometry, strength and stiffness; rock mass behaviour; anisotropy, heterogeneity and the size effect; rock mass classification schemes. Rock engineering topics include: rock excavation; rock stabilization; instability mechanisms in foundations and slopes; rock slope design methods; underground openings in discontinuous and continuous rocks; rock-support interaction; synopsis of numerical methods. Associated laboratory sessions involve stress measurement, core logging, compressive strength determination and index testing.").

PROCESS

The Undergraduate Curriculum Committee is composed of representatives from each program; the Vice-Dean, Undergraduate Studies; the Chair, First Year; the Associate Dean, Cross-Disciplinary Programs; and the Registrar's Office. The Committee meets regularly, and reviews changes to the curriculum.

These changes conform with common practice in most programs in the Faculty, and thereby bring the calendar in-line with practice.

PROGRAMS

All programs are involved in these changes, and the impact on students in the various programs has been considered.

RECOMMENDATION AND MOTION FOR FACULTY COUNCIL

THAT the proposed curriculum changes for the 2014-2015 academic year be approved.