Calendar Home

One Hundred and Twenty Second Session

The Calendar on the Engineering and Applied Science website is an official publication of the Faculty Board. This Calendar is the prevailing and official record of the academic regulations, academic plans of study, descriptions of courses of instruction, and requirements for graduation in all undergraduate plans in the Faculty. It can only be amended by Faculty Board. Amendments will be recorded in the Minutes of the Board and are included in the on-line Calendar (http://engineering.queensu.ca/Calendars/)

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Glossary

Academic Plan

A specified combination of courses leading to a degree in a particular subject.

Academic Program

Refers to the degree program of study that a student is pursuing, i.e., Bachelor of Science or special programs such as UASC, UBUS, UEDU.

Associate Dean (Academic)

In charge of undergraduate studies for the Faculty.

AU

Academic Units, numerically equal to CEAB Accreditation Units.

Board of Trustees

The senior administrative body of the University.

Bursary

Financial award for a student in need.

Calendar

An official publication of academic regulations, plans of study, descriptions of courses of instruction, and requirements for graduation.

CEAB

Canadian Engineering Accreditation Board.

Challenge Examinations

Tests of competence in First Year subjects at the beginning of the year.

CS: Complementary Studies

Topics in Engineering Economics, Communications, Management, Humanities and Social Sciences, Linkage and Professional Issues, and Performance Arts and Languages.

Confidential Examination

An examination paper recovered after the examination and withheld from circulation or publication.

Core

Those courses which are a mandatory part of an academic plan.

Corequisites

Courses which must be taken at the same time as the course in question, or have previously been taken and passed.

Credit

To attribute to an academic record, the accreditation units for a similar course of instruction.

Dean

The Chief Executive Officer of the Faculty.

Department

A subdivision of the Faculty responsible for a particular subject or group of related subjects, or an academic plan.

ECGPA

Engineering Cumulative Grade Point Average - see Regulation 16c for definition.

EGGPA

Engineering Graduation Grade Point Average - see Regulation 16d for definition.

Electives

A group of courses from which a specified number must be chosen to satisfy part of the requirements for the degree.

Engineering Design

Development of elements, systems and processes using mathematics, science and engineering science to meet specific needs and constraints.

Engineering Science

Application of mathematics and basic sciences to the identification and solution of engineering problems.

Engineering Session

Defined as the Fall and Winter terms of the academic year, provided the student is registered in the FEAS for both of these sessions.

Engineering student

A student registered in the FEAS.

ESGPA

Engineering Sessional Grade Point Average - see Regulation 16b for definition.

Exemption

A required course replaced in an academic plan by relevant Work Experience plus an equivalent number of Accreditation Units extra to the academic plan approved by the Operations Committee.

Extended Program

An extension of Year One into the spring term allowing more time for the study of mathematics, chemistry and physics to assist first year students having difficulties in those subjects.

Faculty Board

The Committee charged with overseeing all academic matters in the Faculty.

FEAS

Faculty of Engineering and Applied Science.

GPA

Grade Point Average - see Regulation 16a for definition.

H & SS

Humanities and Social Sciences.

IAESTE

International Association for the Exchange of Students for Technical Experience.

Internship

A twelve or sixteen month period in industry, arranged by the University, for academic credit.

Letter of Permission

A formal document allowing a student to take a course at another institution in lieu of one in the student's regular academic plan.

Natural Sciences

Physics, Chemistry, Earth and Life Sciences.

Operations Committee

A standing committee of Faculty Board which deals with Admissions, Scholarships, Academic Progress, and Curriculum matters.

P.Eng.

Professional Engineer, registered by a Provincial licensing authority.

PEO

Professional Engineers Ontario: The licensing authority in Ontario.

Prerequisites

Courses which must be passed before the course in question can be taken.

Principal

The Chief Executive Officer of the University.

Prior Learning Assessment (PLA)

Challenge Examinations in First Year Subjects.

QUIP

Queen's Undergraduate Internship Program.

Reading Week

A period in which classes are suspended in favour of independent study.

Regular Session

A Regular Session normally consists of the Fall and Winter terms of instruction. In the case of first year students registered in the Extended Program, the Regular Session includes the Spring term.

Regulations

The rules established by the Faculty Board and by the Senate by which a student's academic progress and deportment are governed.

Reread

The reassessment of a student's final paper in a course, on appeal.

SAL

Student Assistance Levy.

Scholarship

A financial award based on academic merit.

Senate

The University's senior academic board.

SOLUS

Student On-Line University System

Sub-plan

One of two or more streams within an academic plan: eg., the Chemical Process Sub-plan in Chemical Engineering.

Substitution

Replacement of a required course, stipulated in the calendar, by another course, with the approval of the Operations Committee.

SURP

School of Urban and Regional Planning.

Term

A period of instruction, usually of 12 weeks duration.

Transcript

A document provided by the Registrar's Office that lists the entire academic record-to-date of a student in the University. An Official Transcript is certified by the Registrar.

Transfer Credit

Credit allowed for a course taken in another Faculty or at another institution.

Withdrawal

A formal process for discontinuing studies in a course or in an academic plan.

Important Dates

Dates apply to the Fall-Winter academic year beginning in September 2015. See Sessional Dates for a complete list.

Registration	Fall: 1 September	SOLUS becomes available to complete the final step of the registration process for students who have pre-registered and pre-paid.
	1 Sept	Tuition payment or Alternate Payment Arrangement due.
	Winter: 10 January	Last day to register without financial penalty for students not registered in any other courses.
Orientation Week	7 - 11 Sept.	

Late Registration		a. After 25 September, students must submit a written appeal for late registration to the Operations Committee. If the appeal is grated, the late fee will apply b. After 1 November (after 1 Feb-winter term) no more registrations are accepted.
Classes Begin and End	Fall: 14 Sept	Classes begin
	4 December	Classes end
	Winter: 4 January	Classes begin
	1 April	Classes end
	Spring: 2 May	Classes begin
	10 June	Classes end
Adding and Dropping Courses		
Beginning 1 September, students can add and drop courses on SOLUS. The Chair of Undergraduate Studies in the specific academic plan must be advised when a course is dropped. Verbal requests to course instructors and/or absence from class are not sufficient and usually result in failure and loss of fee refund.		
Adding	25 September	Last date to add Fall Term courses and Fall-Winter courses.
	15 January	Last date to add Winter Term courses.
Dropping	Fall: 1 Sept	Last date to obtain full refund **
	25 September.	Last date to drop voluntarily
	Fall-Winter: 1 Sept	Last date to obtain full refund **
	15 Jan.	Last date to drop voluntarily
	Winter: 1 Jan	Last date to obtain full refund **

Complete Withdrawal from the University	25 September (January 15 for the winter term)	Last date to withdraw and obtain a full refund **
	22 January	Last date to withdraw from academic plan without failed year.
Student and Bus-It cards must be returned for full or partial refunds of student interest fees.		
Reading Week	15-19 February	
	1 March	Academic Plan Selection for First Year Students Deadline
Exam Dates	Fall: 9-23 December	
	Winter: 7-23 April	
Convocation	Fall	17/18 November
	Spring	TBA
Pre-registration 2016	Classes begin Get "Appointment Date" (pre-registration start date & time) from SOLUS starting approximately 20 June. Select courses on SOLUS from "Appointment Date" start date & time until end of pre-registration period.	
** Information on late registration fees, refunds, and fees in general is provided in the Guide to Registration and Fees issued by the Registrar's Office. Fees information is also available at http://queensu.ca/registrar/financials/tuition-fees		

Dates for Extended Program for Section 900 Courses		
11	January	Extended Program classes begin for Fall courses.
22	January	Last day to add a Fall Extended Program course.

25	January	Last day to drop a Fall Extended Program course.
15-19	February	Extended Program Fall course examinations.
22	February	Extended Program classes begin for Winter courses.
26	February	Last day to drop a Regular Academic Plan Winter term course.
29	February	Last day to drop APSC 151 and/or APSC 161 rewrite examination.
29	February	Last day to add APSC 151 and/or APSC 161 rewrite examination in April.
7	March	Last day to add a Winter Extended Program course.
28	March	Last day to drop a Winter Extended Program course.
1	May	Extended Program fees due.
2	May	Extended Program Spring term begins.
10	June	Extended Program classes end.
13-17	June	Extended Program Winter course examinations.

Undergraduate Academic Plan

Structure and Definitions

The Faculty of Engineering and Applied Science offers degree programs in ten academic plans. Plans nominally of four years' duration lead to the degree of Bachelor of Science in Engineering. Five-year plans, which include an Internship, lead to the degree of Bachelor of Science in Engineering with Professional Internship. The codes for these plans and the prefix used throughout this Calendar for the courses in those disciplines are given below. **The First Year is common to all academic plans.**

Program	*Program Code*	*Course Prefix*
Chemical Engineering	CHEE	CHEE
Civil Engineering	CIVL	CIVL
Computer Engineering	CMPE	SOFT, CMPE or ELEC
Electrical Engineering	ELEC	ELEC

Engineering Chemistry	ENCH	ENCH
Engineering Physics	ENPH	ENPH
Geological Engineering	GEOE	GEOE
Mathematics and Engineering	MTHE	MTHE
Mechanical Engineering	MECH	MECH
Mining Engineering	MINE	MINE
Faculty Courses		APSC
Multi-department Courses		MDEP

There are five major components to each of these academic plans:

MATHEMATICS Elements of algebra, calculus, differential equations, probability, statistics and numerical analysis;
NATURAL SCIENCE Elements of Physics and Chemistry, and in some plans, elements of Earth and Life Sciences;
ENGINEERING SCIENCES Extension of Mathematics and Basic Sciences toward creative applications;
ENGINEERING DESIGN The application of Mathematics, Science, and Engineering Science to meet specific needs; and
COMPLEMENTARY STUDIES Topics in Engineering Economics, Communications, Management, Humanities and Social Sciences, Linkage and Professional Issues, and Performance Arts and Languages. Engineering Sciences and Engineering Design constitute about half of the plan in each case, with the other components approximately equal to each other in weight.

Program Accreditation and Licensing The licensing of engineers in Canada is a provincial and territorial matter. Bodies such as Professional Engineers Ontario (PEO) are established by statute to govern the profession. The Canadian Council of Professional Engineers (CCPE) is the national federation of these governing bodies. A standing committee of CCPE, the Canadian Engineering Accreditation Board (CEAB), is responsible for identifying those educational programs that meet the academic standards required for membership in the profession. From time to time the Faculty of Engineering and Applied Science submits its academic plans to the CEAB for review. All of the academic plans in the Faculty of Engineering and Applied Science are accredited by the CEAB.

Note: *Effective May 1, 2011, the Faculty of Engineering and Applied Science moved each course weight from accreditation units (AU) to credit units. This means, for example, that instead of a weighting of 36 AU, a course will now count as 3 credits. In order to determine the new credit weighting for each course, the AU was divided by 12 and, if needed, rounded to the nearest quarter (0.25, 0.50 or 0.75).*

Academic Plan and Course Symbols and Codes: Plans are identified by a four-letter code (see table above). Courses are identified by:- a four letter code and a three digit number (the first of which identifies the year of the plan in which the course would normally be taken - i.e. 174 is a year one course); - a title; - a letter or letters indicating the term (F=Fall, W=Winter, FW=Fall **AND**Winter, F/W=Fall **OR** Winter, S=Summer, N/O=Not Offered);- a series of numbers indicating the units assigned to lectures (1 credit = one 50 minute lecture) and to laboratory assignments, tutorial, and significant project work (0.5 credits = one hour).

For example, the codes for a typical entry are:

- APSC 174 Introduction to Linear Algebra W | 3.5

This is a Faculty course normally taken in the first year. It is offered in the Winter term, will have 36 fifty-minute lectures (3 lectures per week); no lab; twelve hours in tutorials (one hour per week). The final number is the sum of the accreditation units, and represents the weight of the course. A section on Course Descriptions appears elsewhere in this Calendar.

Requirements for Graduation The minimum number of Accreditation Units required for graduation is stipulated for each of the academic plans in the Faculty. These minimum form part of the curriculum of each plan as described later in the Degree Program section of this Calendar. The minimum number varies from plan to plan, but in the current year all are greater than 1950 AU.

Minimum Requirements for CEAB Accreditation

The Canadian Engineering Accreditation Board (CEAB) requires all that all graduates from accredited engineering programs have Academic Units (AUs) at the time of graduation which meet ALL the following conditions 1-3:

1. Minimum AUs in the following five categories:

M	195AU	Mathematics
NS	195AU	Natural Science
CS	225AU	Complementary Studies
ES	225AU	Engineering Science
ED	225AU	Engineering Design

2. The sum of the AUs in these five categories shown above must be at least **1950 AUs.**
3. Two sums of categories must also meet minimum requirements as shown below e.g. the sum of AUs in Mathematics and Natural Sciences must be at least 420 AU, and the sum of AUs in Engineering Science and Engineering Design must be at least 900 AU:

M+NS	420AU	Mathematics(195 AUs or more) + Natural Science (195 AUs or more)
ES+ED	900AU	Engineering Science (225 AUs or more) + Engineering Design (225 AUs or more)

4. Within the broad five categories, it is expected that time will be spent on such topics as safety procedures, public and worker safety, ethics, equity, and concepts of sustainable development and of environmental stewardship.

   The number of AUs in each of the five categories is listed at the end of each course description in the calendar (provide a link to the calendar). The AUs are listed in the format of (M/NS/CS/ES/ED). For example:

   - MECH 230 Thermodynamics I F | 3.5

   An introductory course in thermodynamics. Topics include: properties and behaviour or pure substances, concepts of heat, work and energy, the First and Second Laws of Thermodynamics, and the analysis of a variety of power and refrigeration cycles. (0/33/0/9/0)

   The numbers in parentheses at the end of the course description are the AUs. This course has 0 Math AUs, 33 Natural Science AUs, 0 Complementary Studies AUs, 9 Engineering Science AUs, and 0 Engineering Design AUs.

This course involves three lectures hours and one tutorial hour per week for the twelve weeks of the Fall term and therefore is assigned a weight of 3.5 credits which equates to 42 (AU) accreditation units. Of these, 33 units deal with topics in the Basic Sciences, and 9 are in Engineering Science. The course contains no Mathematics per se, no Complementary Studies, and no Engineering Design.

Proficiency Test in Written English

Students in all academic plans are required to demonstrate the ability to communicate effectively in written English. Within their first term, students registering in the Faculty for the first time must attempt a written English Proficiency Test. Students who do not pass on the initial attempt will have further opportunities, and may need to pass the test or an equivalent test to meet the prerequisite for further instruction in communication required by the program. A student must pass the English Proficiency Test or an equivalent test, approved by the Associate Dean (Academic), to be eligible for graduation. Students may take advantage of the Faculty's English Support for Engineers program, and programs offered by the Writing Centre (http://sass.queensu.ca/writingcentre/).

Dual Degrees

Dual degrees are offered by the Faculty of Arts and Science can be taken concurrently with a degree in Engineering and Applied Science. Students must apply for admission through the Admission Services Office after one year at Queen's. To be accepted into a Dual Degree program in Engineering and Applied Science, you must have a minimum cumulative GPA of 2.60 or higher. The application deadline for summer term entry is **1 April**, fall term entry is **1 June** and for winter term entry is **1 December**. Candidates must have completed at least one year of study in their current academic plan and must be in good academic standing. Dual Degree programs will normally take at least five years of study, although some combinations of programs will be longer. Usually the path to be followed is intricate and requires the advisement of the Dual Degree Coordinator in the Engineering and Applied Science program. Dual Degree students share 60.0 units from their Engineering degree with their Arts and Science degree. Students must register in additional courses required for their 2nd degree and these additional courses must all be completed at Queen's. Fees for courses registered under the Arts and Science degree will be assessed according to the Faculty of Arts and Science. Further information can be found at http://engineering.queensu.ca/Undergraduate-Programs/Dual-Degrees/index.html

Integrated Learning

Director: Kim Woodhouse
NSERC Chair in Design Engineering: David Strong
Operations Manager: Simon Smith
Student Services, Faculty of Engineering and Applied Science: Room 300
Telephone (613) 533 6772
Fax Number (613) 533 2721
E-mail Address: ilc@queensu.ca
Web Site: http://engineering.queensu.ca/Integrated-Learning-Center/
Beamish-Munro Hall is the home of Integrated Learning, a focus for undergraduate engineering activities at Queen's. This multidisciplinary learning environment has been designed to support problem-based, project-based learning, enhancing design, team and professional skills development. Information on Integrated Learning may be found on the web site, http://engineering.queensu.ca/Integrated-Learning-Center/. Those wishing more information are invited to visit Beamish-Munro Hall, to telephone (613) 533 2055, or to write to ilc@queensu.ca.

Professional Internship Program

The Professional Internship Program allows qualified students the opportunity to pursue career related positions for 12 or 16 months after completion of their second or third year of study at Queen's. (This program is available to students in all programs in the Faculty.)

Employers request applications from third year students more frequently than from second year students, but internships have been arranged for both. Job openings under this program are posted by Career Services throughout the year.

In addition to the industrial experience for which the intern earns a salary, the Program includes prior workshops on resume preparation, interviewing, work performance, and employer expectations. Successful completion of the program requires submission of a formal report or presentation, and a satisfactory assessment of the intern's performance by the Employer. Up to twelve months of the work may meet the criteria for professional work experience required for licensure as a Professional Engineer in Canada.

The 12-month program requires registration in three courses, and the 16-month program requires registration in four courses - each course is 1-term in duration. These are: APSC 301, APSC 302, APSC 303, and APSC 304. There is a special academic fee for these courses. (See the section on Fees in this Calendar.)

Details on the Internship Program can be obtained from the Career Services Office in Gordon Hall, and from their website at http://careers.queensu.ca/. The Engineering and Applied Science Internship Coordinator is George Sweetman, sweetmng@queensu.ca.

University Exchange Programs

The Faculty of Engineering and Applied Science offers student exchanges with other universities around the world. An exchange student can spend one year (two terms or one term) at the host university in a program approved by the Department and the Operations Committee. In most instances the student canl satisfy the requirements for graduation from Queen's in the usual four-year time frame. Details on these programs and a list of the host institutions can be found at http://engineering.queensu.ca/Undergraduate-Programs/Exchange-Programs.html Details on the IAESTE program can be obtained from the Queen's University International Centre, John Deutsch University Centre.

Non-academic Student Services and Resources

Information on the services and resources available to students at Queen's, such as housing, medical services, and student activities, can be found on the Dean of Student Affairs web page at http://www.queensu.ca/studentaffairs/departments.html, or the Faculty general web address at http://engineering.queensu.ca/. The services of the Engineering Society are listed at http://engsoc.queensu.ca.

First Years Studies

First Year Studies, B.Sc.

The first year of study in Engineering and Applied Science is based on a common curriculum and serves as an introduction to all of the academic plans offered by the Faculty. The choice of academic plan the student intends to follow in the second and subsequent years is made in February in the Winter Term of the first year.

First Year Curriculum

- APSC 100 Engineering Practice I S | K11

- APSC 111 Mechanics F | 3.5
- APSC 112 Electricity and Magnetism W | 3.5
- APSC 131 Chemistry and Materials F | 3.5
- APSC 132 Chemistry and its Applications W | 3.5
- APSC 142 Introduction to Computer Programming for Engineers F/W | 3
- APSC 151 Earth Systems and Engineering F | 4
- APSC 161 Engineering Graphics F | 3.5
- APSC 171 Calculus I F | 3.5
- APSC 172 Calculus II W | 3.5
- APSC 174 Introduction to Linear Algebra W | 3.5

Minimum Total Credits: 46

Challenge Examinations in Year One Subjects: Prior Learning Assessment

Exceptionally well qualified applicants who feel that their preparation would allow them to follow an accelerated plan of study are encouraged to write challenge examinations that are available in most of the First Year courses. These examinations are usually written during the first week of term in September and are only available to those students who have not yet started any classes in Engineering and Applied Science. Application to write should be made to the First Year Program Assistant, (613) 533-2055, engineering.reception@queensu.ca, before 31 July. There is a special fee for each Challenge examination (see the section on Fees.)

Credit will be granted for those First Year courses in which competence is indicated by the results of the challenge examinations. A student may then elect to reduce the First Year curriculum by those courses for which exemption has been obtained, or elect to undertake an accelerated curriculum by replacing those courses with more advanced courses. Students who wish to preserve their eligibility for scholarship standing will need to formulate a program which provides the same or greater unit load as the standard First Year curriculum.

First Year Advice and Counseling

First Year students looking for academic advice and counseling are encouraged to contact the Program Associate, Student Services, Faculty of Engineering and Applied Science by phone at 533-2055 or by email at engineering.first.year@queensu.ca.

The Douglas Tutorials

A gift from Dr. James Douglas (Queen's BA, 1858) in 1910 made possible the establishment of a program by which First Year students are tutored by students selected from senior years. Details are available in the Faculty Office, and on the web at http://engineering.queensu.ca/Current-Students/First-Year-Studies/DouglasTutorials.html

The EngSoc Engvents

The Engvents Committee's mandate is to connect engineering students of all years and disciplines through team based competitions and social events hosted throughout the year. Past events have included paintballing, dodgeball tournaments, bowling nights, amazing race style scavenger hunts, and even a Boat Cruise on Lake Ontario! So come on out, connect with fellow engineers, and have a great time with Engvents! If you have any questions or would like to get involved with Engvents, contact engvents@engsoc.queensu.ca.

The EngSoc 'EngLink' System

For help using the EngSoc 'EngLink' system, see http://englinks.ca/

The Extended Program

The Extended Program provides an opportunity for First Year students who experience difficulties with the introductory courses APSC 111, APSC 131, and/or APSC 171 in the fall semester to retake these courses in the winter semester. Registration in the Extended Program takes place in early January. The courses normally completed in December are reviewed, and final examinations are rewritten in February during Reading Week. Instruction in the second term courses in APSC 112, APSC 132, APSC 172 and APSC 174 begins after Reading Week, is suspended when regular Winter term lectures end, and resumes after the normal examination period. These second term courses are completed in June. There is a special fee for each course in the Spring term (see the Section on Fees) *

Orientation Nights

In late January and early February each department holds an Orientation Night for first year students to introduce them to the department and to its academic plan(s). Students are encouraged to attend as many of these evening seminars as possible to help them make their plan choice. Help in reaching a decision regarding future studies can also be obtained in private discussions with upper year students, instructors, and the Program Associate, Student Services in the Faculty Office. Help is available on web pages maintained the departments in the Faculty (see http://engineering.queensu.ca/Current-Students/First-Year-Studies/DisciplineOrientationSchedule.html).

Choice of Program: Preregistration

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Admission to a Second Year Program

The rules governing the admission to the second year are given in the Faculty Regulations Section: in particular, Regulations 2b, 2f, 2g, and 10. Briefly, if a student has passed all of the courses in the First Year plan with marks of 1.6 ECGPA or better, admission to the second year will be unconditional. Otherwise, there may be constraints. Advice should be sought from the Faculty Office, or from the Chair of Undergraduate Studies in the program of choice.

Academic Plans

First Year, Engineering and Applied Science

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Chemical Engineering

Department Head P.J. McLellan
Undergraduate Chair M. Guay
Undergraduate Assistant L.D. Joanette

Office Dupuis Hall, Room 205
Telephone (613) 533-6000 Ext. 74829
E-mail undergrad@chee.queensu.ca
Departmental Web Site http://www.chemeng.queensu.ca

The Chemical Engineering academic plan provides students with a versatile engineering experience based on fundamental chemical and biochemical engineering concepts, while strengthening knowledge in chemistry and mathematics. Students may elect to pursue the Chemical Process Engineering Sub-plan (CHE1) or the Bioengineering - Biochemical, Biomedical, Bioenvironmental Sub-plan (CHE2). In addition to the technical content of the plan, students are introduced to business skills (technical communication, technical entrepreneurship, process economics and project management). In fourth year, students work in groups on design projects and select from courses involving client-based industrial consulting projects, or research projects under the supervision of academic staff or professional engineers.

Ancillary Fees

Chemical Engineering and Engineering Chemistry students may be required to pay ancillary fees for course related learning materials, safety equipment and field trips. A compulsory one-time $10 fee for an I-Class token providing students 24-hour access during the academic school year (September to May) to Dupuis Hall as well as to the Department's computer cluster. Computer equipment within the cluster is equipped with software programs that are required for use in various CHEE courses. The fee is payable to the Department of Chemical Engineering, Dupuis Hall, Room 201 (debit or credit card only please).

Biochemical Engineering - Biochemical/Biomedical Stream Sub-Plan, B. Sc. (2016)

Second Year CORE 2013-2014

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- CHEE 229 Cell Based Engineering Principles F | 4
- ENCH 211 Main Group Chemistry F | 4.5
- ENCH 212 Principles of Chemical Reactivity F | 3.75
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- CHEE 210 Thermodynamic Properties of Fluids W | 3.5
- CHEE 218 Laboratory Projects I W | 2.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 245 Applied Organic Chemistry I W | 3.5

Minimum Total Credits: 45.25

Third Year CORE 2014-2015

- CHEE 310 Fundamentals of Engineering Innovation and Entrepreneurship F | 3.5
- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5

- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 342 Environmental Biotechnology F | 3.5 [1]
- CHEE 380 Biochemical Engineering F | 3.5
- CHEE 315 Laboratory Projects II F/W | 4 [2]
- CHEE 319 Process Dynamics and Control W | 3.5
- CHEE 332 Design of Unit Operations W | 3.5
- CHEE 360 Technical Communications W | 1.5
- CHEE 370 Waste Treatment Processes W | 3.5
- ELECTIVE Technical Elective (Minimum 3 Credits) F/W | 3 [3]
- ELECTIVE Complementary Studies, List A, B, C or D (3 Credits) F/W | 3 [3]

Minimum Total Credits: 43

[1] *CHE2a students take CHEE 342 in 3rd year and CHEE 340 in 4th year. CHE2a students may replace CHEE 342 with an elective from the CHE1 Group A TECH list.*

[2] *CHE2 students are preloaded into the winter term of CHEE 315 to maintain a balanced course load, but can switch sections and/or terms with the instructor's permission.*

[3] *Electives can be taken in either the fall or winter term, but recommend taking electives in winter term to maintain a balanced course load.*

Fourth Year CORE 2015-2016

- CHEE 418 Strategies for Process Investigations F | 3.5
- CHEE 452 Transport Phenomena in Physiological Systems F | 3.5
- CHEE 470 Design of Manufacturing Processes F | 6.25
- CHEE 340 Biomedical Engineering W | 3.5 [1]
- ELECTIVE Technical Electives (Minimum 6 Credits) F or W | 6
- ELECTIVE Complementary Studies, List A, B, C or D (6 Credits) F or W | 6

Plus One Of:

- APSC 400 Technology, Engineering and Management (TEAM) FW* | 6.5
  OR
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
  OR
- CHEE 405 Biochemical/Biomedical Research Project FW | 7

Minimum Total Credits: 35.25

[1] *CHE2a students take CHEE 342 in 3rd year and CHEE 340 in 4th year. CHE2a students may replace CHEE 342 with an elective from the CHE1 Group A TECH list.*

Technical Electives

In some cases, a course on this list is already core for a Sub-plan, and that course is therefore excluded as an elective for that Sub-plan. Some of these elective courses may not be available to students due to pre-requisite course requirements. The student is responsible for confirming that he/she has the necessary prerequisites or permission of the instructor.

Course availability and the term in which a course is held can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to SOLUS to find out if the TECH course is offered this upcoming year.

Students in the Biochemical Engineering Sub-plan - Biochemical/Biomedical Stream (CHE2a) must take a minimum of 9 credits in technical electives. One (1) technical elective must be taken from the CHE1 Group A List and two (2) technical electives from the Biochemical/Biomedical stream list.

Students in the Biochemical Engineering Sub-Plan take the following technical electives.

1. One (1) technical elective must be taken from the CHE1 Group A list.
2. Two (2) technical electives from the relevant stream sub-plan list (CHE2a Biochemical/Biomedical stream or CHE2b Environmental stream).

Chemical Process Engineering Sub-plan: Technical Electives

Complementary Studies

Students choose 9 credits from the approved Lists A, B, C, or D of which 6 credits must be taken from List A. Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Economics

To meet the engineering economics requirement, students take CHEE 310 (this is a CORE course).

Communications

To meet the communications course requirement, students take APSC 293 and CHEE 360 (these are CORE courses).

Biochemical Engineering - Environmental Stream Sub-Plan, B. Sc. (2016)

Second Year CORE 2013-2014

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- CHEE 229 Cell Based Engineering Principles F | 4
- ENCH 211 Main Group Chemistry F | 4.5
- ENCH 212 Principles of Chemical Reactivity F | 3.75
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- CHEE 210 Thermodynamic Properties of Fluids W | 3.5
- CHEE 218 Laboratory Projects I W | 2.5

- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 245 Applied Organic Chemistry I W | 3.5

Minimum Total Credits: 45.25

Third Year CORE 2014-2015

- CHEE 310 Fundamentals of Engineering Innovation and Entrepreneurship F | 3.5
- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 342 Environmental Biotechnology F | 3.5
- CHEE 380 Biochemical Engineering F | 3.5
- CHEE 315 Laboratory Projects II F/W | 4 [1]
- CHEE 319 Process Dynamics and Control W | 3.5
- CHEE 332 Design of Unit Operations W | 3.5
- CHEE 360 Technical Communications W | 1.5
- CHEE 370 Waste Treatment Processes W | 3.5
- ELECTIVE Technical Elective (Minimum 3 Credits) F or W | 3 [2]
- ELECTIVE Complementary Studies List A, B D or D (3 Credits) F or W | 3 [2]

Minimum Total Credits: 43

[1] *CHE2 students are preloaded into the winter term of CHEE 315 to maintain a balanced course load, but can switch sections and/or terms with the instructor's permission.*

[2] *Electives can be taken in either the fall or winter term, but recommend taking electives in winter term to maintain a balanced course load.*

Fourth Year CORE 2015-2016

- CHEE 418 Strategies for Process Investigations F | 3.5
- CHEE 452 Transport Phenomena in Physiological Systems F | 3.5
- CHEE 470 Design of Manufacturing Processes F | 6.25
- CHEE 340 Biomedical Engineering W | 3.5 [1]
- ELECTIVE Technical Electives (Minimum 6 Credits) F or W | 6
- ELECTIVE Complementary Studies, List A, B, C or D (6 Credits) F or W | 6

Plus One Of:

- APSC 400 Technology, Engineering and Management (TEAM) FW* | 6.5
  OR
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
  OR
- CHEE 406 Bioenvironmental Research Project FW | 7

Minimum Total Credits: 35.25

[1] *CHE2b students may replace CHEE 340 with an elective from the CHE1 Group A List.*

Technical Electives

In some cases, a course on this list is already core for a Sub-plan, and that course is therefore excluded as an elective for that Sub-plan. Some of these elective courses may not be available to students due to pre-requisite course requirements. The student is responsible for confirming that he/she has the necessary prerequisites or permission of the instructor.

Course availability and the term in which a course is held can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to SOLUS to find out if the TECH course is offered this upcoming year.

Students in the Biochemical Engineering Sub-plan - Environmental Stream (CHE2b) must take a minimum of 9 credits in technical electives. One (1) technical elective must be taken from the CHE1 Group A List and two (2) technical electives from the Environmental stream list.

Students in the Biochemical Engineering Sub-Plan take the following technical electives.

1. One (1) technical elective must be taken from the CHE1 Group A list.
2. Two (2) technical electives from the relevant stream sub-plan list (CHE2a Biochemical/Biomedical stream or CHE2b Environmental stream).

Chemical Process Engineering Sub-plan: Technical Electives

Complementary Studies

Students choose 9 credits from the approved Lists A, B, C, or D of which 6 credits must be taken from List A.

Engineering Economics

To meet the engineering economics requirement, students take CHEE 310 (this is a CORE course).

Communications

To meet the communications course requirement, students take APSC 293 and CHEE 360 (these are CORE courses).

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Bioengineering - Biochemical, Biomedical, Bioenvironmental Sub-Plan, B. Sc. (2017)

Second Year CORE 2014-2015

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5

- CHEE 229 Cell Based Engineering Principles F | 4
- ENCH 211 Main Group Chemistry F | 4.5
- ENCH 212 Principles of Chemical Reactivity F | 3.75
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- CHEE 210 Thermodynamic Properties of Fluids W | 3.5
- CHEE 218 Laboratory Projects I W | 2.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 245 Applied Organic Chemistry I W | 3.5

Minimum Total Credits: 45.25

Third Year CORE 2015-2016

- CHEE 310 Fundamentals of Engineering Innovation and Entrepreneurship F | 3.5
- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 342 Environmental Biotechnology F | 3.5 [1]
- CHEE 380 Biochemical Engineering F | 3.5
- CHEE 315 Laboratory Projects II F/W | 4 [2]
- CHEE 319 Process Dynamics and Control W | 3.5
- CHEE 332 Design of Unit Operations W | 3.5
- CHEE 340 Biomedical Engineering W | 3.5 [1]
- CHEE 360 Technical Communications W | 1.5
- CHEE 370 Waste Treatment Processes W | 3.5
- ELECTIVE Complementary Studies List A, B D or D (3 Credits) F/W | 3 [3]

Minimum Total Credits: 43.5

[1] *Depending on their interest in biomedical or environmental, CHE2 students may replace either CHEE 340 or CHEE 342, but not both, with a Group A TECH.*

[2] *CHE2 students are preloaded into the winter term of CHEE 315 to maintain a balanced course load, but can switch sections and/or terms with the instructor's permission.*

[3] *Electives can be taken in either the fall or winter term, but recommend taking electives in winter term to maintain a balanced course load.*

Fourth Year CORE 2016-2017

- CHEE 418 Strategies for Process Investigations F | 3.5
- CHEE 452 Transport Phenomena in Physiological Systems F | 3.5
- CHEE 470 Design of Manufacturing Processes F | 6.25
- ELECTIVE Technical Elective (Minimum 9 Credits) F/W | 9

- ELECTIVE Complementary Studies, List A, B, C or D (6 Credits) F/W | 6

Plus One Of:

- APSC 400 Technology, Engineering and Management (TEAM) FW* | 6.5
  OR
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
  OR
- CHEE 408 Bioengineering Research Project FW | 7

Minimum Total Credits: 34.75

Technical Electives

In some cases, a course on this list is already core for a Sub-plan, and that course is therefore excluded as an elective for that Sub-plan. Some of these elective courses may not be available to students due to pre-requisite course requirements. The student is responsible for confirming that he/she has the necessary prerequisites or permission of the instructor.

Course availability and the term in which a course is held can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to SOLUS to find out if the TECH course is offered this upcoming year.

Students in the Bioengineering - Biochemical, Biomedical, Bioenvironmental Sub-plan (CHE2) must take a minimum of 9 credits in technical electives. One (1) technical elective must be taken from the CHE1 Group A List and two (2) technical electives from the Group C list.

Students in the Bioengineering – Biochemical, Biomedical, Bioenvironmental Sub-plan take the following technical electives:

1. One (1) technical elective must be taken from the CHE1 Group A list.
2. Two (2) technical electives from the Group C list.

Chemical Process Engineering Sub-plan: Technical Electives

Complementary Studies

Students choose 9 credits from the approved Lists A, B, C, or D of which 6 credits must be taken from List A. Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Economics

To meet the engineering economics requirement, students take CHEE 310 (this is a CORE course).

Communications

To meet the communications course requirement, students take APSC 293 and CHEE 360 (these are CORE courses).

Bioengineering - Biochemical, Biomedical, Bioenvironmental Sub-Plan, B. Sc. (2018)

Second Year CORE 2015-2016

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- CHEE 229 Cell Based Engineering Principles F | 4
- ENCH 211 Main Group Chemistry F | 4.5
- ENCH 212 Principles of Chemical Reactivity F | 3.75
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- CHEE 210 Thermodynamic Properties of Fluids W | 3.5
- CHEE 218 Laboratory Projects I W | 2.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 245 Applied Organic Chemistry I W | 3.5

Minimum Total Credits: 45.25

Third Year CORE 2016-2017

- CHEE 310 Fundamentals of Engineering Innovation and Entrepreneurship F | 3.5
- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 342 Environmental Biotechnology F | 3.5 [2]
- CHEE 380 Biochemical Engineering F | 3.5
- CHEE 315 Laboratory Projects II F/W | 4 [1]
- CHEE 319 Process Dynamics and Control W | 3.5
- CHEE 332 Design of Unit Operations W | 3.5
- CHEE 340 Biomedical Engineering W | 3.5 [2]
- CHEE 360 Technical Communications W | 1.5
- CHEE 370 Waste Treatment Processes W | 3.5
- ELECTIVE Complementary Studies List A, B D or D (3 Credits) F/W | 3 [3]

Minimum Total Credits: 43.5

[1] *CHE2 students are preloaded into the winter term of CHEE 315 to maintain a balanced course load, but can switch sections and/or terms with the instructor's permission.*

[2] *Depending on their interest in biomedical or environmental, CHE2 students may replace either CHEE 340 or CHEE 342, but not both, with a Group A TECH.*

[3] *Electives can be taken in either the fall or winter term, but recommend taking electives in winter term to maintain a balanced course load*

Fourth Year CORE 2017-2018

- CHEE 418 Strategies for Process Investigations F | 3.5
- CHEE 452 Transport Phenomena in Physiological Systems F | 3.5
- CHEE 470 Design of Manufacturing Processes F | 6.25
- ELECTIVE Technical Elective (Minimum 9 Credits) F/W | 9
- ELECTIVE Complementary Studies, List A, B, C or D (6 Credits) F/W | 6

Plus One Of:

- APSC 400 Technology, Engineering and Management (TEAM) FW* | 6.5
  OR
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
  OR
- CHEE 408 Bioengineering Research Project FW | 7

Minimum Total Credits: 34.75

Technical Electives

In some cases, a course on this list is already core for a Sub-plan, and that course is therefore excluded as an elective for that Sub-plan. Some of these elective courses may not be available to students due to pre-requisite course requirements. The student is responsible for confirming that he/she has the necessary prerequisites or permission of the instructor.

Course availability and the term in which a course is held can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to SOLUS to find out if the TECH course is offered this upcoming year.

Students in the Bioengineering - Biochemical, Biomedical, Bioenvironmental Sub-plan (CHE2) must take a minimum of 9 credits in technical electives. One (1) technical elective must be taken from the CHE1 Group A List and two (2) technical electives from the Group C list.

Students in the Bioengineering – Biochemical, Biomedical, Bioenvironmental Sub-plan take the following technical electives:

1. One (1) technical elective must be taken from the CHE1 Group A list.
2. Two (2) technical electives from the Group C list.

Chemical Process Engineering Sub-plan: Technical Electives

Complementary Studies

Students choose 9 credits from the approved Lists A, B, C, or D of which 6 credits must be taken from List A. Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Economics

To meet the engineering economics requirement, students take CHEE 310 (this is a CORE course).

Communications

To meet the communications course requirement, students take APSC 293 and CHEE 360 (these are CORE courses).

Chemical Engineering - Chemical Process Engineering Sub-Plan, B. Sc. (2018)

Second Year CORE 2015-2016

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- CHEE 224 Transport Phenomena Fundamentals F | 3
- ENCH 211 Main Group Chemistry F | 4.5
- ENCH 212 Principles of Chemical Reactivity F | 3.75
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- CHEE 210 Thermodynamic Properties of Fluids W | 3.5
- CHEE 218 Laboratory Projects I W | 2.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 245 Applied Organic Chemistry I W | 3.5

Minimum Total Units: 44.25

Third Year CORE 2016-2017

- CHEE 310 Fundamentals of Engineering Innovation and Entrepreneurship F | 3.5
- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 315 Laboratory Projects II F/W | 4 [1]
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 380 Biochemical Engineering F | 3.5
- CHEE 319 Process Dynamics and Control W | 3.5
- CHEE 323 Industrial Catalysis W | 3.5
- CHEE 331 Design of Unit Operations W | 3.5
- CHEE 360 Technical Communications W | 1.5
- CHEE 370 Waste Treatment Processes W | 3.5
- ELECTIVE Complementary Studies List A, B, C or D (3 credits) F/W | 3
- ELECTIVE Technical Electives (minimum 3 credits) F/W | 3 [2]

Minimum Total Units: 43

[1] *CHE1 students are preloaded into the fall term of CHEE 315 (instructor's request), but can change sections and/or terms with the instructor's permission.*

[2] *Electives can be taken in either the fall or winter terms, but recommend taking in winter term to maintain a balanced course load.*

Fourth Year CORE 2017-2018

- CHEE 418 Strategies for Process Investigations F | 3.5
- CHEE 470 Design of Manufacturing Processes F | 6.25
- CHEE 412 Transport Phenomena in Chemical Engineering W | 3.5
- ELECTIVE Technical Elective (minimum 6 credits) F/W | 6
- ELECTIVE Complementary Studies List A, B, C or D (6 credits) F/W | 6

Plus Two Of:

- APSC 400 Technology, Engineering and Management (TEAM) FW* | 6.5
  OR
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
  OR
- CHEE 421 Research Project FW | 7
  OR
- CHEE 420 Laboratory Projects III F/W | 4 [1]
  AND
- Technical Elective (Group A or Group B) F/W | 3 [1]

Minimum Total Credits: 38.75

[1] *CHEE 420 and a TECH elective from either Group A or Group B count together as one choice.*

Technical Electives

In some cases, a course on this list is already core for a Sub-plan, and that course is therefore excluded as an elective for that Sub-plan. Some of these elective courses may not be available to students due to pre-requisite course requirements. The student is responsible for confirming that he/she has the necessary prerequisites or permission of the instructor.

Course availability and the term in which a course is held can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to SOLUS to find out if the TECH course is offered this upcoming year.

Students in the Process Engineering Sub-plan (CHE1) must take a minimum of nine (9) credits in technical electives of which a minimum of three (3) credits must be from the CHE1 Group A technical electives list and the remaining six (6) credits from either the CHE1 Group A or Group B technical electives list.

Chemical Process Engineering Sub-plan: Technical Electives

Complementary Studies

Students choose 9 credits from the approved Lists A, B, C, or D of which 6 credits must be taken from List A. Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Economics

To meet the engineering economics requirement, students take CHEE 310 (this is a CORE course).

Communications

To meet the communications course requirement, students take APSC 293 and CHEE 360 (these are CORE courses).

Chemical Engineering - Chemical Process Engineering Sub-Plan, B. Sc. (2016)

Second Year CORE 2013-2014

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- ENCH 211 Main Group Chemistry F | 4.5
- ENCH 212 Principles of Chemical Reactivity F | 3.75
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- CHEE 210 Thermodynamic Properties of Fluids W | 3.5
- CHEE 218 Laboratory Projects I W | 2.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 245 Applied Organic Chemistry I W | 3.5
- ELECTIVE Complementary Studies List A, B D or D (3 credits) F or W | 3[1]

Minimum Total Credits: 44.25

[1] *Electives can be taken in either the fall or winter term, but recommend taking in the fall term for course load balance.*

Third Year CORE 2014-2015

- CHEE 310 Fundamentals of Engineering Innovation and Entrepreneurship F | 3.5
- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 315 Laboratory Projects II F/W | 4 [1]
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 380 Biochemical Engineering F | 3.5
- CHEE 319 Process Dynamics and Control W | 3.5
- CHEE 331 Design of Unit Operations W | 3.5
- CHEE 360 Technical Communications W | 1.5

- CHEE 370 Waste Treatment Processes W | 3.5
- ELECTIVE Technical Electives F or W | 9 (minimum 9 credits) [2]

Minimum Total Credits: 42.5

[1] *CHE1 students are preloaded into the fall term of CHEE 315 (instructor's request), but can change sections and/or terms with the instructor's permission.*

[2] *Electives can be taken in either the fall or winter terms, but recommend taking in winter term to maintain a balanced course load.*

Fourth Year CORE 2015-2016

- CHEE 418 Strategies for Process Investigations F | 3.5
- CHEE 470 Design of Manufacturing Processes F | 6.25
- CHEE 412 Transport Phenomena in Chemical Engineering W | 3.5
- ELECTIVE Complementary Studies List A, B D or D (6 credits) F/W | 6
- ELECTIVE Technical Electives (minimum 3 credits) F/W | 3

Plus Two Of:

- APSC 400 Technology, Engineering and Management (TEAM) FW* | 6.5
  OR
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
  OR
- CHEE 421 Research Project FW | 7
  OR
- CHEE 420 Laboratory Projects III F/W | 4 [1]
  AND
- Technical Elective (minimum 3 credits; Group A or Group B) 3 [1]

Minimum Total Credits: 35.75

[1] *CHEE 420 and a TECH elective from either Group A or Group B count together as one choice.*

Technical Electives

In some cases, a course on this list is already core for a Sub-plan, and that course is therefore excluded as an elective for that Sub-plan. Some of these elective courses may not be available to students due to pre-requisite course requirements. The student is responsible for confirming that he/she has the necessary prerequisites or permission of the instructor.

Course availability and the term in which a course is held can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to SOLUS to find out if the TECH course is offered this upcoming year.

Students in the Process Engineering Sub-plan (CHE1) must take a minimum of twelve (12) credits in technical electives of which a minimum of six (6) credits must be from the CHE1 Group A technical electives list and the remaining six (6) credits from either the CHE1 Group A or Group B technical electives list.

Chemical Process Engineering Sub-plan: Technical Electives

Complementary Studies

Students choose 9 credits from the approved Lists A, B, C, or D of which 6 credits must be taken from List A. Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Economics

To meet the engineering economics requirement, students take CHEE 310 (this is a CORE course).

Communications

To meet the communications course requirement, students take APSC 293 and CHEE 360 (these are CORE courses).

Chemical Engineering - Chemical Process Engineering Sub-Plan, B. Sc. (2017)

Second Year CORE 2014-2015

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- ENCH 211 Main Group Chemistry F | 4.5
- ENCH 212 Principles of Chemical Reactivity F | 3.75
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- CHEE 210 Thermodynamic Properties of Fluids W | 3.5
- CHEE 218 Laboratory Projects I W | 2.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 245 Applied Organic Chemistry I W | 3.5
- ELECTIVE Complementary Studies List A, B, C or D (3 credits) F/W | 3 [1]

Minimum Total Units: 44.25

[1] *Electives can be taken in either the fall or winter term, but recommend taking in the fall term for course load balance.*

Third Year CORE 2015-2016

- CHEE 310 Fundamentals of Engineering Innovation and Entrepreneurship F | 3.5
- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 315 Laboratory Projects II F/W | 4 [1]
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5

- CHEE 380 Biochemical Engineering F | 3.5
- CHEE 319 Process Dynamics and Control W | 3.5
- CHEE 323 Industrial Catalysis W | 3.5
- CHEE 331 Design of Unit Operations W | 3.5
- CHEE 360 Technical Communications W | 1.5
- CHEE 370 Waste Treatment Processes W | 3.5
- ELECTIVE Technical Electives (minimum 6 credits) F/W | 6 [2]

Minimum Total Units: 43

[1] *CHE1 students are preloaded into the fall term of CHEE 315 (instructor's request), but can change sections and/or terms with the instructor's permission.*

[2] *Electives can be taken in either the fall or winter terms, but recommend taking in winter term to maintain a balanced course load.*

Fourth Year CORE 2016-2017

- CHEE 418 Strategies for Process Investigations F | 3.5
- CHEE 470 Design of Manufacturing Processes F | 6.25
- CHEE 412 Transport Phenomena in Chemical Engineering W | 3.5
- ELECTIVE Technical Elective (minimum 3 credits) F/W | 3
- ELECTIVE Complementary Studies List A, B, C or D (6 credits) F/W | 6

Plus Two Of:

- APSC 400 Technology, Engineering and Management (TEAM) FW* | 6.5
  OR
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
  OR
- CHEE 421 Research Project FW | 7
  OR
- CHEE 420 Laboratory Projects III F/W | 4
  AND
- Technical Elective (Group A or Group B) F/W | 3 [1]

Minimum Total Credits: 35.75

[1] *CHEE 420 and a TECH elective from either Group A or Group B count together as one choice.*

Technical Electives

In some cases, a course on this list is already core for a Sub-plan, and that course is therefore excluded as an elective for that Sub-plan. Some of these elective courses may not be available to students due to pre-requisite course requirements. The student is responsible for confirming that he/she has the necessary prerequisites or permission of the instructor.

Course availability and the term in which a course is held can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to SOLUS to find out if the TECH course is offered this upcoming year.

Students in the Process Engineering Sub-plan (CHE1) must take a minimum of nine (9) credits in technical electives of which a minimum of three (3) credits must be from the CHE1 Group A technical electives list and the remaining six (6) credits from either the CHE1 Group A or Group B technical electives list.

Chemical Process Engineering Sub-plan: Technical Electives

Complementary Studies

Students choose 9 credits from the approved Lists A, B, C, or D of which 6 credits must be taken from List A. Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Economics

To meet the engineering economics requirement, students take CHEE 310 (this is a CORE course).

Communications

To meet the communications course requirement, students take APSC 293 and CHEE 360 (these are CORE courses).

Civil Engineering

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Civil Engineering focuses on the analysis, design, and improvement of the human environment—both natural and constructed. Our students will learn how the world works and will provide improvements in the overall quality of life, make better use of limited resources, develop sustainable technologies, and create attractive and functional places to live and work.

Civil Engineering at Queen's University prepares students to identify emerging issues and develop innovative solutions to the numerous civil engineering, societal, and global challenges of the future.

The core undergraduate curriculum covers the key components of today's Civil Engineering professions. The study of environmental and sustainability issues is integrated throughout the academic plan to better reflect that the assessment of these concerns is integral to all civil engineering projects. The first three years of our plan provide broad-based training in: mathematics; science (physics, chemistry & geology); fluid, structural and soil mechanics; materials (water, concrete, steel, soil & plastics); and engineering problem solving & design. Students in their fourth year are able to either specialize in an area of interest, or further diversify their training. Specialization can be under the themes of buildings & structures, water & the environment, or geoengineering. This student choice arises in the selection of:

technical electives, topics for realistic design projects, areas to conduct advanced research, and practical industrial internships.

Civil Engineering, B. Sc. (Class of 2016)

Second Year Common CORE- 2013/14

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- CIVL 200 Civil Week I - Professional Skills F | 2.5
- CIVL 210 Chemistry for Civil Engineers F | 4.5
- CIVL 230 Solid Mechanics I F | 4.25
- MTHE 224 Applied Mathematics for Civil Engineers F | 4.2
- Complementary Studies- Humanities & Social Sciences - List A F | 3-0-0 | 3
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- CIVL 215 Materials for Civil Engineers W | 4.5
- CIVL 222 Numerical Methods for Civil Engineers W | 5
- CIVL 231 Solid Mechanics II W | 4.5
- CIVL 250 Hydraulics I W | 4

Minimum Credits: 45.5

Third Year Common CORE -2014/15

- CIVL 300 Civil Week - Professional Skills F | 2.5
- CIVL 330 Structural Analysis F | 3.75
- CIVL 340 Geotechnical Engineering I F | 3.75
- CIVL 350 Hydraulics II F | 3.75
- CIVL 371 Groundwater Engineering F | 3.75
- Complementary Studies- Humanities & Social Sciences - List A F | 3-0-0 | 3
- CIVL 331 Structural Steel Design W | 4
- CIVL 341 Geotechnical Engineering II W | 4
- CIVL 370 Deleted - Fundamentals of Environmental Engineering |
- CIVL 380 Deleted - Applied Sustainability and Public Health in Civil Engineering |
- Management Elective W | 3-0-0 | 3

Minimum Credits: 39.5

Fourth Year Common CORE -2015/16

- CIVL 400 Civil Week - Professional Skills F | 2.5
- CIVL 460 Civil Engineering Design and Practice IV FW | K6
- Complementary Studies - List A, B, C, or D F | 3-0-0 | 3
- Electives F&W | 25.75

Minimum Credits: 37.25

Electives

All students must choose **EIGHT** Electives, at least **SIX** of which must be Technical Electives from List 1 shown below. The SEVENTH elective may be from List 1 or List 2 shown below. The **EIGHTH** elective may be from List 1 or List 2 or a Free Elective - see course list below.

Civil Engineering: Technical Electives

A Free Elective can be any of the following courses with a minimum of 3 credits:

- Any 3 credit course appearing anywhere in the Applied Science calendar, in the course descriptions list, in the requirements for any academic plan, or in the lists of eligible complementary studies courses
- Any course at the 100 level or higher from the Arts and Science calendar with any of the following subject codes: ANAT, BCHM, BIOL, CDNS, CHEM, CISC,COGS, COMM, DEVS, GEOL, GIMS, GISC, GISQ, GPHY, HLTH, IDIS, INTS, ENSC,EPID, LING, MATH, MICR, PHAR, PHYS, PHGY, STSC, STAT, WRIT
- Any of the graduate courses offered in Urban and Regional Planning
    - *Free Electives must be approved by the Undergraduate Chair

Civil Engineering, B. Sc. (Class of 2017)

Second Year Common CORE- 2014/15

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- CIVL 200 Civil Week I - Professional Skills F | 2.5
- CIVL 210 Chemistry for Civil Engineers F | 4.5
- CIVL 230 Solid Mechanics I F | 4.25
- MTHE 224 Applied Mathematics for Civil Engineers F | 4.2
- Complementary Studies- Humanities & Social Sciences List A F | 3-0-0 | 3
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- CIVL 215 Materials for Civil Engineers W | 4.5
- CIVL 222 Numerical Methods for Civil Engineers W | 5
- CIVL 231 Solid Mechanics II W | 4.5
- CIVL 250 Hydraulics I W | 4

Minimum Credits: 44.45

Note: A minimum of 6 credits must be taken from Complementary Studies List A.

Third Year Common CORE -2015/16

- CIVL 300 Civil Week - Professional Skills F | 2.5

- CIVL 330 Structural Analysis F | 3.75
- CIVL 340 Geotechnical Engineering I F | 3.75
- CIVL 350 Hydraulics II F | 3.75
- CIVL 371 Groundwater Engineering F | 3.75
- Complementary Studies - Humanities & Social Sciences List A F | 3-0-0 | 3
- CIVL 331 Structural Steel Design W | 4
- CIVL 341 Geotechnical Engineering II W | 4
- CIVL 360 Civil Engineering Design and Practice III W | K4
- CIVL 372 Water and Wastewater Engineering W | 4
- Management Elective W | 3-0-0 | 3

Minimum Credits: 39.5

Note: A minimum of 6 credits must be taken from Complementary Studies List A.

Fourth Year Common CORE -2016/17

- CIVL 400 Civil Week - Professional Skills F | 2.5
- CIVL 460 Civil Engineering Design and Practice IV FW | K6
- Complementary Studies- List A, B, C, or D F | 3-0-0 | 3
- Electives F&W | 25.75

Minimum Credits: 37.25

Electives

All students must choose EIGHT Electives, *at least SIX of which must be Technical Electives from List 1 shown below.* The **SEVENTH** Elective may be from List 1 or List 2 shown below. The **EIGHTH** Elective may be from List 1 or List 2 or a Free Elective - see course list below.

Civil Engineering: Technical Electives

A Free Elective can be any of the following courses with a minimum of 3 credits

- Any 3 credit course appearing anywhere in the Applied Science calendar, in the course descriptions list, in the requirements for any academic plan, or in the lists of eligible complementary studies courses
- Any course at the 100 level or higher from the Arts and Science calendar with any of the following subject codes: ANAT, BCHM, BIOL, CDNS, CHEM, CISC,COGS, COMM, DEVS, GEOL, GIMS, GISC, GISQ, GPHY, HLTH, IDIS, INTS, ENSC,EPID, LING, MATH, MICR, PHAR, PHYS, PHGY, STSC, STAT, WRIT
- Any of the graduate courses offered in Urban and Regional Planning
    - *Free Electives must be approved by the Undergraduate Chair

Civil Engineering, B. Sc. (Class of 2018)

Second Year Common CORE- 2015/16

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- CIVL 200 Civil Week I - Professional Skills F | 2.5
- CIVL 210 Chemistry for Civil Engineers F | 4.5
- CIVL 230 Solid Mechanics I F | 4.25
- MTHE 224 Applied Mathematics for Civil Engineers F | 4.2
- Complementary Studies- Humanities & Social Sciences List A F | 3-0-0 | 3
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- CIVL 215 Materials for Civil Engineers W | 4.5
- CIVL 222 Numerical Methods for Civil Engineers W | 5
- CIVL 231 Solid Mechanics II W | 4.5
- CIVL 250 Hydraulics I W | 4

Minimum Credits: 44.45

Note: A minimum of 6 credits must be taken from Complementary Studies List A.

Third Year Common CORE -2016/17

- CIVL 300 Civil Week - Professional Skills F | 2.5
- CIVL 330 Structural Analysis F | 3.75
- CIVL 340 Geotechnical Engineering I F | 3.75
- CIVL 350 Hydraulics II F | 3.75
- CIVL 371 Groundwater Engineering F | 3.75
- Complementary Studies – Humanities & Social Sciences List A F | 3-0-0 | 3
- CIVL 331 Structural Steel Design W | 4
- CIVL 341 Geotechnical Engineering II W | 4
- CIVL 360 Civil Engineering Design and Practice III W | K4
- CIVL 372 Water and Wastewater Engineering W | 4
- Management Elective W | 3-0-0 | 3

Minimum Credits: 39.5

Note: A minimum of 6 credits must be taken from Complementary Studies List A.

Fourth Year Common CORE -2017/18

- CIVL 400 Civil Week - Professional Skills F | 2.5
- CIVL 460 Civil Engineering Design and Practice IV FW | K6
- Complementary Studies- List A, B, C, or D F | 3-0-0 | 3
- Electives F&W | 25.75

Minimum Credits: 37.25

Electives

All students must choose EIGHT Electives, *at least SIX of which must be Technical Electives from List 1 shown below.* The SEVENTH Elective may be from List 1 or List 2 shown below. The **EIGHTH** Elective may be from List 1 or List 2 or a Free Elective - see course list below.

Civil Engineering: Technical Electives

A Free Elective can be any of the following courses with a minimum of 3 credits:

- Any 3 credit course appearing anywhere in the Applied Science calendar, in the course descriptions list, in the requirements for any academic plan, or in the lists of eligible complementary studies courses
- Any course at the 100 level or higher from the Arts and Science calendar with any of the following subject codes: ANAT, BCHM, BIOL, CDNS, CHEM, CISC,COGS, COMM, DEVS, GEOL, GIMS, GISC, GISQ, GPHY, HLTH, IDIS, INTS, ENSC,EPID, LING, MATH, MICR, PHAR, PHYS, PHGY, STSC, STAT, WRIT
- Any of the graduate courses offered in Urban and Regional Planning
    - *Free Electives must be approved by the Undergraduate Chair

Computer Engineering

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Computer Engineers deal with the architecture, design, implementation, and verification of the hardware and software for computing systems that are increasingly being used in embedded or networked environments. The Computer Engineering plan offers a broad range of supporting course material to prepare graduates for entry into the profession. In the hardware area, courses cover digital logic and digital systems engineering, computer organization and system architecture, microprocessors, and integrated circuit engineering. Software courses include programming languages, data structures and algorithms, operating systems, real-time software design, databases, compilers, software requirements analysis, formal methods in software engineering, and techniques for human-computer interaction. Computer communication network courses include material on reliable and secure information transfer protocols, switching and routing through multipath networks, and wireless networking.

The Computer Engineering plan is "streamed". Through choice of elective courses in third and fourth year, students can either focus their studies in one or more areas of specialization ("streams"), or pursue a broader coverage of the subject field. Streams are detailed on the Departmental web pages.

First Year courses in Computer Science (APSC 142), Mathematics (APSC 171, APSC 172 and APSC 174), Engineering Practice (APSC 100) and Physics (APSC 112) form the basis for further study in Computer Engineering. Good performance is advisable for students planning to enter this academic plan.

Computer Engineering, B. Sc. (Class of 2016)

Elective courses in years three and four are to be chosen from Electives Lists A, B and C shown below (under Fourth Year), and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1. Exceed the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2. Have at least 4 courses from combined Electives Lists B and C (but no more than 5 courses taken from List C can be counted towards fulfilling the degree program). Courses that qualify to be on Lists B and C will change yearly to reflect any instructor changes.
3. Have at least 5 four-hundred level elective courses.
4. Counting required core courses, plus elective courses chosen for second, third and fourth year, result in a total of not less than 116.5 credits for those years.

Available combinations of elective courses are subject to timetabling constraints.

Second Year Common CORE – 2013/14

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- CMPE 212 Introduction to Computing Science II F/W | 4
- ELEC 221 Electric Circuits F | 4.25
- ELEC 271 Digital Systems F | 4.25
- ELEC 293 Deleted - Electrical and Computer Engineering Laboratory I |
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3
- Complementary Studies, List A F | 3
- ELEC 252 Electronics I W | 4.25
- ELEC 270 Discrete Mathematics with Computer Engineering Applications W | 3.5
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 294 Deleted - Electrical and Computer Engineering Laboratory II |
- ELEC 299 Mechatronics Project W | K1.5

Total Credits: 43.75

Remaining Credits Balance: 72.75

Third Year Common CORE – 2014/15

- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5
- ELEC 377 Operating Systems F | 4
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- ELEC 326 Probability and Random Processes W | 3.5
- ELEC 374 Digital Systems Engineering W | 4.25
- ELEC 390 Electrical and Computer Engineering Design W | K2.25

- CMPE 223 Software Specifications W | 3
  OR
- CMPE 320 Fundamentals of Software Development W | 4

- Electives Choose 4 electives from Electives Lists A or B or C (see lists under 4th year below) F/W | 12

- Complementary Studies List A F/W | 3-0-0 | 3

Total Credits: 39.5 or 40.5

Remaining Credits Balance: 33.25 or 32.25

Fourth Year Common CORE – 2015/16

- ELEC 498 Computer Engineering Project FW | K7 *
- Electives Choose a sufficient number of Electives from List A or B or C to fulfil the minimum program requirements in all CEAB categories F/W | 23.25 or 22.25
- Complementary Studies, List A, B, C or D F/W | 3

Minimum Total Credits: 33.25 or 32.5

Remaining Credits Balance: 0

* with Departmental and instructor support, students may request to substitute APSC 381 and APSC 480 for ELEC 390 and ELEC 498

Electives

Computer Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Electrical Engineering Plan, the Engineering Economics course is APSC 221, and the Communications course isAPSC 293 (communications units are also included inside course ELEC 498).

Computer Engineering, B. Sc. (Class of 2017)

Elective courses in years three and four are to be chosen from Electives Lists A, B and C shown below (under Fourth Year), and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1. Exceed the minimum Accreditation Units (AU) set by ECE in each CEAB category.

2. Have at least 4 courses from combined Electives Lists B and C (but no more than 5 courses taken from List C can be counted towards fulfilling the degree program). Courses that qualify to be on Lists B and C will change yearly to reflect any instructor changes.
3. Have at least 5 four-hundred level elective courses.
4. Counting required core courses, plus elective courses chosen for second, third and fourth year, result in a total of not less than 116.5 credits for those years.

Available combinations of elective courses are subject to timetabling constraints.

Second Year Common CORE – 2014/15

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 271 Digital Systems F | 4.25
- ELEC 278 Fundamentals of Information Structures F | 4
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3
- Complementary Studies, List A F | 3
- CMPE 212 Introduction to Computing Science II F/W | 4
- ELEC 252 Electronics I W | 4.25
- ELEC 270 Discrete Mathematics with Computer Engineering Applications W | 3.5
- ELEC 274 Computer Architecture W | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5

Total Credits: 44.5

Remaining Credits Balance: 72

Third Year Common CORE – 2015/16

- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5
- ELEC 377 Operating Systems F | 4
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- ELEC 326 Probability and Random Processes W | 3.5
- ELEC 374 Digital Systems Engineering W | 4.25
- ELEC 390 Electrical and Computer Engineering Design W | K2.25

- CMPE 223 Software Specifications W | 3
  OR
- CMPE 320 Fundamentals of Software Development W | 4

- Electives Choose 4 electives from Electives Lists A or B or C (see lists under 4th year below) F/W | 12
- 1 of Complementary Studies List A F/W | 3-0-0 | 3

Total Credits: 39.5 or 40.5

Remaining Credits Balance: 32.5 or 31.5

Fourth Year Common CORE – 2016/17

- ELEC 498 Computer Engineering Project FW | K7 *
- Electives Choose a sufficient number of Electives from List A or B or C to fulfil the minimum program requirements in all CEAB categories F/W | 22.5 or 21.5
- Complementary Studies, List A, B, C or D F/W | 3

Minimum Total Credits: 32.5 or 31.5

Remaining Credits Balance: 0

* with Departmental and instructor support, students may request to substitute APSC 381 and APSC 480 for ELEC 390 and ELEC 498

Electives

Computer Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Electrical Engineering Program, the Engineering Economics course is APSC 221, and the Communications course isAPSC 293 (communications units are also included inside course ELEC 498).

Computer Engineering, B. Sc. (Class of 2018)

Elective courses in years three and four are to be chosen from Electives Lists A, B and C shown below (under Fourth Year), and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1. Exceed the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2. Have at least 4 courses from combined Electives Lists B and C (but no more than 5 courses taken from List C can be counted towards fulfilling the degree program). Courses that qualify to be on Lists B and C will change yearly to reflect any instructor changes.
3. Have at least 5 four-hundred level elective courses.
4. Counting required core courses, plus elective courses chosen for second, third and fourth year, result in a total of not less than 116.5 credits for those years.

Available combinations of elective courses are subject to timetabling constraints.

Second Year Common CORE – 2015/16

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 271 Digital Systems F | 4.25
- ELEC 278 Fundamentals of Information Structures F | 4
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3
- Complementary Studies, List A F | 3
- CMPE 212 Introduction to Computing Science II F/W | 4
- ELEC 252 Electronics I W | 4.25
- ELEC 270 Discrete Mathematics with Computer Engineering Applications W | 3.5
- ELEC 274 Computer Architecture W | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5

Total Credits: 44.5

Remaining Credits Balance: 72

Third Year Common CORE – 2016/17

- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5
- ELEC 377 Operating Systems F | 4
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- ELEC 326 Probability and Random Processes W | 3.5
- ELEC 374 Digital Systems Engineering W | 4.25
- ELEC 390 Electrical and Computer Engineering Design W | K2.25

- CMPE 223 Software Specifications W | 3
  OR
- CMPE 320 Fundamentals of Software Development W | 4

- Electives Choose 4 electives from Electives Lists A or B or C (see lists under 4th year below) F/W | 12
- 1 of Complementary Studies List A F/W | 3-0-0 | 3

Total Credits: 39.5 or 40.5

Remaining Credits Balance: 32.5 or 31.5

Fourth Year Common CORE – 2017/18

- ELEC 498 Computer Engineering Project FW | K7 *
- Electives Choose a sufficient number of Electives from List A or B or C to fulfil the minimum program requirements in all CEAB categories F/W | 22.5 or 21.5
- Complementary Studies, List A, B, C or D F/W | 3

Minimum Total Credits: 32.5 or 31.5

Remaining Credits Balance: 0

* with Departmental and instructor support, students may request to substitute APSC 381 and APSC 480 for ELEC 390 and ELEC 498

Electives

Computer Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Electrical Engineering Program, the Engineering Economics course is APSC 221, and the Communications course isAPSC 293 (communications units are also included inside course ELEC 498).

Electrical Engineering

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Electrical Engineers deal with telecommunications, computers, electronics, signal processing, robotics, biomedicine, transportation, industrial process control, electrical power generation and distribution, and design and operation of industrial machinery. The Electrical Engineering plan is intended to prepare graduates for entry into this broad discipline. Fundamental courses in electric and electronic circuits, electromagnetics, signals and systems, applied mathematics, and other topics in second and third year provide the basis for specialization in a number of areas through more advanced elective courses in signal processing, digital and wireless communication, control systems, electric machines, robotics, power electronics, microwave and optical communication systems, and integrated circuit engineering. The Electrical Engineering plan also incorporates core and elective courses in digital logic, computer systems, and software for additional breadth.

The Electrical Engineering plan is "streamed". Through choice of elective courses in third and fourth year, students can either focus their studies in one or more areas of specialization ("streams"), or pursue a broader coverage of the subject field. Streams are detailed on the Departmental web pages.

First year courses in Mathematics (APSC 171, APSC 172, APSC 174), Physics (APSC 112), Engineering Practice (APSC 100) and Computing (APSC 142) form the basis for further study in Electrical Engineering. Good performance in these courses is advisable for students planning to enter this program.

Electrical Engineering, B. Sc. (Class of 2016)

Elective courses in years three and four are to be chosen from Electives Lists A and B (shown under fourth year), and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1. Exceed the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2. Have at least 5 courses from Electives List A.
3. Have at least 5 four-hundred level elective courses.
4. Result in a total of not less than 116.5 credits counting all courses for second, third and fourth years (remaining AU balance is shown below after each year).

Available combinations of elective courses are subject to timetabling constraints.

Second Year Common CORE – 2013/14

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- CMPE 212 Introduction to Computing Science II F/W | 4
- ELEC 221 Electric Circuits F | 4.25
- ELEC 271 Digital Systems F | 4.25
- ELEC 293 Deleted - Electrical and Computer Engineering Laboratory I |
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3
- Complementary Studies, List A F | 3-0-0 | 3
- ELEC 252 Electronics I W | 4.25
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 294 Deleted - Electrical and Computer Engineering Laboratory II |
- ELEC 299 Mechatronics Project W | K1.5
- MTHE 228 Complex Analysis W | 3.5

Total Credits: 43.75

Remaining Credits Balance: 72.75

Third Year Common CORE – 2014/15

- ELEC 323 Continuous-Time Signals and Systems F | 3.75
- ELEC 353 Electronics II F | 4.5
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5
- ELEC 381 Applications of Electromagnetics F | 3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- ELEC 324 Discrete-Time Signals and Systems W | 4
- ELEC 326 Probability and Random Processes W | 3.5
- ELEC 390 Electrical and Computer Engineering Design W | K2.25
- ENPH 336 Solid State Devices W | 3.25
- Electives 1 of Electives List A or B F/W | 3
- 1 of Electives List A of B F/W | 3

- 1 of Complementary Studies List A F/W | 3-0-0 | 3

Total Credits: 41.25

Remaining Credits Balance: 31.5

Fourth Year Common CORE – 2015/16

- ELEC 490 Electrical Engineering Project FW | K7 *
- Complementary Studies, List A, B, C or D F/W | 3
- Electives F/W | 21.5

Total Credits: 31.5

Remaining Credits Balance: 0

* with Departmental and instructor support, students may request to substitute APSC 381 and APSC 480 for ELEC 390 and ELEC 490

Electives

Electrical Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the ECE Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Electrical Engineering Plan, the Engineering Economics course is APSC 221, and the Communications course is APSC 293 (1 credit of communications units are also included in course ELEC 490).

Electrical Engineering, B. Sc. (Class of 2017)

Elective courses in years three and four are to be chosen from Electives Lists A and B (shown under fourth year), and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1. Exceed the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2. Have at least 5 courses from Electives List A.
3. Have at least 5 four-hundred level elective courses.

4. Result in a total of not less than 116.5 credits counting all courses for second, third and fourth years (remaining AU balance is shown below after each year).

Available combinations of elective courses are subject to timetabling constraints.

Second Year Common CORE – 2014/15

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 271 Digital Systems F | 4.25
- ELEC 278 Fundamentals of Information Structures F | 4
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3
- Complementary Studies, List A F | 3-0-0 | 3
- ELEC 252 Electronics I W | 4.25
- ELEC 273 Numerical Methods and Optimization W | 3.5
- ELEC 274 Computer Architecture W | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5
- MTHE 228 Complex Analysis W | 3.5

Total Credits: 44.0

Remaining Credits Balance: 72.5

Third Year Common CORE – 2015/16

- ELEC 323 Continuous-Time Signals and Systems F | 3.75
- ELEC 353 Electronics II F | 4.5
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5
- ELEC 381 Applications of Electromagnetics F | 3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- ELEC 324 Discrete-Time Signals and Systems W | 4
- ELEC 326 Probability and Random Processes W | 3.5
- ELEC 390 Electrical and Computer Engineering Design W | K2.25
- ENPH 336 Solid State Devices W | 3.25
- Electives 1 of Electives List A or B F/W | 3
- 1 of Electives List A of B F/W | 3
- 1 of Complementary Studies List A F/W | 3-0-0 | 3

Total Credits: 41.25

Remaining Credits Balance: 31.25

Fourth Year Common CORE – 2016/17

- ELEC 490 Electrical Engineering Project FW | K7 *
- Complementary Studies, List A, B, C or D F/W | 3
- Electives F/W | 21.25

Total Credits: 31.25

Remaining Credits Balance: 0

* with Departmental and instructor support, students may request to substitute APSC 381 and APSC 480 for ELEC 390 and ELEC 490

Electives

Electrical Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the ECE Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Electrical Engineering Plan, the Engineering Economics course is APSC 221, and the Communications course is APSC 293 (1 credit of communications units are also included in course ELEC 490).

Electrical Engineering, B. Sc. (Class of 2018)

Elective courses in years three and four are to be chosen from Electives Lists A and B (shown under fourth year), and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1. Exceed the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2. Have at least 5 courses from Electives List A.
3. Have at least 5 four-hundred level elective courses.
4. Result in a total of not less than 116.5 credits counting all courses for second, third and fourth years (remaining AU balance is shown below after each year).

Available combinations of elective courses are subject to timetabling constraints.

Second Year Common CORE – 2015/16

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 271 Digital Systems F | 4.25

- ELEC 278 Fundamentals of Information Structures F | 4
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3
- Complementary Studies, List A F | 3-0-0 | 3
- ELEC 252 Electronics I W | 4.25
- ELEC 273 Numerical Methods and Optimization W | 3.5
- ELEC 274 Computer Architecture W | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5
- MTHE 228 Complex Analysis W | 3.5

Total Credits: 44.0

Remaining Credits Balance: 72.5

Third Year Common CORE – 2016/17

- ELEC 323 Continuous-Time Signals and Systems F | 3.75
- ELEC 353 Electronics II F | 4.5
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5
- ELEC 381 Applications of Electromagnetics F | 3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- ELEC 324 Discrete-Time Signals and Systems W | 4
- ELEC 326 Probability and Random Processes W | 3.5
- ELEC 390 Electrical and Computer Engineering Design W | K2.25
- ENPH 336 Solid State Devices W | 3.25
- Electives 1 of Electives List A or B F/W | 3
- 1 of Electives List A of B F/W | 3
- 1 of Complementary Studies List A F/W | 3-0-0 | 3

Total Credits: 41.25

Remaining Credits Balance: 31.25

Fourth Year Common CORE – 2017/18

- ELEC 490 Electrical Engineering Project FW | K7 *
- Complementary Studies, List A, B, C or D F/W | 3
- Electives F/W | 21.25

Total Credits: 31.25

Remaining Credits Balance: 0

* with Departmental and instructor support, students may request to substitute APSC 381 and APSC 480 for ELEC 390 and ELEC 490

Electives

Electrical Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the ECE Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Electrical Engineering Plan, the Engineering Economics course is APSC 221, and the Communications course is APSC 293 (1 credit of communications units are also included in course ELEC 490).

Engineering Chemistry

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The Engineering Chemistry program is offered by the Department of Chemical Engineering with the close cooperation of the Department of Chemistry. The academic program is accredited by the Canadian Engineering Accreditation Board as an engineering discipline and the Canadian Society for Chemistry as a chemistry program. The curriculum integrates a core of chemistry with a body of engineering in a manner that allows chemical knowledge to be put into practice. Beginning with a concentration on basic engineering principles, science, and mathematics, courses in the latter years allow for specialization in three areas: Advanced Materials, Environmental Chemistry and Biosciences.

Ancillary Fees

Chemical Engineering and Engineering Chemistry students may be required to pay ancillary fees for course related learning materials, safety equipment and field trips. Currently this consists of a compulsory one-time $10 fee for an I-Class token providing students 24-hour access during the academic school year (September to May) to Dupuis Hall as well as to the Department's computer cluster. Computer equipment within the cluster is equipped with software programs that are required for use in various CHEE courses. The fee is payable to the Department of Chemical Engineering, Dupuis Hall, Room 201 (debit or credit card only please).

Engineering Chemistry, B. Sc. (Class of 2016)

Second Year Common CORE 2013-2014

- CHEE 221 Chemical Processes and Systems F | 3.5
- ENCH 211 Main Group Chemistry F | 4.5
- ENCH 212 Principles of Chemical Reactivity F | 3.75
- ENCH 213 Introduction to Chemical Analysis F | 4.5
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- CHEE 210 Thermodynamic Properties of Fluids W | 3.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 222 Methods of Structure Determination W | 3.75
- ENCH 245 Applied Organic Chemistry I W | 3.5
- ELECTIVES F or W | 6

Minimum Total Credits: 49.5

Third Year Common CORE 2014-2015

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- ENCH 312 Transition Metal Chemistry F | 3.5
- ENCH 346 Quantum Mechanics and Molecular Simulation F | 3.5
- CHEE 315 Laboratory Projects II F/W | 4 [1]
- CHEE 323 Industrial Catalysis W | 3.5
- CHEE 333 Design of Unit Operations W | 3.5
- CHEE 360 Technical Communications W | 1.5
- ENCH 345 Applied Organic Chemistry II W | 3

- ENCH 398 Experimental Chemistry I F | 3.5 [2]
  OR
- ENCH 399 Experimental Chemistry II W | 3.5 [2]

- Electives (minimum 3 credits) F/W | 3

Minimum Credits: 43

[1] ENCH students are preloaded into the winter term of CHEE 315 (instructor's request), but can change sections and/or terms with the instructor's permission.

[2] ENCH students can choose either ENCH 398 or ENCH 399, but are preloaded into the winter term to maintain a balanced course load.

Fourth Year Common CORE 2015-2016

- CHEE 460 NOT OFFERED THIS YEAR - Applied Surface and Colloid Science F | 3.5 [1]

- CHEE 470 Design of Manufacturing Processes F | 6.25
- ENCH 417 Research Project FW* | 9
- CHEE 461 Electrochemical Engineering W | 3.5
- Electives (minimum 18 credits) F/W | 18

Plus One Of:

- CHEE 380 Biochemical Engineering F | 3.5 [2]
- CHEE 340 Biomedical Engineering W | 3.5 [2]

Minimum Total Credits: 43.75

[1] CHEE 460 will not be offered in 2015-2016; ENCH students in 4th year will instead choose an elective from the Group A TECH list and add the course during registration.

ENCH students are preloaded into the winter term of CHEE 315 (instructor's request), but can change sections and/or terms with the instructor's permission.

[2] CHEE 450 will not be offered in 2015-2016; ENCH students in 4th year will instead choose either CHEE 340 or CHEE 380 and add the course during registration.

Electives

In addition to the CORE courses listed in 2nd, 3rd and 4th year, ENCH students are required to take the following:

1. Either APSC 221 or CHEE 310 to meet the engineering economics requirement of their program. Typically, this course would be taken in year 2 or year 3. NOTE: The course is NOT preloaded like CORE courses – students will need to register for the course in SOLUS during registration.
2. Nine (9) credits of Complementary Studies electives, of which six (6) credits must be from approved List A, the remaining three (3) credits from either List A, B, C or D.
3. Three (3) technical elective courses from the approved Group A list (any combination from Materials, Environment, Biosciences, and General lists).
4. Two (2) technical elective courses from the approved Group B list.

NOTE: Some of these elective courses may not be available to students due to pre-requisite course requirements. The student is responsible for confirming that he/she has the necessary prerequisites or permission of the instructor.

PLEASE NOTE: Course availability and the term in which a course is held can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to SOLUS to find out if the TECH course is offered for the upcoming year

Engineering Chemistry: Technical Electives

Engineering Economics

To meet the engineering economics requirement, students take either APSC 221 or CHEE 310 (this is a CORE course).

Communications

To meet the communications requirement, students take APSC 293 and CHEE 360 (these are CORE courses).

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Chemistry, B. Sc. (Class of 2017)

Second Year Common CORE 2014-2015

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- ENCH 211 Main Group Chemistry F | 4.5
- ENCH 212 Principles of Chemical Reactivity F | 3.75
- ENCH 213 Introduction to Chemical Analysis F | 4.5
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- CHEE 210 Thermodynamic Properties of Fluids W | 3.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 222 Methods of Structure Determination W | 3.75
- ENCH 245 Applied Organic Chemistry I W | 3.5

Minimum Total Credits: 47

Third Year Common CORE 2015-2016

- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- ENCH 312 Transition Metal Chemistry F | 3.5
- ENCH 398 Experimental Chemistry I F | 3.5
- CHEE 323 Industrial Catalysis W | 3.5
- CHEE 324 Organic Process Development W | 3.5
- CHEE 333 Design of Unit Operations W | 3.5
- CHEE 360 Technical Communications W | 1.5
- ENCH 399 Experimental Chemistry II W | 3.5
- Electives (minimum 6 credits) F/W | 6

Plus One Of:

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3 [1]
- CHEE 310 Fundamentals of Engineering Innovation and Entrepreneurship F | 3.5 [1]

Minimum Credits: 42

[1] ENCH students choose either APSC 221 or CHEE 310 (but not both). NOTE: This course will NOT be preloaded like CORE courses; students will need to register for their choice in SOLUS during registration.

Fourth Year Common CORE 2016-2017

- CHEE 460 NOT OFFERED THIS YEAR - Applied Surface and Colloid Science F | 3.5
- CHEE 470 Design of Manufacturing Processes F | 6.25
- ENCH 346 Quantum Mechanics and Molecular Simulation F | 3.5
- ENCH 417 Research Project FW* | 9
- CHEE 315 Laboratory Projects II F/W | 4 [1]
- CHEE 461 Electrochemical Engineering W | 3.5
- Electives (minimum 12 credits) F/W | 12

Plus One Of:

- CHEE 380 Biochemical Engineering F | 3.5 [2]
- CHEE 340 Biomedical Engineering W | 3.5 [2]

Minimum Total Credits: 45.25

[1] ENCH students are preloaded into the winter term of CHEE 315 (instructor's request), but can change sections and/or terms with the instructor's permission.

[2] ENCH students choose either CHEE 340 or CHEE 380. NOTE: This course will NOT be preloaded like CORE courses; students will need to register for their choice in SOLUS during registration

Electives

In addition to the CORE courses listed in 2nd, 3rd and 4th year, ENCH students are required to take the following:

1. Nine (9) credits of Complementary Studies electives, of which six (6) credits must be from approved List A, the remaining three (3) credits from either List A, B, C or D.
2. Two (2) Technical Elective courses from the approved Group A list (any combination from Materials, Environment, Biosciences, and General lists), and one (1) Technical Elective courses from the approved Group B list.

NOTE: Some of these elective courses may not be available to students due to pre-requisite course requirements. The student is responsible for confirming that he/she has the necessary prerequisites or permission of the instructor.

PLEASE NOTE: Course availability and the term in which a course is held can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to SOLUS to find out if the TECH course is offered for the upcoming year

Engineering Chemistry: Technical Electives

Engineering Economics

To meet the engineering economics requirement, students take either APSC 221 or CHEE 310 (this is a CORE course).

Communications

To meet the communications requirement, students take APSC 293 and CHEE 360 (these are CORE courses).

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Chemistry, B. Sc. (Class of 2018)

Second Year Common Core -2015-2016

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- ENCH 211 Main Group Chemistry F | 4.5
- ENCH 212 Principles of Chemical Reactivity F | 3.75
- ENCH 213 Introduction to Chemical Analysis F | 4.5
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- CHEE 210 Thermodynamic Properties of Fluids W | 3.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 222 Methods of Structure Determination W | 3.75
- ENCH 245 Applied Organic Chemistry I W | 3.5

Minimum Total Credits: 47

Third Year Common Core 2016-2017

- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- ENCH 312 Transition Metal Chemistry F | 3.5
- ENCH 398 Experimental Chemistry I F | 3.5
- CHEE 323 Industrial Catalysis W | 3.5
- CHEE 324 Organic Process Development W | 3.5
- CHEE 333 Design of Unit Operations W | 3.5
- CHEE 360 Technical Communications W | 1.5
- ENCH 399 Experimental Chemistry II W | 3.5
- Electives (minimum 6 credits) F/W | 6

Plus One Of:

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3 [1]
- CHEE 310 Fundamentals of Engineering Innovation and Entrepreneurship F | 3.5 [1]

Minimum Credits: 42

[1] ENCH students choose either APSC 221 or CHEE 310 (but not both). NOTE: This course will NOT be preloaded like CORE courses; students will need to register for their choice in SOLUS during registration.

Fourth Year Common Core 2017-2018

- CHEE 460 NOT OFFERED THIS YEAR - Applied Surface and Colloid Science F | 3.5
- CHEE 470 Design of Manufacturing Processes F | 6.25
- ENCH 346 Quantum Mechanics and Molecular Simulation F | 3.5
- ENCH 417 Research Project FW* | 9
- CHEE 315 Laboratory Projects II F/W | 4 [1]
- CHEE 461 Electrochemical Engineering W | 3.5
- Electives (minimum 12 credits) F/W | 12

Plus One Of:

- CHEE 340 Biomedical Engineering W | 3.5 [2]
- CHEE 380 Biochemical Engineering F | 3.5 [2]

Minimum Total Credits: 45.25

[1] ENCH students are preloaded into the winter term of CHEE 315 (instructor's request), but can change sections and/or terms with the instructor's permission.

[2] ENCH students choose either CHEE 340 or CHEE 380. NOTE: This course will NOT be preloaded like CORE courses; students will need to register for their choice in SOLUS during registration.

Electives:

In addition to the CORE courses listed in 2nd, 3rd and 4th year, ENCH students are required to take the following:

1. Nine (9) credits of Complementary Studies electives, of which six (6) credits must be from approved List A, the remaining three (3) credits from either List A, B, C or D.
2. Two (2) Technical Elective courses from the approved Group A list (any combination from Materials, Environment, Biosciences, and General lists), and one (1) Technical Elective course from the approved Group B list.

NOTE: Some of these elective courses may not be available to students due to pre-requisite course requirements. The student is responsible for confirming that he/she has the necessary prerequisites or permission of the instructor.

PLEASE NOTE: Course availability and the term in which a course is held can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to SOLUS to find out if the TECH course is offered for the upcoming year

Engineering Chemistry: Technical Electives

Engineering Economics:

To meet the engineering economics requirement, students take either APSC 221 or CHEE 310 (this is a CORE course).

Communications:

To meet the communications requirement, students take APSC 293 and CHEE 360 (these are CORE courses).

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Physics

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Core courses in the Engineering Physics plan provide the student with fundamental physical principles and theoretical tools for professional practice as well as a firm foundation in modern experimental techniques. To relate these abilities to the attitudes and knowledge of other engineering disciplines, the plan has four sub-plans: electrical, materials, mechanical, and computing. These sub-plans provide a sequence of courses in other engineering departments and thus provide career or graduate studies opportunities in both engineering and applied physics.

NOTE: Students will not be registered in any core second year engineering physics courses until they have passed all the required first year mathematics and physics courses. It is strongly recommended that students have a grade of C- or better in the first year mathematics and physics courses.

Fourth year elective courses must be chosen such that at the end of the academic plan each student meets or exceeds the Canadian Engineering Accreditation Board (CEAB) program requirements. A spreadsheet will be provided by the Undergraduate Chair to aid fourth year students with their course selection.

Options available:

- Electrical Option
- Materials Option
- Mechanical Option
- Computing Option

Engineering Physics, B. Sc. (Class of 2016)

Second Year Common Core - 2013/2014

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- MTHE 227 Vector Analysis F | 3
- MTHE 237 Differential Equations for Engineering Science F | 3.25
- ENPH 242 Relativity and Quanta F | 3.5
- ENPH 211 Applied Physics W | 3.5
- ENPH 225 Mechanics W | 3.5
- ENPH 239 Electricity and Magnetism W | 3.5
- ENPH 252 Management of Experimental Data W | 1.25
- ENPH 253 Engineering Physics Laboratory W | K3.5

Electrical Sub-Plan (P1)

- ELEC 271 Digital Systems F | 4.25
- ELEC 252 Electronics I W | 4.25
- ENPH 213 Computational Engineering Physics W | 4
- ELEC 293 Deleted - Electrical and Computer Engineering Laboratory I |
- ELEC 221 Electric Circuits F | 4.25

Materials Sub-Plan (P3)

- MECH 270 Materials Science and Engineering F | 3.75
- MECH 241 Fluid Mechanics I W | 3.5
- ENPH 213 Computational Engineering Physics W | 4
- ELEC 210 Introductory Electric Circuits and Machines W | 4.25

Mechanical Sub-Plan (P4)

- MECH 230 Thermodynamics I F | 3.5
- ENPH 213 Computational Engineering Physics W | 4
- MECH 241 Fluid Mechanics I W | 3.5
- ELEC 210 Introductory Electric Circuits and Machines W | 4.25

Computing Sub-Plan (P6)

- CMPE 212 Introduction to Computing Science II F/W | 4
- ELEC 221 Electric Circuits F | 4.25
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 293 Deleted - Electrical and Computer Engineering Laboratory I |
- ELEC 271 Digital Systems F | 4.25

Third Year Common Core - 2014/2015

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- MTHE 338 Fourier Methods for Boundary Value Problems F | 3.5 *
- ENPH 344 Introduction to Quantum Mechanics F | 3.5
- ENPH 354 Engineering Physics Design Project W | 3.5
- Complementary Studies, List A F/W | 3 **
- ENPH 345 Quantum Physics of Atoms, Nuclei and Particles W | 3.5
- ENPH 353 Engineering Physics Laboratory II F | 2.5

Note:

* MTHE 338 may be replaced by ENPH 312. The second half of ENPH 312 replaces one of the required fourth year Physics List A electives.

** Students are free to take Complementary Studies courses at any time in their program that suits their interests, workloads, and schedules. Read explanatory notes on Complementary Studies at the end of this section.

APSC 381 may be taken as a technical elective for students particularly interested in engineering design.

ENPH 491 and ENPH 495 are fourth year Physics List A electives offered every second year which students in their third year can consider taking.

Note: In February of Third Year students may apply for permission to take ENPH 456 and ENPH 457 as a combined alternate to (ENPH 455, a 4th year List "B" course, and the Engineering Elective) to facilitate an **Accelerated Master's** graduate degree ending 16 months after completion of the undergraduate Engineering Physics program. Details will be given in January of your 3rd year.

Electrical Sub-Plan (P1)

- ELEC 323 Continuous-Time Signals and Systems F | 3.75
- ELEC 353 Electronics II F | 4.5
- ENPH 372 Thermodynamics W | 3.5
- ELEC 324 Discrete-Time Signals and Systems W | 4
- ELEC 326 Probability and Random Processes W | 3.5

Materials Sub-Plan (P3)

- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
- MECH 370 Principles of Materials Processing F | 3.5
- ENPH 334 Electronics for Applied Scientists F | 5
- ENPH 372 Thermodynamics W | 3.5
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

Mechanical Sub-Plan (P4)

- ENPH 334 Electronics for Applied Scientists F | 5
- MECH 330 Applied Thermodynamics II F | 3.5
- MECH 341 Fluid Mechanics II W | 3.5
- MECH 346 Heat Transfer W | 3.5
- MECH 350 Automatic Control W | 3.5

Computing Sub-Plan (P6)

- CMPE 271 Scientific Computing W | 3
- ENPH 334 Electronics for Applied Scientists F | 5
- CMPE 320 Fundamentals of Software Development W | 4
- ELEC 274 Computer Architecture W | 4
- ENPH 372 Thermodynamics W | 3.5

Fourth Year Common Core - 2015/2016

- ENPH 431 Electromagnetic Theory F | 3.5
- ENPH 454 Advanced Engineering Physics Design Project F | 4.5 **
- Complementary Studies, List A F/W | 3 **
- Complementary Studies, List A, B, C or D F/W | 3 **

- Engineering Elective (any 300- or 400-level Engineering and Applied Science course) F/W | 3
- ENPH 455 Engineering Physics Thesis FW | 4 *
- ENPH 453 Advanced Physics Laboratory W | 3.5

Note:

* Students may take (ENPH 456 and ENPH 457) as a combined alternate to ENPH 455, List "B" and Engineering Elective. See the description after 3rd year.

** Students may instead take APSC 480, Multi-disciplinary Industry Engineering Design Project (9 credits FW) as a substitute for ENPH 454 and one list "B" course. Note that APSC 480 has a prerequisite of APSC 381 or permission of the instructor.

Physics List A:

One from Physics List A:

- ENPH 321 Advanced Mechanics W | 3.5
- ENPH 414 Introduction to General Relativity F | 3
- ENPH 460 Laser Optics W | 3.5
- ENPH 472 Statistical Mechanics F | 3.5
- ENPH 480 Solid State Physics F | 3.5
- ENPH 483 Nanoscience and Nanotechnology W | 3.5
- ENPH 490 Nuclear Physics F | 3.5
- ENPH 491 Physics of Nuclear Reactors F | 3.5 [1]
- ENPH 495 Introduction to Medical Physics W | 3 [2]

Note:

[1] ENPH 491 will be offered in 2015/2016 and alternate years thereafter.

[2] ENPH 495 will be offered in 2014/2015 and alternate years thereafter.

Electrical Sub-Plan (P1)

- ENPH 336 Solid State Devices W | 3.25

Electrical List B:

Two courses from Electrical List B, at least one of which must be numbered above 400:*

- ELEC 408 Biomedical Signal and Image Processing F | 3
- ELEC 409 NOT OFFERED THIS YEAR - Bioinformatic Analytics W | 3
- ELEC 421 Digital Signal Processing: Filters and System Design F | 4
- ELEC 422 NOT OFFERED THIS YEAR - Digital Signal Processing: Random Models and Applications F | 3
- ELEC 443 Linear Control Systems F | 4
- ELEC 448 NOT OFFERED THIS YEAR - Introduction to Robotics: Mechanics and Control W | 3.5

- ELEC 451 NOT OFFERED THIS YEAR - Digital Integrated Circuit Engineering F | 3
- ELEC 454 Analog Electronics W | 3.25
- ELEC 457 NOT OFFERED THIS YEAR - Integrated Circuits and System Applications W | 3
- ELEC 461 Digital Communications F | 3.5
- ELEC 464 Wireless Communications W | 3
- ELEC 471 Computer Networks I F | 3
- ELEC 476 NOT OFFERED THIS YEAR - Modelling and Systems Simulation W | 3.5
- ELEC 478 NOT OFFERED THIS YEAR - Computer Networks II W | 3
- ELEC 483 NOT OFFERED THIS YEAR - Microwave and RF Circuits and Systems W | 4.5
- ELEC 486 Fiber Optic Communications W | 3.75
- CHEE 340 Biomedical Engineering W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other options within Engineering Physics.

Materials Sub-Plan (P3)

- ENPH 480 Solid State Physics F | 3.5

Materials List B:

Two courses from Materials List B:*

- MDEP 437 Fuel Cell Technology F | 3.5
- MECH 423 Introduction to Microsystems F | 3.5
- MECH 425 Engineering for Sustainable Development W | 3.5
- MECH 470 Deformation Processing W | 3.5
- MECH 476 Engineering of Polymers and Composite Materials W | 3.5
- MECH 478 Biomaterials F | 3.5
- MECH 479 NOT OFFERED THIS YEAR - Nano-Structured Materials F | 3.5
- MECH 483 Nuclear Materials W | 3.5
- MECH 484 Introduction to Ceramics F | 3.5
- CHEE 340 Biomedical Engineering W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other options within Engineering Physics.

Mechanical Sub-Plan (P4)

Mechanical List B:

Three courses: two from Mechanical List B, and one from Physics List A or Mechanical List B:*

- CHEE 340 Biomedical Engineering W | 3.5
- MDEP 437 Fuel Cell Technology F | 3.5
- MECH 420 Vibrations W | 3.5
- MECH 423 Introduction to Microsystems F | 3.5
- MECH 424 Sustainable Product Design W | 3.5
- MECH 425 Engineering for Sustainable Development W | 3.5
- MECH 430 Thermal Systems Design F | 4
- MECH 435 Internal Combustion Engines W | 3.5
- MECH 439 Turbomachinery F | 3.5
- MECH 441 Fluid Mechanics III W | 3.5
- MECH 444 Computational Fluid Dynamics W | 3.5
- MECH 448 Compressible Fluid Flow F | 3.5
- MECH 452 Mechatronics Engineering F | 4
- MECH 456 Introduction to Robotics F | 3.5
- MECH 465 Computer-Aided Design F | 3.5
- MECH 480 Airplane Aerodynamics and Performance W | 3.5
- MECH 481 Wind Energy F | 3.5
- MECH 482 Noise Control W | 3.5
- MECH 492 Biofluids W | 3.5
- MECH 495 Ergonomics and Design W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other options within Engineering Physics.

Computing Sub-Plan (P6)

Computing List B:

Three courses: two from Computing List B and one from Physics List A or Computing List B. At least one of the Computing List B courses must be numbered above 400:*

- CHEE 340 Biomedical Engineering W | 3.5
- CMPE 330 Computer-Integrated Surgery F | 3
- CMPE 365 Algorithms I F | 4
- CMPE 452 Neural and Genetic Computing F | 3
- CMPE 454 Computer Graphics W | 3
- CMPE 457 Image Processing and Computer Vision F | 3
- CMPE 458 Programming Language Processors W | 4
- CMPE 472 Medical Informatics W | 3
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5
- ELEC 374 Digital Systems Engineering W | 4.25 [1]
- ELEC 377 Operating Systems F | 4
- ELEC 408 Biomedical Signal and Image Processing F | 3
- ELEC 409 NOT OFFERED THIS YEAR - Bioinformatic Analytics W | 3

Note:

[1]With permission of the instructor.

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other sub-plans within Engineering Physics.

Complementary Studies:

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Engineering Physics Plan, the Engineering Economics course is APSC 221, and the Communications requirements are met through courses in the core plan.

Engineering Physics, B. Sc. (Class of 2017)

Second Year Common Core - 2014/2015

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- MTHE 227 Vector Analysis F | 3
- MTHE 237 Differential Equations for Engineering Science F | 3.25
- ENPH 242 Relativity and Quanta F | 3.5
- ELEC 221 Electric Circuits F | 4.25
- ENPH 211 Applied Physics W | 3.5
- ENPH 225 Mechanics W | 3.5
- ENPH 239 Electricity and Magnetism W | 3.5
- ENPH 252 Management of Experimental Data W | 1.25
- ENPH 253 Engineering Physics Laboratory W | K3.5

Electrical Sub-Plan (P1)

- ELEC 271 Digital Systems F | 4.25
- ELEC 252 Electronics I W | 4.25
- ENPH 213 Computational Engineering Physics W | 4

Materials Sub-Plan (P3)

- MECH 270 Materials Science and Engineering F | 3.75
- MECH 241 Fluid Mechanics I W | 3.5
- ENPH 213 Computational Engineering Physics W | 4

Mechanical Sub-Plan (P4)

- MECH 230 Thermodynamics I F | 3.5
- ENPH 213 Computational Engineering Physics W | 4
- MECH 241 Fluid Mechanics I W | 3.5

Computing Sub-Plan (P6)

- CMPE 212 Introduction to Computing Science II F/W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- CMPE 271 Scientific Computing W | 3

Third Year Common Core - 2015/2016

- MTHE 338 Fourier Methods for Boundary Value Problems F | 3.5 *
- ENPH 344 Introduction to Quantum Mechanics F | 3.5
- ENPH 354 Engineering Physics Design Project W | 3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- Complementary Studies, List A F/W | 3 **
- ENPH 345 Quantum Physics of Atoms, Nuclei and Particles W | 3.5
- ENPH 353 Engineering Physics Laboratory II F | 2.5

Note:

* MTHE 338 may be replaced by ENPH 312. The second half of ENPH 312 replaces one of the required fourth year Physics List A electives.

** Students are free to take Complementary Studies courses at any time in their program that suits their interests, workloads, and schedules. Read explanatory notes on Complementary Studies at the end of this section.

APSC 381 may be taken as a technical elective for students particularly interested in engineering design.

ENPH 491 and ENPH 495 are fourth year Physics List A electives offered every second year which students in their third year can consider taking.

Note: In February of Third Year students may apply for permission to take ENPH 456 and ENPH 457 as a combined alternate to (ENPH 455, a 4th year List "B" course, and the Engineering Elective), to facilitate an **Accelerated Master's** graduate degree ending 16 months after completion of the undergraduate Engineering Physics program. Details will be given in January of your 3rd year.

Electrical Sub-Plan (P1)

- ELEC 323 Continuous-Time Signals and Systems F | 3.75
- ELEC 353 Electronics II F | 4.5
- ENPH 372 Thermodynamics W | 3.5
- ELEC 324 Discrete-Time Signals and Systems W | 4
- ELEC 326 Probability and Random Processes W | 3.5

Materials Sub-Plan (P3)

- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
- MECH 370 Principles of Materials Processing F | 3.5
- ENPH 334 Electronics for Applied Scientists F | 5
- ENPH 372 Thermodynamics W | 3.5
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

Mechanical Sub-Plan (P4)

- ENPH 334 Electronics for Applied Scientists F | 5
- MECH 330 Applied Thermodynamics II F | 3.5
- MECH 341 Fluid Mechanics II W | 3.5
- MECH 346 Heat Transfer W | 3.5
- MECH 350 Automatic Control W | 3.5

Computing Sub-Plan (P6)

- ELEC 271 Digital Systems F | 4.25
- ENPH 334 Electronics for Applied Scientists F | 5
- CMPE 320 Fundamentals of Software Development W | 4
- ELEC 274 Computer Architecture W | 4
- ENPH 372 Thermodynamics W | 3.5

Fourth Year Common Core - 2016/2017

- ENPH 431 Electromagnetic Theory F | 3.5
- ENPH 454 Advanced Engineering Physics Design Project F | 4.5 **
- Complementary Studies, List A F/W | 3 **
- Complementary Studies, List A, B, C or D F/W | 3 **
- Engineering Elective (any 300- or 400-level Engineering and Applied Science course) F/W | 3
- ENPH 455 Engineering Physics Thesis FW | 4 *
- ENPH 453 Advanced Physics Laboratory W | 3.5

Note:

* Students may take (ENPH 456 and ENPH 457) as a combined alternate to ENPH 455, List "B" and Engineering Elective. See the description after 3rd year.

** Students may instead take APSC 480, Multi-disciplinary Industry Engineering Design Project (9 credits FW) as a substitute for ENPH 454 and one list "B" course. Note that APSC 480 has a prerequisite of APSC 381 or permission of the instructor.

Physics List A:

One from Physics List A:

- ENPH 321 Advanced Mechanics W | 3.5
- ENPH 414 Introduction to General Relativity F | 3
- ENPH 460 Laser Optics W | 3.5
- ENPH 472 Statistical Mechanics F | 3.5
- ENPH 480 Solid State Physics F | 3.5
- ENPH 483 Nanoscience and Nanotechnology W | 3.5
- ENPH 490 Nuclear Physics F | 3.5
- ENPH 491 Physics of Nuclear Reactors F | 3.5 [1]

- ENPH 495 Introduction to Medical Physics W | 3 [2]

Note:

[1] ENPH 491 will be offered in 2015/2016 and alternate years thereafter.

[2] ENPH 495 will be offered in 2016/2017 and alternate years thereafter.

Electrical Sub-Plan (P1)

- ENPH 336 Solid State Devices W | 3.25

Electrical List B:

Two courses from Electrical List B, at least one of which must be numbered above 400*:

- ELEC 408 Biomedical Signal and Image Processing F | 3
- ELEC 409 NOT OFFERED THIS YEAR - Bioinformatic Analytics W | 3
- ELEC 421 Digital Signal Processing: Filters and System Design F | 4
- ELEC 422 NOT OFFERED THIS YEAR - Digital Signal Processing: Random Models and Applications F | 3
- ELEC 443 Linear Control Systems F | 4
- ELEC 448 NOT OFFERED THIS YEAR - Introduction to Robotics: Mechanics and Control W | 3.5
- ELEC 451 NOT OFFERED THIS YEAR - Digital Integrated Circuit Engineering F | 3
- ELEC 454 Analog Electronics W | 3.25
- ELEC 457 NOT OFFERED THIS YEAR - Integrated Circuits and System Applications W | 3
- ELEC 461 Digital Communications F | 3.5
- ELEC 464 Wireless Communications W | 3
- ELEC 471 Computer Networks I F | 3
- ELEC 476 NOT OFFERED THIS YEAR - Modelling and Systems Simulation W | 3.5
- ELEC 478 NOT OFFERED THIS YEAR - Computer Networks II W | 3
- ELEC 483 NOT OFFERED THIS YEAR - Microwave and RF Circuits and Systems W | 4.5
- ELEC 486 Fiber Optic Communications W | 3.75
- CHEE 340 Biomedical Engineering W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other options within Engineering Physics.

Materials Sub-Plan (P3)

- ENPH 480 Solid State Physics F | 3.5

Materials List B:

Two courses from Materials List B*:

- MDEP 437 Fuel Cell Technology F | 3.5
- MECH 423 Introduction to Microsystems F | 3.5
- MECH 470 Deformation Processing W | 3.5
- MECH 476 Engineering of Polymers and Composite Materials W | 3.5
- MECH 478 Biomaterials F | 3.5
- MECH 479 NOT OFFERED THIS YEAR - Nano-Structured Materials F | 3.5
- MECH 483 Nuclear Materials W | 3.5
- MECH 484 Introduction to Ceramics F | 3.5
- CHEE 340 Biomedical Engineering W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a list B course above with a list B course from one of the other options within Engineering Physics.

Mechanical Sub-Plan (P4)

Mechanical List B:

Three courses: two from Mechanical List B, and one from Physics List A or Mechanical List B*:

- CHEE 340 Biomedical Engineering W | 3.5
- MDEP 437 Fuel Cell Technology F | 3.5
- MECH 420 Vibrations W | 3.5
- MECH 423 Introduction to Microsystems F | 3.5
- MECH 424 Sustainable Product Design W | 3.5
- MECH 430 Thermal Systems Design F | 4
- MECH 435 Internal Combustion Engines W | 3.5
- MECH 439 Turbomachinery F | 3.5
- MECH 441 Fluid Mechanics III W | 3.5
- MECH 444 Computational Fluid Dynamics W | 3.5
- MECH 448 Compressible Fluid Flow F | 3.5
- MECH 452 Mechatronics Engineering F | 4
- MECH 456 Introduction to Robotics F | 3.5
- MECH 465 Computer-Aided Design F | 3.5
- MECH 480 Airplane Aerodynamics and Performance W | 3.5
- MECH 481 Wind Energy F | 3.5
- MECH 482 Noise Control W | 3.5
- MECH 492 Biofluids W | 3.5
- MECH 495 Ergonomics and Design W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other options within Engineering Physics.

Computing Sub-Plan (P6)

Computing List B:

Three courses: two from Computing List B and one from Physics List A or Computing List B. At least one of the Computing List B courses must be numbered above 400*:

- CHEE 340 Biomedical Engineering W | 3.5
- CMPE 330 Computer-Integrated Surgery F | 3
- CMPE 365 Algorithms I F | 4
- CMPE 452 Neural and Genetic Computing F | 3
- CMPE 454 Computer Graphics W | 3
- CMPE 457 Image Processing and Computer Vision F | 3
- CMPE 458 Programming Language Processors W | 4
- CMPE 472 Medical Informatics W | 3
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5
- ELEC 374 Digital Systems Engineering W | 4.25 [1]
- ELEC 377 Operating Systems F | 4
- ELEC 408 Biomedical Signal and Image Processing F | 3
- ELEC 409 NOT OFFERED THIS YEAR - Bioinformatic Analytics W | 3

Note:

[1]With permission of the instructor.

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other sub-plans within Engineering Physics.

Complementary Studies:

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Engineering Physics Plan, the Engineering Economics course is APSC 221, and the Communications requirements are met through courses in the core plan.

Engineering Physics, B. Sc. (Class of 2018)

Second Year Common Core - 2015/2016

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- MTHE 227 Vector Analysis F | 3
- MTHE 237 Differential Equations for Engineering Science F | 3.25
- ENPH 242 Relativity and Quanta F | 3.5
- ELEC 221 Electric Circuits F | 4.25
- ENPH 211 Applied Physics W | 3.5
- ENPH 225 Mechanics W | 3.5
- ENPH 239 Electricity and Magnetism W | 3.5
- ENPH 252 Management of Experimental Data W | 1.25
- ENPH 253 Engineering Physics Laboratory W | K3.5

- ENPH 213 Computational Engineering Physics W | 4

Electrical Sub-Plan (P1)

- ELEC 271 Digital Systems F | 4.25
- ELEC 252 Electronics I W | 4.25

Materials Sub-Plan (P3)

- MECH 270 Materials Science and Engineering F | 3.75
- MECH 241 Fluid Mechanics I W | 3.5

Mechanical Sub-Plan (P4)

- MECH 230 Thermodynamics I F | 3.5
- MECH 241 Fluid Mechanics I W | 3.5

Computing Sub-Plan (P6)

- CMPE 212 Introduction to Computing Science II F/W | 4
- ELEC 278 Fundamentals of Information Structures F | 4

Third Year Common Core - 2016/2017

- MTHE 338 Fourier Methods for Boundary Value Problems F | 3.5 *
- ENPH 344 Introduction to Quantum Mechanics F | 3.5
- ENPH 354 Engineering Physics Design Project W | 3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- Complementary Studies, List A W | 3 **
- ENPH 345 Quantum Physics of Atoms, Nuclei and Particles W | 3.5
- ENPH 353 Engineering Physics Laboratory II F | 2.5

Note:

* MTHE 338 may be replaced by ENPH 312. The second half of ENPH 312 replaces one of the required fourth year Physics List A electives.

** Students are free to take Complementary Studies courses at any time in their program that suits their interests, workloads, and schedules. Read explanatory notes on Complementary Studies at the end of this section.

APSC 381 may be taken as a technical elective for students particularly interested in engineering design.

ENPH 491 and ENPH 495 are fourth year Physics List A electives offered every second year which students in their third year can consider taking.

Note: In February of Third Year students may apply for permission to take ENPH 456 and ENPH 457 as a combined alternate to (ENPH 455, a 4th year List "B" course, and the Engineering Elective), to facilitate an **Accelerated**

Master's graduate degree ending 16 months after completion of the undergraduate Engineering Physics program. Details will be given in January of your 3rd year.

Electrical Sub-Plan (P1)

- ELEC 323 Continuous-Time Signals and Systems F | 3.75
- ELEC 353 Electronics II F | 4.5
- ENPH 372 Thermodynamics W | 3.5
- ELEC 324 Discrete-Time Signals and Systems W | 4
- ELEC 326 Probability and Random Processes W | 3.5

Materials Sub-Plan (P3)

- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
- MECH 370 Principles of Materials Processing F | 3.5
- ENPH 334 Electronics for Applied Scientists F | 5
- ENPH 372 Thermodynamics W | 3.5
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

Mechanical Sub-Plan (P4)

- ENPH 334 Electronics for Applied Scientists F | 5
- MECH 330 Applied Thermodynamics II F | 3.5
- MECH 341 Fluid Mechanics II W | 3.5
- MECH 346 Heat Transfer W | 3.5
- MECH 350 Automatic Control W | 3.5

Computing Sub-Plan (P6)

- ELEC 271 Digital Systems F | 4.25
- ENPH 334 Electronics for Applied Scientists F | 5
- CMPE 320 Fundamentals of Software Development W | 4
- ELEC 274 Computer Architecture W | 4
- ENPH 372 Thermodynamics W | 3.5

Fourth Year Common Core - 2017/2018

- ENPH 431 Electromagnetic Theory F | 3.5
- ENPH 454 Advanced Engineering Physics Design Project F | 4.5 **
- Complementary Studies, List A F/W | 3 **
- Complementary Studies, List A, B, C or D F/W | 3 **
- Engineering Elective (any 300- or 400-level Engineering and Applied Science course) F/W | 3
- ENPH 455 Engineering Physics Thesis FW | 4 *
- ENPH 453 Advanced Physics Laboratory W | 3.5

Note:

* Students may take (ENPH 456 and ENPH 457) as a combined alternate to ENPH 455, List "B" and Engineering Elective. See the description after 3rd year.

** Students may instead take APSC 480 APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9 as a substitute for ENPH 454 and one list "B" course. Note that APSC 480 has a prerequisite of APSC 381 or permission of the instructor.

Physics List A:

One from Physics List A:

- ENPH 321 Advanced Mechanics W | 3.5
- ENPH 414 Introduction to General Relativity F | 3
- ENPH 460 Laser Optics W | 3.5
- ENPH 472 Statistical Mechanics F | 3.5
- ENPH 480 Solid State Physics F | 3.5
- ENPH 483 Nanoscience and Nanotechnology W | 3.5
- ENPH 490 Nuclear Physics F | 3.5
- ENPH 491 Physics of Nuclear Reactors F | 3.5 [1]
- ENPH 495 Introduction to Medical Physics W | 3 [2]

Note:

[1] ENPH 491 will be offered in 2017/2018 and alternate years thereafter.

[2] ENPH 495 will be offered in 2016/2017 and alternate years thereafter.

Electrical Sub-Plan (P1)

- ENPH 336 Solid State Devices W | 3.25

Electrical List B:

Two courses from Electrical List B, at least one of which must be numbered above 400*:

- ELEC 408 Biomedical Signal and Image Processing F | 3
- ELEC 409 NOT OFFERED THIS YEAR - Bioinformatic Analytics W | 3
- ELEC 421 Digital Signal Processing: Filters and System Design F | 4
- ELEC 422 NOT OFFERED THIS YEAR - Digital Signal Processing: Random Models and Applications F | 3
- ELEC 443 Linear Control Systems F | 4
- ELEC 448 NOT OFFERED THIS YEAR - Introduction to Robotics: Mechanics and Control W | 3.5
- ELEC 451 NOT OFFERED THIS YEAR - Digital Integrated Circuit Engineering F | 3
- ELEC 454 Analog Electronics W | 3.25
- ELEC 457 NOT OFFERED THIS YEAR - Integrated Circuits and System Applications W | 3
- ELEC 461 Digital Communications F | 3.5

- ELEC 464 Wireless Communications W | 3
- ELEC 471 Computer Networks I F | 3
- ELEC 476 NOT OFFERED THIS YEAR - Modelling and Systems Simulation W | 3.5
- ELEC 478 NOT OFFERED THIS YEAR - Computer Networks II W | 3
- ELEC 483 NOT OFFERED THIS YEAR - Microwave and RF Circuits and Systems W | 4.5
- ELEC 486 Fiber Optic Communications W | 3.75
- CHEE 340 Biomedical Engineering W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other options within Engineering Physics.

Materials Sub-Plan (P3)

- ENPH 480 Solid State Physics F | 3.5

Materials List B:

Two courses from Materials List B*:

- MDEP 437 Fuel Cell Technology F | 3.5
- MECH 423 Introduction to Microsystems F | 3.5
- MECH 470 Deformation Processing W | 3.5
- MECH 476 Engineering of Polymers and Composite Materials W | 3.5
- MECH 478 Biomaterials F | 3.5
- MECH 479 NOT OFFERED THIS YEAR - Nano-Structured Materials F | 3.5
- MECH 483 Nuclear Materials W | 3.5
- MECH 484 Introduction to Ceramics F | 3.5
- CHEE 340 Biomedical Engineering W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a list B course above with a list B course from one of the other options within Engineering Physics.

Mechanical Sub-Plan (P4)

Mechanical List B:

Three courses: two from Mechanical List B, and one from Physics List A or Mechanical List B*:

- CHEE 340 Biomedical Engineering W | 3.5
- MDEP 437 Fuel Cell Technology F | 3.5
- MECH 420 Vibrations W | 3.5
- MECH 423 Introduction to Microsystems F | 3.5
- MECH 424 Sustainable Product Design W | 3.5

- MECH 430 Thermal Systems Design F | 4
- MECH 435 Internal Combustion Engines W | 3.5
- MECH 439 Turbomachinery F | 3.5
- MECH 441 Fluid Mechanics III W | 3.5
- MECH 444 Computational Fluid Dynamics W | 3.5
- MECH 448 Compressible Fluid Flow F | 3.5
- MECH 452 Mechatronics Engineering F | 4
- MECH 456 Introduction to Robotics F | 3.5
- MECH 465 Computer-Aided Design F | 3.5
- MECH 480 Airplane Aerodynamics and Performance W | 3.5
- MECH 481 Wind Energy F | 3.5
- MECH 482 Noise Control W | 3.5
- MECH 492 Biofluids W | 3.5
- MECH 495 Ergonomics and Design W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other options within Engineering Physics.

Computing Sub-Plan (P6)

Computing List B:

Three courses: two from Computing List B and one from Physics List A or Computing List B. At least one of the Computing List B courses must be numbered above 400*:

- CHEE 340 Biomedical Engineering W | 3.5
- CMPE 330 Computer-Integrated Surgery F | 3
- CMPE 365 Algorithms I F | 4
- CMPE 452 Neural and Genetic Computing F | 3
- CMPE 454 Computer Graphics W | 3
- CMPE 457 Image Processing and Computer Vision F | 3
- CMPE 458 Programming Language Processors W | 4
- CMPE 472 Medical Informatics W | 3
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5
- ELEC 374 Digital Systems Engineering W | 4.25 [1]
- ELEC 377 Operating Systems F | 4
- ELEC 408 Biomedical Signal and Image Processing F | 3
- ELEC 409 NOT OFFERED THIS YEAR - Bioinformatic Analytics W | 3

Note:

[1]With permission of the instructor.

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other sub-plans within Engineering Physics.

Complementary Studies:

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Engineering Physics Plan, the Engineering Economics course is APSC 221, and the Communications requirements are met through courses in the core plan.

Geological Engineering

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Geological Engineering is a broad and creative field of engineering which combines the practical application of the principles, concepts and techniques of the geological sciences with engineering investigation, analysis and design, to provide reliable and sustainable engineered solutions to human needs.

Geological Engineering at Queen's University prepares students for design challenges related to: energy, water and mineral resource exploration, extraction and management; to environmental protection, management and remediation; to geotechnical design on, with and underneath earth materials; to geo-hazard risk mitigation; and to the non-destructive geophysical investigation of the subsurface environment for engineering purposes. The academic plan provides an enhanced understanding, essential for reliable and sustainable design solutions, of the inherent variability in the engineering properties of earth materials as well as their changes with time and environment and the impact of their genesis on these properties.

The Geological Engineering plan offers a common second year curriculum, to provide students with a foundation in geological sciences and broad exposure to a variety of geo-engineering problems and design approaches. The extensive and well-rounded core program offered in third and fourth year is augmented by a number of technical elective choices. This allows each student to specialize by taking several courses in an area of interest, including mineral and energy exploration, geotechnical engineering, geo-environmental engineering, or geophysics. Alternatively, a student can choose to sample a variety of upper year courses in the discipline of Geological Engineering.

Geological Engineering Curriculum

It is recommended that students consult an academic advisor in each year of their plan, to ensure that they are taking the required number of Technical Electives and Complementary Studies courses to fulfill the academic plan requirements as well as those of the Canadian Engineering Accreditation Board. Students need to plan ahead to ensure that they take courses in the appropriate years along with the necessary prerequisites.

Revisions to the Geological Engineering plan are ongoing. There are separate sections for the Classes of 2016, 2017, and 2018. Please refer to the appropriate calendar for your year of graduation.

The Technical Elective List is given at the end of this section. Complementary Studies are discussed at the end of each year calendar entry. Students may take elective courses (5 Technical and 3 Complementary Studies courses) in any of the elective slots available in the 3rd and 4th years of the plan, but usually 2 TECHNICAL Electives and 1 COMPLEMENTARY electives are taken in third year, and 3 TECHNICAL and 2 COMPLEMENTARY electives are taken in fourth year.

Field Work

Field work is a necessary part of Geological Engineering training, and field trips and field projects are offered in each year of study because the Department wishes to provide the best education possible. Employers and alumni from the Department are universally enthusiastic about the value of this component of the Geological Engineering plan. In accordance with University policies, students will receive specialized instruction in field safety.

A field skills course is undertaken during the fall term of second year. A two-week Geological Engineering field school is held in the spring immediately following final exams. Students are expected to take this course at the end of their second year. This course requires teams of students to design and carry out geological and engineering site investigations related to specific geological engineering problems. A second core field course in fourth year deals with engineering and design issues related to geo-environmental, geotechnical and resource management issues within the mineral industry.

Students entering 2nd year in 2013 and 2014 paid a one-time Field Transportation Levy. The cost of accommodation and food, while on field trips or at field schools, will be borne by the student. Additional transportation fees may apply for students attending numerous field courses.

Students entering 2nd year in 2015 and beyond: The cost of field trips and courses, including transportation, accommodation and food (when it is supplied), will be borne by the student.

A list of the field education costs for each course is provided on the departmental web page. These costs are subject to change, and will be finalized by June 1 each year for the following academic year. These costs will be payable by the due dates listed in the table. Subsidies will be provided by the Department when funding permits.

Students may incur additional field trip costs for courses they elect to take as a part of their degree. Students should consult with course instructors regarding these costs before registering in courses with a field trip component.

Geological Engineering, B. Sc. (Class of 2016)

Second Year Common Core – 2013/14 (Class of 2016 Only)

- CIVL 230 Solid Mechanics I F | 4.25
- GEOE 221 Geological Engineering Field Methods F | 4.5
- GEOE 232 Mineralogy F | 4.5
- GEOE 281 Earth Systems Engineering F | 3.5
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- GEOE 235 Genesis and Characterization of Solid Earth Materials W | 4.5
- GEOE 238 Surficial Processes, Sedimentation and Stratigraphy W | 4
- GEOE 249 Geophysical Characterization of the Earth W | 3.5
- GEOE 282 Earth Systems Engineering II: Resources and Environment W | 3.5

Take one of:

- MTHE 227 Vector Analysis F | 3
  OR
- GEOE 207 History of Life F | 3.5

Intersession (Taken in Spring following 2nd Year)

- GEOE 300 Geological Engineering Field School S | 5

Third Year Common Core – 2014/15 (Class of 2016 only)

- CHEE 209 Analysis of Process Data F | 3.5
- GEOE 321 Analysis of Rock Structures F | 4
- GEOE 343 Applied Hydrogeology F | 3.75
- GEOE 359 Applied Quantitative Analysis in Geological Engineering F | 3.5
- GEOE 362 Resource Engineering W | 3.5
- GEOE 319 Applied Geophysics W | 3
- GEOE 333 Terrain Evaluation W | 4
- GEOE 345 Site Investigation & Geological Engineering Design W | 4
- GEOE 365 Geochemical Characterization of the Earth W | 4
- Elective F/W | 3
- Elective F/W | 3
- Elective F/W | 3

Fourth Year Common Core- 2015/16 (Class of 2016 only)

- GEOE 410 Geological Engineering Field School F | 4
- GEOE 446 Engineering Design Project I F | K3
- GEOE 413 Engineering Geology and Rock Engineering Design F | 3.5
- GEOE 447 Engineering Design Project II W | K5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- Elective F/W | 3
- Elective F/W | 3
- Elective F/W | 3
- Elective F/W | 3
- Elective F/W | 3

Electives

The Geological Engineering plan requires that each student take 5 Technical Electives and 3 Complementary Studies Electives (below). The Technical Elective list is at the end of the Geological Engineering plan calendar entry. These courses can be taken at any point during the program to accommodate timetabling, but usually 2 TECHNICAL Electives and 1 COMPLEMENTARY electives are taken in third year, and 3 TECHNICAL and 2 COMPLEMENTARY electives are taken in fourth year. Students should plan to ensure that prerequisite and co-requisite requirements are met. Students should note that a reduction of total course load to less than 80% of the normal load may prevent them from holding Queen's University scholarships.

Geological Engineering: Technical Electives

Complementary Studies:

Refer to the Complementary Studies section of this calendar for courses that may be taken for all Engineering plans. For the Geological Engineering Plan, the Engineering Economics course is APSC 221, and the Communications course is APSC 293 in addition to first year plan and the three Complementary Studies courses (as above): 2 from List A and 1 from Lists A, B, C, or D.

Geological Engineering, B. Sc. (Class of 2017)

Second Year Common Core – 2014/15 (Class of 2017 Only)

- CIVL 230 Solid Mechanics I F | 4.25
- GEOE 221 Geological Engineering Field Methods F | 4.5
- GEOE 232 Mineralogy F | 4.5
- GEOE 281 Earth Systems Engineering F | 3.5
- GEOE 238 Surficial Processes, Sedimentation and Stratigraphy W | 4
- CHEE 209 Analysis of Process Data F | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- GEOE 235 Genesis and Characterization of Solid Earth Materials W | 4.5
- GEOE 249 Geophysical Characterization of the Earth W | 3.5
- MTHE 232 Deleted - Differential Equations |

Intersession (Taken in Spring following 2nd Year)

- GEOE 300 Geological Engineering Field School S | 5

Third Year Common Core – 2015/16 (Class of 2017 only)

- GEOE 321 Analysis of Rock Structures F | 4
- GEOE 343 Applied Hydrogeology F | 3.75
- GEOE 359 Applied Quantitative Analysis in Geological Engineering F | 3.5
- GEOE 362 Resource Engineering W | 3.5
- GEOE 319 Applied Geophysics W | 3
- GEOE 345 Site Investigation & Geological Engineering Design W | 4
- GEOE 333 Terrain Evaluation W | 4
- GEOE 365 Geochemical Characterization of the Earth W | 4
- Elective F/W | 3
- Elective F/W | 3
- Elective F/W | 3

Fourth Year Common Core- 2016/17 (Class of 2017 only)

- GEOE 207 History of Life F | 3.5
- GEOE 410 Geological Engineering Field School F | 4

- GEOE 446 Engineering Design Project I F | K3
- GEOE 413 Engineering Geology and Rock Engineering Design F | 3.5
- GEOE 447 Engineering Design Project II W | K5
- Elective F/W | 3
- Elective F/W | 3
- Elective F/W | 3
- Elective F/W | 3
- Elective F/W | 3

Electives

The Geological Engineering plan requires that each student take 5 Technical Electives and 3 Complementary Studies Electives (below). The Technical Elective list is at the end of the Geological Engineering plan calendar entry. These courses can be taken at any point during the program to accommodate timetabling, but usually 2 TECHNICAL Electives and 1 COMPLEMENTARY electives are taken in third year, and 3 TECHNICAL and 2 COMPLEMENTARY electives are taken in fourth year. Students should plan to ensure that prerequisite and co-requisite requirements are met. Students should note that a reduction of total course load to less than 80% of the normal load may prevent them from holding Queen's University scholarships. Note that GEOE 207 may be taken in either 3rd or 4th year.

Geological Engineering: Technical Electives

Complementary Studies

Refer to the Complementary Studies section of this calendar for courses that may be taken for all Engineering programs. For the Geological Engineering Program, the Engineering Economics course is APSC 221, and the Communications course is APSC 293 in addition to first year program and the three Complementary Studies courses (as above): 2 from List A and 1 from Lists A,B,C, or D.

Geological Engineering, B. Sc. (Class of 2018)

Second Year Common Core – 2015/16 (Class of 2018 Only)

- CHEE 209 Analysis of Process Data F | 3.5
- CIVL 230 Solid Mechanics I F | 4.25
- GEOE 221 Geological Engineering Field Methods F | 4.5
- GEOE 232 Mineralogy F | 4.5
- GEOE 281 Earth Systems Engineering F | 3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- GEOE 235 Genesis and Characterization of Solid Earth Materials W | 4.5
- GEOE 238 Surficial Processes, Sedimentation and Stratigraphy W | 4
- GEOE 249 Geophysical Characterization of the Earth W | 3.5
- MTHE 225 Ordinary Differential Equations F/W | 3.5

Intersession (Taken in Spring following 2nd Year)

- GEOE 300 Geological Engineering Field School S | 5

Third Year Common Core – 2016/17 (Class of 2018 only)

- GEOE 321 Analysis of Rock Structures F | 4
- GEOE 343 Applied Hydrogeology F | 3.75
- GEOE 359 Applied Quantitative Analysis in Geological Engineering F | 3.5
- GEOE 362 Resource Engineering W | 3.5
- GEOE 319 Applied Geophysics W | 3
- GEOE 333 Terrain Evaluation W | 4
- GEOE 345 Site Investigation & Geological Engineering Design W | 4
- GEOE 365 Geochemical Characterization of the Earth W | 4
- Elective F/W | 3
- Elective F/W | 3
- Elective F/W | 3

Fourth Year Common Core- 2017/18 (Class of 2018 only)

- GEOE 207 History of Life F | 3.5
- GEOE 410 Geological Engineering Field School F | 4
- GEOE 446 Engineering Design Project I F | K3
- GEOE 413 Engineering Geology and Rock Engineering Design F | 3.5
- GEOE 447 Engineering Design Project II W | K5
- Elective F/W | 3
- Elective F/W | 3
- Elective F/W | 3
- Elective F/W | 3
- Elective F/W | 3

Electives

The Geological Engineering plan requires that each student take 5 Technical Electives and 3 Complementary Studies Electives (below). The Technical Elective list is at the end of the Geological Engineering plan calendar entry. These courses can be taken at any point during the program to accommodate timetabling, but usually 2 TECHNICAL Electives and 1 COMPLEMENTARY electives are taken in third year, and 3 TECHNICAL and 2 COMPLEMENTARY electives are taken in fourth year. Students should plan to ensure that prerequisite and co-requisite requirements are met. Students should note that a reduction of total course load to less than 80% of the normal load may prevent them from holding Queen's University scholarships. Note that GEOE 207 may be taken in either 3rd or 4th year.

Geological Engineering: Technical Electives

Complementary Studies

Refer to the Complementary Studies section of this calendar for courses that may be taken for all Engineering programs. For the Geological Engineering Program, the Engineering Economics course is APSC 221, and the Communications course is APSC 293 in addition to first year program and the three Complementary Studies courses (as above): 2 from List A and 1 from Lists A,B,C, or D.

Mathematics and Engineering

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This plan was developed at Queen's in response to the need for engineers who possess the skills and insights of applied mathematicians. In the second and third years of the plan, half of the curriculum consists of honours courses in pure and applied mathematics; the balance consists of engineering courses in one of three sub-plans offered in cooperation with the departments of Mechanical, Electrical and Computer Engineering, and the School of Computing. The sub-plans are developed with appropriate applications of mathematics to engineering in the final year. The sub-plans are:

(M6) APPLIED MECHANICS: (mechanics, dynamics, fluid mechanics, thermodynamics)

(M9) COMPUTING AND COMMUNICATIONS: (computer science, software design, communication, information systems, and electrical engineering)

(M11) SYSTEMS AND ROBOTICS: (electrical and mechanical engineering, control, communications, information systems, robotics, and mechanics)

Options available:

- Applied Mechanics Option
- Computing and Communications Option
- Systems and Robotics Option

Mathematics and Engineering, B. Sc. (Class of 2016)

Second Year Common Core - 2013/2014

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- MTHE 217 Algebraic Structures with Applications F | 3.5
- MTHE 237 Differential Equations for Engineering Science F | 3.25
- MTHE 280 Advanced Calculus F | 3.5
- MTHE 281 Introduction to Real Analysis W | 3.5
- MTHE 312 Deleted - Linear Algebra |

Applied Mechanics Sub-Plan (M6)

- CIVL 220 NOT OFFERED THIS YEAR - Statics and Solid Mechanics F | 4
- MECH 230 Thermodynamics I F | 3.5
- ENPH 252 Management of Experimental Data W | 1.25
- ELEC 210 Introductory Electric Circuits and Machines W | 4.25

- MECH 228 Kinematics and Dynamics W | 3.5
- MECH 241 Fluid Mechanics I W | 3.5

Minimum Total Credits: 42

Computing and Communications Sub-Plan (M9)

- ELEC 221 Electric Circuits F | 4.25
- ELEC 271 Digital Systems F | 4.25
- ELEC 293 Deleted - Electrical and Computer Engineering Laboratory I |
- ELEC 252 Electronics I W | 4.25
- ELEC 274 Computer Architecture W | 4
- ELEC 294 Deleted - Electrical and Computer Engineering Laboratory II |
- ENPH 239 Electricity and Magnetism W | 3.5

Minimum Total Credits: 42.75

Systems and Robotics Sub-Plan (M11)

- ELEC 221 Electric Circuits F | 4.25
- ELEC 271 Digital Systems F | 4.25
- ELEC 293 Deleted - Electrical and Computer Engineering Laboratory I |
- ENPH 225 Mechanics W | 3.5
- ELEC 252 Electronics I W | 4.25
- ELEC 274 Computer Architecture W | 4
- ELEC 294 Deleted - Electrical and Computer Engineering Laboratory II |

Minimum Total Credits: 42.75

Third Year Common Core - 2014/2015

- MTHE 326 Functions of a Complex Variable F | 3
- MTHE 332 Introduction to Control W | 4
- MTHE 334 Mathematical Methods for Engineering and Physics F | 3.5
- MTHE 335 Mathematics of Engineering Systems W | 3.5
- MTHE 393 Engineering Design and Practice for Mathematics and Engineering W | K4
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3

Applied Mechanices Sub-Plan (M6)

- MECH 321 Solid Mechanics II F | 3.5
- MECH 328 Dynamics and Vibration F | 3.5
- MECH 330 Applied Thermodynamics II F | 3.5
- MECH 398 Mechanical Engineering Laboratory I F | K2
- MECH 323 Machine Design W | 4.5

- MECH 341 Fluid Mechanics II W | 3.5
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 42

NOTE: Students intending to take MECH 452 in fourth year should take the Technical Elective ELEC 310 in third year and delay APSC 221 until fourth year.

Computing and Communications Sub-Plan (M9)

- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5
- MTHE 351 Probability I F | 3.5
- Complementary Studies, List A F/W | 3
- CMPE 212 Introduction to Computing Science II F/W | 4
- MTHE 353 Probability II W | 3

Minimum Total Credits: 43

Systems and Robotics Sub-Plan (M11)

- MTHE 351 Probability I F | 3.5
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5
- Complementary Studies, List A F | 3
- ENPH 239 Electricity and Magnetism W | 3.5
- MTHE 353 Probability II W | 3

Minimum Total Credits: 42.5

Fourth Year Common Core - 2015/2016

- MTHE 494 Mathematics and Engineering Seminar F | 3
- MTHE 493 Engineering Mathematics Project FW* | K7.5

Applied Mechanics Sub-Plan (M6)

- MTHE 430 Modern Control Theory F | 4
- MTHE 351 Probability I F | 3.5
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A, B, C, or D W | 3
- MTHE 439 Lagrangian Mechanics, Dynamics, and Control W | 3.5

Elective

M6 students must choose 4 technical electives: a minimum of one (1) technical elective must be taken from List I; and the remaining from List II, subject to the requirement that the elective selection satisfies the following two criteria:

1. the selection exceeds the minimum of 40 Accreditation Units (AUs) in Engineering Design (ED) and
2. the selection exceeds the minimum of 120 AUs in Engineering Design + Engineering Science (ES+ED).

PLEASE NOTE: the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered

Mathematics and Engineering, Applied Mechanics: Technical Electives

Minimum Total Credits: 42.5

Computing and Communications Sub-Plan (M9)

- MTHE 474 Information Theory F | 3
- MTHE 455 Stochastic Processes and Applications F | 3.5
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A, B, C or D F/W | 3
- CMPE 365 Algorithms I F | 4
- MTHE 477 Data Compression and Source Coding W | 3

Elective

M9 students must choose 4 technical electives: a minimum of two (2) technical electives must be taken from List I; and the remaining from List II.

PLEASE NOTE: the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.

Mathematics and Engineering, Computing and Communications: Technical Electives

Minimum Total Credits: 42

Systems and Robotics Sub-Plan (M11)

- MTHE 430 Modern Control Theory F | 4
- MTHE 472 Control of Stochastic Systems W | 3
- MTHE 474 Information Theory F | 3
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A, B, C or D F/W | 3

Elective

M11 students must choose 4 technical electives: a minimum of two (2) technical electives must be taken from List I; and the remaining from List II.

PLEASE NOTE: the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.

Mathematics and Engineering, Systems and Robotics: Technical Electives

Minimum Total Credits: 38.5

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Mathematics and Engineering Program, the Engineering Economics course is APSC 221, and the Communications requirements are met through courses taken in the core program (MTHE 393, MTHE 494, MTHE 493 and APSC 293).

Mathematics and Engineering, B. Sc. (Class of 2017)

Second Year Common Core - 2014/2015

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- MTHE 217 Algebraic Structures with Applications F | 3.5
- MTHE 237 Differential Equations for Engineering Science F | 3.25
- MTHE 280 Advanced Calculus F | 3.5
- MTHE 281 Introduction to Real Analysis W | 3.5
- MTHE 312 Deleted - Linear Algebra |

Applied Mechanics Sub-Plan (M6)

- CIVL 220 NOT OFFERED THIS YEAR - Statics and Solid Mechanics F | 4
- MECH 230 Thermodynamics I F | 3.5
- ENPH 252 Management of Experimental Data W | 1.25
- ELEC 210 Introductory Electric Circuits and Machines W | 4.25
- MECH 228 Kinematics and Dynamics W | 3.5
- MECH 241 Fluid Mechanics I W | 3.5

Minimum Total Credits: 42

Computing and Communications Sub-Plan (M9)

- ELEC 221 Electric Circuits F | 4.25
- ELEC 271 Digital Systems F | 4.25
- ELEC 252 Electronics I W | 4.25
- ELEC 274 Computer Architecture W | 4
- ENPH 239 Electricity and Magnetism W | 3.5

Minimum Total Credits: 42.5

Systems and Robotics Sub-Plan (M11)

- ELEC 221 Electric Circuits F | 4.25
- ELEC 271 Digital Systems F | 4.25
- ENPH 225 Mechanics W | 3.5
- ELEC 252 Electronics I W | 4.25
- ELEC 274 Computer Architecture W | 4

Minimum Total Credits: 42.5

Third Year Common Core - 2015/2016

- MTHE 326 Functions of a Complex Variable F | 3
- MTHE 332 Introduction to Control W | 4
- MTHE 334 Mathematical Methods for Engineering and Physics F | 3.5
- MTHE 335 Mathematics of Engineering Systems W | 3.5
- MTHE 393 Engineering Design and Practice for Mathematics and Engineering W | K4
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3

Applied Mechanics Sub-Plan (M6)

- MECH 321 Solid Mechanics II F | 3.5
- MECH 328 Dynamics and Vibration F | 3.5
- MECH 330 Applied Thermodynamics II F | 3.5
- MECH 398 Mechanical Engineering Laboratory I F | K2
- MECH 323 Machine Design W | 4.5
- MECH 341 Fluid Mechanics II W | 3.5
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 43.5

NOTE: Students intending to take MECH 452 in fourth year should take the Technical Elective ELEC 310 in third year and delay APSC 221 until fourth year.

Computing and Communications Sub-Plan (M9)

- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5
- MTHE 351 Probability I F | 3.5
- Complementary Studies, List A F/W | 3
- CMPE 212 Introduction to Computing Science II F/W | 4
- MTHE 353 Probability II W | 3

Minimum Total Credits: 43

Systems and Robotics Sub-Plan (M11)

- MTHE 351 Probability I F | 3.5
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5
- Complementary Studies, List A F | 3
- ENPH 239 Electricity and Magnetism W | 3.5
- MTHE 353 Probability II W | 3

Minimum Total Credits: 42.5

Fourth Year Common Core - 2016/2017

- MTHE 494 Mathematics and Engineering Seminar F | 3
- MTHE 493 Engineering Mathematics Project FW* | K7.5

Applied Mechanics Sub-Plan (M6)

- MTHE 430 Modern Control Theory F | 4
- MTHE 351 Probability I F | 3.5
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A, B, C, or D W | 3
- MTHE 439 Lagrangian Mechanics, Dynamics, and Control W | 3.5

Elective

M6 students must choose 4 technical electives: a minimum of one (1) technical elective must be taken from List I; and the remaining from List II, subject to the requirement that the elective selection satisfies the following two criteria:

1. the selection exceeds the minimum of 40 Accreditation Units (AUs) in Engineering Design (ED) and
2. the selection exceeds the minimum of 120 AUs in Engineering Design + Engineering Science (ES+ED).

PLEASE NOTE: the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.

Mathematics and Engineering, Applied Mechanics: Technical Electives

Minimum Total Credits: 42.5

Computing and Communications Sub-Plan (M9)

- MTHE 474 Information Theory F | 3
- MTHE 455 Stochastic Processes and Applications F | 3.5
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A, B, C or D F/W | 3
- CMPE 365 Algorithms I F | 4

- MTHE 477 Data Compression and Source Coding W | 3

Elective

M9 students must choose 4 technical electives: a minimum of two (2) technical electives must be taken from List I; and the remaining from List II.

PLEASE NOTE: the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.

Mathematics and Engineering, Computing and Communications: Technical Electives

Minimum Total Credits: 42

Systems and Robotics Sub-Plan (M11)

- MTHE 430 Modern Control Theory F | 4
- MTHE 472 Control of Stochastic Systems W | 3
- MTHE 474 Information Theory F | 3
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A, B, C or D F/W | 3

Elective

M11 students must choose 4 technical electives: a minimum of two (2) technical electives must be taken from List I; and the remaining from List II.

PLEASE NOTE: the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.

Mathematics and Engineering, Systems and Robotics: Technical Electives

Minimum Total Credits: 38.5

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Mathematics and Engineering Program, the Engineering Economics course is APSC 221, and the Communications requirements are met through courses taken in the core program (MTHE 393, MTHE 494, MTHE 493 and APSC 293).

Mathematics and Engineering, B. Sc. (Class of 2018)

Second Year Common Core - 2015/2016

- APSC 200 Engineering Design and Practice II F/W | K4

- APSC 293 Engineering Communications l F/W | K1
- MTHE 217 Algebraic Structures with Applications F | 3.5
- MTHE 237 Differential Equations for Engineering Science F | 3.25
- MTHE 280 Advanced Calculus F | 3.5
- MTHE 281 Introduction to Real Analysis W | 3.5
- MTHE 212 Linear Algebra W | 3.5

Applied Mechanics Sub-Plan (M6)

- MECH 221 Statics and Solid Mechanics F, O/L | 4
- MECH 230 Thermodynamics I F | 3.5
- ENPH 252 Management of Experimental Data W | 1.25
- ELEC 210 Introductory Electric Circuits and Machines W | 4.25
- MECH 228 Kinematics and Dynamics W | 3.5
- MECH 241 Fluid Mechanics I W | 3.5

Minimum Total Credits: 42.25

Computing and Communications Sub-Plan (M9)

- ELEC 221 Electric Circuits F | 4.25
- ELEC 271 Digital Systems F | 4.25
- ELEC 252 Electronics I W | 4.25
- ELEC 274 Computer Architecture W | 4
- ENPH 239 Electricity and Magnetism W | 3.5

Minimum Total Credits: 42.5

Systems and Robotics Sub-Plan (M11)

- ELEC 221 Electric Circuits F | 4.25
- ELEC 271 Digital Systems F | 4.25
- ENPH 225 Mechanics W | 3.5
- ELEC 252 Electronics I W | 4.25
- ELEC 274 Computer Architecture W | 4

Minimum Total Credits: 42.5

Third Year Common Core - 2016/2017

- MTHE 326 Functions of a Complex Variable F | 3
- MTHE 332 Introduction to Control W | 4
- MTHE 334 Mathematical Methods for Engineering and Physics F | 3.5
- MTHE 335 Mathematics of Engineering Systems W | 3.5
- MTHE 393 Engineering Design and Practice for Mathematics and Engineering W | K4

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3

Applied Mechanics Sub-Plan (M6)

- MECH 321 Solid Mechanics II F | 3.5
- MECH 328 Dynamics and Vibration F | 3.5
- MECH 330 Applied Thermodynamics II F | 3.5
- MECH 398 Mechanical Engineering Laboratory I F | K2
- MECH 323 Machine Design W | 4.5
- MECH 341 Fluid Mechanics II W | 3.5
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 43.5

NOTE: Students intending to take MECH 452 in fourth year should take the Technical Elective ELEC 310 in third year and delay APSC 221 until fourth year.

Computing and Communications Sub-Plan (M9)

- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5
- MTHE 351 Probability I F | 3.5
- Complementary Studies, List A F/W | 3
- CMPE 212 Introduction to Computing Science II F/W | 4
- MTHE 353 Probability II W | 3

Minimum Total Credits: 43

Systems and Robotics Sub-Plan (M11)

- MTHE 351 Probability I F | 3.5
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5
- Complementary Studies, List A F | 3
- ENPH 239 Electricity and Magnetism W | 3.5
- MTHE 353 Probability II W | 3

Minimum Total Credits: 42.5

Fourth Year Common Core - 2016/2017

- MTHE 494 Mathematics and Engineering Seminar F | 3
- MTHE 493 Engineering Mathematics Project FW* | K7.5

Applied Mechanics Sub-Plan (M6)

- MTHE 430 Modern Control Theory F | 4
- MTHE 351 Probability I F | 3.5
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A, B, C, or D W | 3
- MTHE 439 Lagrangian Mechanics, Dynamics, and Control W | 3.5

Elective

M6 students must choose 4 technical electives: a minimum of one (1) technical elective must be taken from List I; and the remaining from List II, subject to the requirement that the elective selection satisfies the following two criteria:

1. the selection exceeds the minimum of 40 Accreditation Units (AUs) in Engineering Design (ED) and
2. the selection exceeds the minimum of 120 AUs in Engineering Design + Engineering Science (ES+ED).

PLEASE NOTE: the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.

Mathematics and Engineering, Applied Mechanics: Technical Electives

Minimum Total Credits: 42.5

Computing and Communications Sub-Plan (M9)

- MTHE 474 Information Theory F | 3
- MTHE 455 Stochastic Processes and Applications F | 3.5
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A, B, C or D F/W | 3
- CMPE 365 Algorithms I F | 4
- MTHE 477 Data Compression and Source Coding W | 3

Elective

M9 students must choose 4 technical electives: a minimum of two (2) technical electives must be taken from List I; and the remaining from List II.

PLEASE NOTE: *the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.*

Mathematics and Engineering, Computing and Communications: Technical Electives

Minimum Total Credits: 42

Systems and Robotics Sub-Plan (M11)

- MTHE 430 Modern Control Theory F | 4
- MTHE 472 Control of Stochastic Systems W | 3
- MTHE 474 Information Theory F | 3

- Complementary Studies, List A F/W | 3
- Complementary Studies, List A, B, C or D F/W | 3

Elective

M11 students must choose 4 technical electives: a minimum of two (2) technical electives must be taken from List I; and the remaining from List II.

PLEASE NOTE: *the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.*

Mathematics and Engineering, Systems and Robotics: Technical Electives

Minimum Total Credits: 38.5

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Mathematics and Engineering Program, the Engineering Economics course is APSC 221, and the Communications requirements are met through courses taken in the core program (MTHE 393, MTHE 494, MTHE 493 and APSC 293

Mechanical Engineering

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The second year curriculum is common to all sub-plans, but prior to or during the second year, students select from the following options (sub-plans) for their third year: General (ME1) allows students to select technical electives from a variety of specialized areas of study; Materials (ME2) includes courses in materials and metallurgical engineering; or Biomechanical (ME3) includes courses in the biomechanical field. Note that with the wide variety of courses offered, the Department cannot guarantee all courses are conflict free or offered each calendar year, particularly for students who choose to transfer or change options in their third or fourth year. Transferring programs could also result in extending the length of the program beyond the typical 4 years.

Students are invited to participate in one of the international design competition teams such as the Autonomous Sailboat Team (MAST), Baja SAE Team, Formula SAE Team, SAE Aero Design Team, ECO Vehicle Design Team, Fuel Cell Design Team or the Solar Design Team.

Options available:

- Materials Option
- Biomechanical Option

Mechanical and Materials Engineering, B.Sc. (Class of 2016)

Second Year Common Core- 2013/14

- CIVL 220 NOT OFFERED THIS YEAR - Statics and Solid Mechanics F | 4
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- MECH 213 Manufacturing Methods F | 4.5
- MECH 230 Thermodynamics I F | 3.5
- MECH 270 Materials Science and Engineering F | 3.75
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 210 Introductory Electric Circuits and Machines W | 4.25
- MTHE 272 Application of Numerical Methods W | 3.5
- MECH 215 Instrumentation and Measurement F | 3.5
- MECH 228 Kinematics and Dynamics W | 3.5
- MECH 241 Fluid Mechanics I W | 3.5

Minimum Total Credits: 42.75

Note: Students should be aware that poor academics, transfers or a change in option choice may result in their program requirements taking more than the typical 4 years because of course recovery, new course requirements, course availability and conflicts. The department cannot possibly guarantee that courses will not conflict when a student changes options or transfers especially after their 2nd year.

Third Year Common Core – 2014/15

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- MECH 321 Solid Mechanics II F | 3.5
- MECH 328 Dynamics and Vibration F | 3.5
- ENPH 333 Deleted - Electronics for Scientists and Engineers |
- MECH 323 Machine Design W | 4.5
- MECH 346 Heat Transfer W | 3.5
- MECH 350 Automatic Control W | 3.5
- MTHE 367 Engineering Data Analysis W | 3.5
- Complementary Studies, List A (recommended) or a Technical Elective* (See Technical Elective List) W (F if in ME3) | Min. 3

General Sub-Plan (ME1)

- MECH 330 Applied Thermodynamics II F | 3.5

- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
  OR

- MECH 398 Mechanical Engineering Laboratory I F | K2
- MECH 341 Fluid Mechanics II W | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2
  OR
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 42.5

Materials Sub-Plan (ME2)

- MECH 370 Principles of Materials Processing F | 3.5
- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

Minimum Total Credits: 42.5

Biomechanical Sub-Plan (ME3)

- CHEE 442 Biomedical Engineering W | 3.5
- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
  OR
- MECH 398 Mechanical Engineering Laboratory I F | K2
- MECH 393 Biomechanical Product Development F | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2
  OR
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 42.5

Fourth Year Common Core (All Sub-Plans) – 2015/16

- Complementary Studies, List A F or W | 3
- Complementary Studies, List A, B, C or D F or W | 3
- ME1 and ME2 Technical Electives (See Technical Elective List) F and W | 23.5
- ME3 Technical Electives (See Technical Elective List) F and W | 20

Important to Note: Students must have a minimum total of 23.5 credits of Technical Electives in the ME1 and ME2 options, and a minimum total of 20 credits of Technical Electives in the ME3 option. This count includes any non-core technical electives or free electives taken in a student's 2nd, 3rd and 4th years from the specific lists required for their option.

General Sub-Plan (ME1) Core

- MECH 460 Team Project - Conceive and Design F | K4 *
- MECH 464 Communications and Project Management F | 1.5

Minimum Total Credits: 35

Materials Sub-Plan (ME2) Core

- MECH 460 Team Project - Conceive and Design F | K4 *
- MECH 464 Communications and Project Management F | 1.5

Minimum Total Credits: 35

Biomechanical Sub-Plan (ME3) Core

- MECH 460 Team Project - Conceive and Design F | K4 *
  AND
- MECH 462 Team Project - Implement and Operate W | K3.5 *

- MECH 464 Communications and Project Management F | 1.5

Minimum Total Credits: 35

* Capstone Design Course

All students must take a final year capstone design course in their program; for ME1 and ME2 option, students, this course would normally be MECH 460 (4 credits, Fall) coupled with MECH 464 (1.5 credits, Fall). ME3 option students will normally take MECH 460 (4 credits, Fall) and MECH 464 (1.5 credits, Fall and MECH 462 (3.5 credits in the Winter).

However, students in the ME1 and ME2 options may choose to take APSC 480, Multi-disciplinary Industry Engineering Design Project (9 credits FW) as a substitute for MECH 460 and MECH 464, and if the case will receive 3.5 credits of List 1 technical electives that will count towards their required minimum technical elective credit count.

ME3 students may choose to take APSC 480 (9 credits, FW) as a substitute for MECH 460, MECH 464, and MECH 462.

Note that APSC 480 has a prerequisite of APSC 381 and this is taken in the Winter term of third year.

Important Note: All students, regardless of their option, who want to take APSC 480 must make sure they **DROP** MECH 460, MECH 464(and MECH 462 if ME3) from their preloaded courses on Solus, and **ADD** APSC 480, **AND**, all students are limited to taking only **ONE** capstone final year project course, MECH 460 or APSC 480.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Mechanical Plan, the Engineering Economics core course is APSC 221, and the Communications core courses are APSC 293 and MECH 464.

Technical Electives

Mechanical and Materials Engineering, B.Sc. (Class of 2017)

Second Year Common Core - 2014/15

- CIVL 220 NOT OFFERED THIS YEAR - Statics and Solid Mechanics F | 4
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- MECH 213 Manufacturing Methods F | 4.5
- MECH 230 Thermodynamics I F | 3.5
- MECH 270 Materials Science and Engineering F | 3.75
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- ELEC 210 Introductory Electric Circuits and Machines W | 4.25
- MTHE 272 Application of Numerical Methods W | 3.5
- MECH 215 Instrumentation and Measurement F | 3.5
- MECH 228 Kinematics and Dynamics W | 3.5
- MECH 241 Fluid Mechanics I W | 3.5

Minimum Total Credits: 43.25

Note: Students should be aware that poor academics, transfers or a change in option choice may result in their program requirements taking more than the typical 4 years because of course recovery, new course requirements, availability and conflicts. The department cannot possibly guarantee that courses will not conflict when a student changes options or transfers especially after their 2nd year.

Third Year Common Core - 2015/16

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- MECH 321 Solid Mechanics II F | 3.5
- MECH 328 Dynamics and Vibration F | 3.5
- ELEC 310 Introductory Analog Electronic and Digital Circuits F | 4.5
- MECH 323 Machine Design W | 4.5
- MECH 346 Heat Transfer W | 3.5
- MECH 350 Automatic Control W | 3.5
- MTHE 367 Engineering Data Analysis W | 3.5

General Sub-Plan (ME1)

- MECH 330 Applied Thermodynamics II F | 3.5

- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
  OR
- MECH 398 Mechanical Engineering Laboratory I F | K2

- MECH 341 Fluid Mechanics II W | 3.5

- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2
  OR
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 40.5

Materials Sub-Plan (ME2)

- MECH 370 Principles of Materials Processing F | 3.5
- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

Minimum Total Credits: 40.5

Biomechanical Sub-Plan (ME3)

- MECH 393 Biomechanical Product Development F | 3.5

- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
  OR
- MECH 398 Mechanical Engineering Laboratory I F | K2

- CHEE 340 Biomedical Engineering W | 3.5

- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2
  OR
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 40.5

Fourth Year Common Core - 2016/2017

- Complementary Studies, List A F or W | 6
- Complementary Studies, List A, B, C or D F or W | 3
- ME1 and ME2 Technical Electives (See Technical Elective List) F and W | 23.5
- ME3 Technical Electives (See Technical Elective List) F and W | 20

Important to Note: Students must have a minimum total of 23.5 credits of Technical Electives in the ME1 and ME2 options, and a minimum total of 20 credits of Technical Electives in the ME3 option. This count includes any non-core technical electives or free electives taken in a student's 2nd, 3rd and 4th years from the specific lists required for their option.

General Sub-Plan (ME1) Core

- MECH 460 Team Project - Conceive and Design F | K4 *
- MECH 464 Communications and Project Management F | 1.5

Minimum Total Credits: 38

Materials Sub-Plan (ME2) Core

- MECH 460 Team Project - Conceive and Design F | K4 *
- MECH 464 Communications and Project Management F | 1.5

Minimum Total Credits: 38

Biomechanical Sub-Plan (ME3) Core

- MECH 460 Team Project - Conceive and Design F | K4 *
  AND
- MECH 462 Team Project - Implement and Operate W | K3.5 *

- MECH 464 Communications and Project Management F | 1.5

Minimum Total Credits: 38

* Capstone Design Course

All students must take a final year capstone design course in their program. For the ME1 and ME2 option students this course would normally be MECH 460 (4 credits, Fall) coupled with MECH 464 (1.5 credits, Fall). ME3 students will normally take MECH 460 (4 credits, Fall) and MECH 464 (1.5 credits, Fall) and MECH 462 (3.5 credits in Winter).

However, students in the ME1 and ME2 options may choose to take APSC 480, Multi-disciplinary Industry Engineering Design Project (9 credits FW) as a substitute for MECH 460 and MECH 464, and if the case will receive 3.5 credits of List 1 technical electives that will count towards their required minimum option technical elective credit count.

ME3 students may choose to take APSC 480 (9 credits, FW) as a substitute for MECH 460, MECH 464, and MECH 462

Note that APSC 480 has a prerequisite of APSC 381 and this is taken in the winter term of third year.

Important Note: All students, regardless of their option, who want to take APSC 480 must make sure they **DROP** MECH 460, MECH 464, (and MECH 462 if ME3) from their preloaded courses on SOLUS, and **ADD** APSC 480,**AND**, all students are limited to taking only **ONE** final year capstone project course, MECH 460 or APSC 480.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Mechanical Program, the Engineering Economics core course is APSC 221, and the Communications core courses are APSC 293 and MECH 464.

Technical Electives

Mechanical and Materials Engineering: Technical Electives

Mechanical and Materials Engineering, B.Sc. (Class of 2018)

Second Year Common Core- 2015/2016

- MECH 221 Statics and Solid Mechanics F, O/L | 4
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- MECH 213 Manufacturing Methods F | 4.5
- MECH 230 Thermodynamics I F | 3.5
- MECH 215 Instrumentation and Measurement F | 3.5
- MECH 270 Materials Science and Engineering F | 3.75
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 210 Introductory Electric Circuits and Machines W | 4.25
- MTHE 272 Application of Numerical Methods W | 3.5
- MECH 216 Instrumentation and Measurement Labs W | K2
- MECH 228 Kinematics and Dynamics W | 3.5
- MECH 241 Fluid Mechanics I W | 3.5

Minimum Total Credits: 44.5

Note: Students should be aware that a transfer or a change in option choice may result in their program requirements taking more than the typical 4 years because of course availability and conflicts. The department cannot possibly guarantee that courses will not conflict when a student changes options or transfers, especially after 2nd year.

Third Year Common Core- 2016/2017

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- MECH 321 Solid Mechanics II F | 3.5
- MECH 328 Dynamics and Vibration F | 3.5
- ELEC 310 Introductory Analog Electronic and Digital Circuits F | 4.5
- MECH 323 Machine Design W | 4.5
- MECH 346 Heat Transfer W | 3.5
- MECH 350 Automatic Control W | 3.5
- MTHE 367 Engineering Data Analysis W | 3.5

General Sub-Plan (ME1)

- MECH 330 Applied Thermodynamics II F | 3.5

- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
  OR
- MECH 398 Mechanical Engineering Laboratory I F | K2

- MECH 341 Fluid Mechanics II W | 3.5

- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

OR

- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 40.5

Materials Sub-Plan (ME2)

- MECH 370 Principles of Materials Processing F | 3.5
- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

Minimum Total Credits: 40.5

Biomechanical Sub-Plan (ME3)

- CHEE 340 Biomedical Engineering W | 3.5

- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
  OR
- MECH 398 Mechanical Engineering Laboratory I F | K2

- MECH 393 Biomechanical Product Development F | 3.5

- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2
  OR
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 40.5

Fourth Year Common Core- 2017/2018

- Complementary Studies, List A F or W | 6
- Complementary Studies, List A, B, C or D F or W | 3
- ME1 and ME2 Technical Electives (See Technical Elective List) F and W | 23.5
- ME3 Technical Electives (See Technical Elective List) F and W | 20

Important to Note: Students must have a minimum total of 23.5 credits of Technical Electives in the ME1 and ME2 options, and a minimum total of 20 credits of Technical Electives in the ME3 option. This count includes any non-core technical electives or free electives taken in a student's 2nd, 3rd and 4th years from the specific lists required for their option which are outlined in the Technical Elective description.

General Sub-Plan (ME1) Core

- MECH 460 Team Project - Conceive and Design F | K4 *
- MECH 464 Communications and Project Management F | 1.5

Minimum Total Credits: 38

Materials Sub-Plan (ME2) Core

- MECH 460 Team Project - Conceive and Design F | K4 *
- MECH 464 Communications and Project Management F | 1.5

Minimum Total Credits: 38

Biomechanical Sub-Plan (ME3) Core

- MECH 460 Team Project - Conceive and Design F | K4 *
  AND
- MECH 462 Team Project - Implement and Operate W | K3.5 *

- MECH 464 Communications and Project Management F | 1.5

Minimum Total Credits: 38

* Capstone Design Course

All students must take a final year capstone design course in their program. For the ME1 and ME2 option students this course would normally be MECH 460 (4 credits, Fall) coupled with MECH 464 (1.5 credits, Fall). ME3 students will normally take MECH 460 (4 credits, Fall) and MECH 464 (1.5 credits, Fall) and MECH 462 (3.5 credits in Winter).

However, students in the ME1 and ME2 options may choose to take APSC 480, Multi-disciplinary Industry Engineering Design Project (9 credits FW) as a substitute for MECH 460 and MECH 464, and if the case will receive 3.5 credits of List 1 technical electives that will count towards their required minimum option technical elective credit count.

ME3 students may choose to take APSC 480 (9 credits, FW) as a substitute for MECH 460, MECH 464, and MECH 462

Note that APSC 480 has a prerequisite of APSC 381 and this is taken in the winter term of third year.

Important Note: All students, regardless of their option who want to take APSC 480 must make sure they **DROP** MECH 460, MECH 464, (and MECH 462 if ME3) from their pre-loaded courses on SOLUS, and **ADD** APSC 480. All students are limited to taking only **ONE** final year capstone project course, MECH 460 or APSC 480.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Mechanical Program, the Engineering Economics core course is APSC 221, and the Communications core courses are APSC 293 and MECH 464 (or APSC 480).

Technical Electives

Mechanical and Materials Engineering: Technical Electives

Mining Engineering

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The mineral industry deals with the excavation and processing of ore to obtain the mineral products required by contemporary society. To meet industrial requirements, the curriculum of Mining Engineering provides three closely associated options: Mining Engineering, Mineral Processing and Environmental Engineering and Mine-Mechanical Engineering. The Mining Engineering Option, in addition to the fundamentals of mining, includes elements of earthworks and excavation for both surface and underground. In the Mineral Processing and Environmental Engineering option, the subjects addressed include the design, operation and control of ore treatment plants and the environmental control systems required by government regulations. The Mine-Mechanical option produces mining engineers who understand the design, modification, automation, use and maintenance of heavy and specialized equipment in the mining industry.

Options available:

- Mining Option
- Mineral Processing Option
- Mechanical Option

Mining Engineering, B. Sc. (Class of 2016)

Second Year Common Core - 2013/2014

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- CIVL 230 Solid Mechanics I F | 4.25
- MINE 201 Introduction to Mining and Mineral Processing F | 4
- MINE 202 Computer Applications and Instrumentation in Mining F | 1.5
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- ELEC 210 Introductory Electric Circuits and Machines W | 4.25
- MINE 244 Underground Mining W | 3
- MTHE 272 Application of Numerical Methods W | 3.5

Subtotal Credits: 32

Mining Option N1

- MECH 230 Thermodynamics I F | 3.5
- MINE 267 Applied Chemistry for Mining W | 3.5

- MTHE 367 Engineering Data Analysis W | 3.5

Subtotal Credits: 11.5

Minimum Total Credits: 43.5

Minerals Processing Environmental Option N2

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 210 Thermodynamic Properties of Fluids W | 3.5
- MINE 267 Applied Chemistry for Mining W | 3.5

Subtotal Credits: 10

Minimum Total Credits: 42

Mine-Mechanical Option N3

- MECH 230 Thermodynamics I F | 3.5
- MECH 228 Kinematics and Dynamics W | 3.5
- MTHE 367 Engineering Data Analysis W | 3.5

Subtotal Credits: 11

Minimum Total Credits: 43

Third Year Common Core - 2014/2015

- MINE 321 Drilling and Blasting F | 4.5
- MINE 331 Methods of Mineral Separation F | 4.5
- MINE 341 Open Pit Mining F | 4.5
- GEOE 262 Geological Aspects of Mineral Deposits W | 3.75
- MINE 324 Hydraulics for Mining Applications W | 3.5
- MINE 325 Applied Rock Mechanics W | 4.5
- MINE 326 Operations Research W | 4.5

Subtotal Credits 29.75

Mining Option N1

- MINE 339 Mine Ventilation F | 4.5
- Complementary Studies, List A F | 3
- Elective F | 3
- MINE 330 Mineral Industry Economics W | 3.5
- Elective W | 3

Subtotal Credits: 17

Minimum Total Credits: 46.75

Minerals Processing Environmental Option N2

- CHEE 321 Chemical Reaction Engineering F | 3.5
- Complementary Studies, List A F | 3
- Elective F | 3
- CHEE 319 Process Dynamics and Control W | 3.5
- MINE 330 Mineral Industry Economics W | 3.5

Subtotal Credits: 16.5

Minimum Total Credits: 46.25

Mine-Mechanical Option N3

- MECH 270 Materials Science and Engineering F | 3.75
- MECH 328 Dynamics and Vibration F | 3.5
- Complementary Studies, List A F | 3
- MECH 323 Machine Design W | 4.5
- MECH 350 Automatic Control W | 3.5

Subtotal Credits: 18.25

Minimum Total Credits: 48

Fourth Year Common Core - 2015/2016

- MINE 422 Mining and Sustainability F | 4
- MINE 459 Reliability, Maintenance, and Risk Assessment F | 4
- MINE 462 Occupational Health and Safety in Mining Practice F | 3.5
- MINE 434 Project Report F/W | 4

Subtotal Credits: 15.5

Mining Option N1

- MINE 467 Geostatistics and Orebody Modelling F | 4.5
- MINE 469 Stability Analysis in Mine Design F | 4
- MINE 445 Open Pit Mine Design W | 5.5
- MINE 448 Underground Design W | 5.5
- Complementary Studies, List A W | 3
- Elective W | 3

Subtotal Credits: 25.5

Minimum Total Credits: 41

Minerals Processing Environmental Option N2

- MINE 451 Chemical Extraction of Metals F | 3
- MINE 455 Design, Analysis and Operation of Mineral Processes F | 4.5
- MINE 458 Process Investigations W | 4
- Complementary Studies, List A W | 3
- Elective W | 3
- Elective W | 3

Subtotal Credits: 20.5

Minimum Total Credits: 36

Mine-Mechanical Option N3

- MINE 339 Mine Ventilation F | 4.5
- Complementary Studies, List A F | 3
- MINE 330 Mineral Industry Economics W | 3.5
- MINE 471 Mine-Mechanical Design Project W | 5.5
- Elective W | 3
- Elective W | 3

Subtotal Credits: 22.5

Minimum Total Credits: 38

Electives

Students may fulfill their elective requirement by selecting any course as listed under Complementary Studies (first year linkage courses excluded) or any third or fourth year Applied Science course for which the prerequisite requirements have been satisfied.

Mining Engineering: Electives

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Mining Program, the Engineering Economics courses are APSC 221 and MINE 330. The Communications courses are APSC 293 and MINE 434. Included in the core program is an additional 3.5 credits of Linkage in MINE 462.

Mining Engineering, B. Sc. (Class of 2017)

Second Year Common Core - 2014/2015

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- CIVL 230 Solid Mechanics I F | 4.25
- MINE 201 Introduction to Mining and Mineral Processing F | 4
- MINE 202 Computer Applications and Instrumentation in Mining F | 1.5
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- ELEC 210 Introductory Electric Circuits and Machines W | 4.25
- MINE 244 Underground Mining W | 3
- MTHE 272 Application of Numerical Methods W | 3.5

Subtotal Credits: 32

Mining Option N1

- MECH 230 Thermodynamics I F | 3.5
- MINE 267 Applied Chemistry for Mining W | 3.5
- MINE 268 Analytical Methods in Mining W | 1
- MTHE 367 Engineering Data Analysis W | 3.5

Subtotal Credits: 12

Minimum Total Credits: 44

Minerals Processing Environmental Option N2

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 210 Thermodynamic Properties of Fluids W | 3.5
- MINE 267 Applied Chemistry for Mining W | 3.5
- MINE 268 Analytical Methods in Mining W | 1

Subtotal Credits: 10.5

Minimum Total Credits: 42.5

Mine-Mechanical Option N3

- MECH 230 Thermodynamics I F | 3.5
- MECH 228 Kinematics and Dynamics W | 3.5
- MTHE 367 Engineering Data Analysis W | 3.5

Subtotal Credits: 11

Minimum Total Credits: 43

Third Year Common Core - 2015/2016

- MINE 321 Drilling and Blasting F | 4.5
- MINE 331 Methods of Mineral Separation F | 4.5
- MINE 341 Open Pit Mining F | 4.5
- GEOE 262 Geological Aspects of Mineral Deposits W | 3.75
- MINE 324 Hydraulics for Mining Applications W | 3.5
- MINE 325 Applied Rock Mechanics W | 4.5
- MINE 326 Operations Research W | 4.5

Subtotal Credits: 29.75

Mining Option N1

- MINE 339 Mine Ventilation F | 4.5
- Complementary Studies, List A F | 3
- Elective F | 3
- MINE 330 Mineral Industry Economics W | 3.5
- Elective W | 3

Subtotal Credits: 17

Minimum Total Credits: 46.75

Minerals Processing Environmental Option N2

- CHEE 321 Chemical Reaction Engineering F | 3.5
- Complementary Studies, List A F | 3
- Elective F | 3
- CHEE 319 Process Dynamics and Control W | 3.5
- MINE 330 Mineral Industry Economics W | 3.5

Subtotal Credits: 16.5

Minimum Total Credits: 46.25

Mine-Mechanical Option N3

- MECH 270 Materials Science and Engineering F | 3.75
- MECH 328 Dynamics and Vibration F | 3.5
- Complementary Studies, List A F | 3

- MECH 323 Machine Design W | 4.5
- MECH 350 Automatic Control W | 3.5

Subtotal Credits: 18.25

Minimum Total Credits: 48

Fourth Year Common Core - 2016/2017

- MINE 422 Mining and Sustainability F | 4
- MINE 459 Reliability, Maintenance, and Risk Assessment F | 4
- MINE 462 Occupational Health and Safety in Mining Practice F | 3.5
- MINE 434 Project Report F/W | 4

Subtotal Credits: 15.5

Mining Option N1

- MINE 467 Geostatistics and Orebody Modelling F | 4.5
- MINE 469 Stability Analysis in Mine Design F | 4
- MINE 445 Open Pit Mine Design W | 5.5
- MINE 448 Underground Design W | 5.5
- Complementary Studies, List A W | 3
- Elective W | 3

Subtotal Credits: 25.5

Minimum Total Credits: 41

Minerals Processing Environmental Option N2

- MINE 451 Chemical Extraction of Metals F | 3
- MINE 455 Design, Analysis and Operation of Mineral Processes F | 4.5
- MINE 458 Process Investigations W | 4
- Complementary Studies, List A W | 3
- Elective W | 3
- Elective W | 3

Subtotal Credits: 20.5

Minimum Total Credits: 36

Mine-Mechanical Option N3

- MINE 339 Mine Ventilation F | 4.5

- Complementary Studies, List A F | 3
- MINE 330 Mineral Industry Economics W | 3.5
- MINE 471 Mine-Mechanical Design Project W | 5.5
- Elective W | 3
- Elective W | 3

Subtotal Credits: 22.5

Minimum Total Credits: 38

Elective requirements

Each of the three options within the Mining program have specific Complementary Studies List A and Elective requirements.

To determine how many Complementary Studies List A and Electives you must take for your program please refer to the Mining Engineering section of the 'Degree Program' area in the current calendar.

Elective List

- Some of the courses listed in this table also appear on Complimentary Studies List "A". Please note that a course can only count as either an Elective or a List A (not as both).
- Please note that it is the student's responsibility to check SOLUS to determine if a courses is being offered during a particular year and if it is, in which term it is being held. Course availability and the term in which it is held can change on a yearly basis.

Mining Engineering: Electives

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Mining Program, the Engineering Economics courses are APSC 221 and MINE 330. The Communications courses are APSC 293 and MINE 434. Included in the core program is an additional 3.5 credits of Linkage in MINE 462.

Mining Engineering, B. Sc. (Class of 2018)

Second Year Common Core - 2015/2016

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications I F/W | K1
- CIVL 230 Solid Mechanics I F | 4.25
- MINE 201 Introduction to Mining and Mineral Processing F | 4
- MINE 202 Computer Applications and Instrumentation in Mining F | 1.5
- MTHE 225 Ordinary Differential Equations F/W | 3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- ELEC 210 Introductory Electric Circuits and Machines W | 4.25
- MINE 244 Underground Mining W | 3
- MTHE 272 Application of Numerical Methods W | 3.5

Subtotal Credits: 32

Mining Option N1

- MECH 230 Thermodynamics I F | 3.5
- MINE 267 Applied Chemistry for Mining W | 3.5
- MINE 268 Analytical Methods in Mining W | 1
- MTHE 367 Engineering Data Analysis W | 3.5

Subtotal Credits: 12

Minimum Total Credits: 44

Minerals Processing Environmental Option N2

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 210 Thermodynamic Properties of Fluids W | 3.5
- MINE 267 Applied Chemistry for Mining W | 3.5
- MINE 268 Analytical Methods in Mining W | 1

Subtotal Credits: 10.5

Minimum Total Credits: 42.5

Mine-Mechanical Option N3

- MECH 230 Thermodynamics I F | 3.5
- MECH 228 Kinematics and Dynamics W | 3.5
- MTHE 367 Engineering Data Analysis W | 3.5

Subtotal Credits: 11

Minimum Total Credits: 43

Third Year Common Core - 2016/2017

- MINE 321 Drilling and Blasting F | 4.5
- MINE 331 Methods of Mineral Separation F | 4.5
- MINE 341 Open Pit Mining F | 4.5
- GEOE 262 Geological Aspects of Mineral Deposits W | 3.75
- MINE 324 Hydraulics for Mining Applications W | 3.5
- MINE 325 Applied Rock Mechanics W | 4.5
- MINE 326 Operations Research W | 4.5

Subtotal Credits: 29.75

Mining Option N1

- MINE 339 Mine Ventilation F | 4.5
- Complementary Studies, List A F | 3
- Elective F | 3
- MINE 330 Mineral Industry Economics W | 3.5
- Elective W | 3

Subtotal Credits: 17

Minimum Total Credits: 46.75

Minerals Processing Environmental Option N2

- CHEE 321 Chemical Reaction Engineering F | 3.5
- Complementary Studies, List A F | 3
- Elective F | 3
- CHEE 319 Process Dynamics and Control W | 3.5
- MINE 330 Mineral Industry Economics W | 3.5

Subtotal Credits: 16.5

Minimum Total Credits: 46.25

Mine-Mechanical Option N3

- MECH 270 Materials Science and Engineering F | 3.75
- MECH 328 Dynamics and Vibration F | 3.5
- Complementary Studies, List A F | 3
- MECH 323 Machine Design W | 4.5
- MECH 350 Automatic Control W | 3.5

Subtotal Credits: 18.25

Minimum Total Credits: 48

Fourth Year Common Core - 2017/2018

- MINE 422 Mining and Sustainability F | 4
- MINE 459 Reliability, Maintenance, and Risk Assessment F | 4
- MINE 462 Occupational Health and Safety in Mining Practice F | 3.5
- MINE 434 Project Report F/W | 4

Subtotal Credits: 15.5

Mining Option N1

- MINE 467 Geostatistics and Orebody Modelling F | 4.5
- MINE 469 Stability Analysis in Mine Design F | 4
- MINE 445 Open Pit Mine Design W | 5.5
- MINE 448 Underground Design W | 5.5
- Complementary Studies, List A W | 3
- Elective W | 3

Subtotal Credits: 25

Minimum Total Credits: 41

Minerals Processing Environmental Option N2

- MINE 451 Chemical Extraction of Metals F | 3
- MINE 455 Design, Analysis and Operation of Mineral Processes F | 4.5
- MINE 458 Process Investigations W | 4
- Complementary Studies, List A W | 3
- Elective W | 3
- Elective W | 3

Subtotal Credits: 20.5

Minimum Total Credits: 36

Mine-Mechanical Option N3

- MINE 339 Mine Ventilation F | 4.5
- Complementary Studies, List A F | 3
- MINE 330 Mineral Industry Economics W | 3.5
- MINE 471 Mine-Mechanical Design Project W | 5.5
- Elective W | 3
- Elective W | 3

Subtotal Credits: 22.5

Minimum Total Credits: 38

Elective requirements

Each of the three options within the Mining program have specific Complementary Studies List A and Elective requirements.

To determine how many Complementary Studies List A and Electives you must take for your program please refer to the Mining Engineering section of the 'Degree Program' area in the current calendar.

Elective List

- Some of the courses listed in this table also appear on Complimentary Studies List "A". Please note that a course can only count as either an Elective or a List A (not as both).
- Please note that it is the student's responsibility to check SOLUS to determine if a courses is being offered during a particular year and if it is, in which term it is being held. Course availability and the term in which it is held can change on a yearly basis.

Mining Engineering: Electives

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Mining Program, the Engineering Economics courses are APSC 221 and MINE 330. The Communications courses are APSC 293 and MINE 434. Included in the core program is an additional 3.5 credits of Linkage in MINE 462.

Mining Technology

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The modern mining industry is concerned with the stewardship and recovery of the earth's mineral resources in an economic and sustainable manner, while also adhering to ethical and social values. Mining professionals have to be technically proficient, work safely, have business and management skills, recognize and mitigate negative environmental effects, understand the interests of local communities, and design for sustainability. The Bachelor of Mining Engineering Technology curriculum has been designed to provide technical, managerial, and sustainability skills, as well as develop an understanding of the business of mining in terms of economics, finance, and people. Recognizing that technical competence is key to the business of mining, these competencies will be emphasized by providing the necessary fundamental background in science and mathematics, and reinforced through a two-week hands-on field school placement, occurring in the summer of each year (one in Kingston, the other in Timmins), which will also serve to enhance the development of applied skills and theoretical concepts. Ultimately, the curriculum is designed to produce experienced mining professionals with technical hands-on communication and business skills, sensitive to the values of society, and with an ability to adapt to the future needs of the industry.

Progression:

- *All curriculum may be completed at either a full-time or part-time pace.*
- *Courses are group-paced, delivered asynchronously, and are 12 weeks in length.*
- *Upon enrolment, students must complete a customized bridge curriculum (offered via distance delivery), before progressing into Year 3 of the program.*
- *Years 3 and 4 will each contain 12 courses (also offered via distance delivery - pending curriculum committee approval).*

- *Upon completion of each year's curriculum, students will then be required to complete a two-week, laboratory intensive field placement, consisting of a series of labs based on the year's curriculum.*

Mining Engineering Technology, B.Tech.

Bridge Curriculum Common CORE – 2015/16

[1] Mining Engineering Technician stream students take this in their 3rd year program.

- MNTC P01 Engineering Mathematics W | 3 [1]
- MNTC P06 Foundational Chemistry F | 3

Bridge Curriculum Civil/Mechanical Engineering Technologist Stream – 2015/16

- MNTC P02 Mining Geology W | 3

Bridge Curriculum Mining Engineering Technician Stream – 2015/16

- MNTC P03 Foundational Mathematics F | 3
- MNTC P04 Calculus W | 3
- MNTC P05 Foundational Physics W | 3

Year 3 – 2016/17

Pending curriculum committee approval.

Year 4 – 2017/18

Pending curriculum committee approval.

Complementary Studies

Complementary Studies complement the technical content of a student's curriculum, and are sub-divided into **six areas of study**:

- Engineering Economics (EEC);
- Communications (CMC);
- List A Courses: Humanities and Social Sciences (H&SS);
- List B Courses: Linkage and Professional Issues (LNK);
- List C Courses: Performance Arts and Languages (PAL); and
- List D Courses: Management (MGT).

In all academic plans in the Faculty students must complete courses in Complementary Studies amounting to at least 18.75 credits. All of the academic plans in the Faculty have courses in Complementary Studies built into the CORE of the curriculum, and/or have portions of technical courses assigned to topics in Complementary Studies. The exact requirements vary from plan to plan, the details are provided in the curriculum for each Academic Plan.

Students MUST complete a minimum number of credits in some of the above six areas of study. Some of these credits are obtained in faculty-wide core courses while others may be drawn from a list of elective courses. The table below shows the credits in the core courses and lists of elective courses from which additional required credits must be drawn. The lists are updated each year, and a course qualifies as a Complementary Studies course only if it appears on the list for the Academic Session in which the course is taken.

Area of Study	Core Courses	Credits in core courses	List of additional courses	Total required credits
Engineering Economics	APSC 221, APSC 321 OR CHEE 310[1]	3		3
Communications	APSC 100, APSC 293	2	See note 2 below	3
Humanities and Social Science (H&SS)		0	List A	6
Linkage and Professional Issues (LNK)	APSC 100, APSC 151, APSC 200[3]	3	List B	3.5
Any combination of H&SS, LNK, PAL, or MGT			List A, B, C, or D	3
TOTAL				18.5

[1]Note: At the end of each Academic Plan listing in the Calendar there is an explanation of which courses may be taken to meet the requirement for engineering economics.

[2]Note: At the end of each Academic Plan listing in the Calendar there is an explanation of which additional courses must be taken to meet the total credit requirement for Communications.

[3]Note: for the graduating class of 2014 and later, an additional 1 credit of Linkage and Professional issues will be delivered in third and fourth year courses in the Engineering Design and Practice Sequence, satisfying the requirement for 3.5 credit total. In special cases APSC 191 can be used to satisfy the required 3.5 credit of linkage by permission. For the graduating classes of 2013 and earlier, the required 3.5 credit was met by APSC 190 (no longer offered) or APSC 191.

Note that the credits in the table above add up to 18.5 credits, so an additional .25 credit of complementary studies are needed to reach the requirement of 18.75 credits. In many academic plans this additional .25 credit is provided by other upper year engineering courses, but it is the student's responsibility to check.

Engineering Economics Courses:

Engineering Economics courses introduce students to the economic analysis of engineering projects. Each student must take a minimum of 3 credits in Engineering Economics. At the end of each Degree Program listing in the Calendar there is an explanation of how students in that Program meet this requirement.

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3

- CHEE 310 Fundamentals of Engineering Innovation and Entrepreneurship F | 3.5

Communications Courses:

The ability to communicate effectively, both orally and in writing is critical for all engineers. This is developed within each Department's curriculum in a variety of ways, including the evaluation of written reports and oral presentations. There are also courses designed specifically to improve a student's ability to communicate in English; these are listed below. In some programs one or more of these courses may be included in the core of the program.

Each student must take a minimum of 3 CR in Communications. At the end of each Academic Program listing in the Calendar there is an explanation of how students in that Program meet this requirement.

- APSC 293 Engineering Communications l F/W | K1
- CHEE 360 Technical Communications W | 1.5
- CIVL 200 Civil Week I - Professional Skills F | 2.5
- CIVL 300 Civil Week - Professional Skills F | 2.5
- CIVL 400 Civil Week - Professional Skills F | 2.5
- MECH 464 Communications and Project Management F | 1.5
- MINE 434 Project Report F/W | 4
- MTHE 494 Mathematics and Engineering Seminar F | 3
- ENPH 455 Engineering Physics Thesis FW | 4

List A – Humanities and Social Sciences:

Courses in LIST A introduce students to subject matter that deals with central issues, methodologies, and thought processes of the humanities and social sciences.

NOTE: A course will be accepted as a Humanities and Social Sciences (H&SS) credit only if it appears on the list of approved H&SS courses for the Academic Session in which the course is taken.

The following are the courses approved as H&SS credits for the Academic Session 2013-2014:

Art (ARTH only **except** ARTH 245, 404, 460)

Classics (all CLST **except** CLST 203; GREK 208, 321, 322, 421, 422, and 430; LATN 209, 310, , 321, 322, 327, 421 and 422)

Development Studies (all DEVS)

Drama (DRAM 100, 201, 200, 202, 205, 210, 211, 216, 251, 252, 289, 300, 301, 303, 306, 310, 311, 371, 375, 381, 401, 405, and 476)

Economics (all ECON **except** ECON 250, 255, 322, 437, 445, 450, and 455)

English language and literature (ENGL only)

Environmental Studies (ENSC 290, 305, 310, 315, 321, 420, and 490)

Film Studies (FILM 104, 106, 110, 140, 206, 216, 226, 236, 240, 260 (formerly 315), 300, 301, 302, 303, 305, 306, 307, 315 (renamed 260), 320, 322, 323, 331, 335, 336, 337, 338, 339, 340, 345, 353, 368, 385, 415, 422, 425, 430, 435, 440, and 445

French (FREN, 227, 241, 285, 290, 304, 305, 306, 315, 323, 324, 325, 327, 335, 342, 343, 351, 363, 387/487, 388, 390/490, 391, 395, 396, , 406, , 424, and 477) (FRST 290)

Geography (GPHY 227, 228, 229, 250, 254, 257, 258, 259, 325, 327, 332, 336, 337, 338, 339, 351, 352, 359, 362, 365, and 368, 370)

Gender Studies (all GNDS)

German Language and Literature (GRMN 181, 308, 309, 311, 317, 419, 426, 427, 429, 433, 441, and 453)

Hebrew (HEBR 135, 191, 292, 391 and 393)

History (all HIST **except** HIST 257)

Health (HLTH 430)

Interdisciplinary Studies (IDIS 302-305)

International Studies (all INTS)

Jewish Studies (all JWST)

Languages, Literatures & Cultures (LLCU 200, 201, 209, 215, 320, 205, 210, 214, 226, 232, 233, 234, 247, 248, 257, 301, 308, 309, 316, 319, 320, 322, 326, 327, 328, 329, 330, 331, 332, 339, 340, 495)

Law (LAW 201 only)

Linguistics (LING 202, 205, 350, and 475)

Multi-Disciplinary (MDEP 221)

Music (MUSC 101, 102, 103, 171, 203, 204, 205, 289, 326, 333, 480, and 486)

Philosophy (all PHIL)

Physical and Health Education (HLTH 101, 237, 239, 333, 334, and 405)

Political Studies (all POLS **except** POLS 385)

Psychology (PSYC 100, 215, 221, 231, 235, 241, 251, 305, 321, 333, 335, 342, 348, 350, 355, 360, 380, 397, 400, 420, 423, 430, 433, 434, 435, 436, 437, 439, 440, 441, 442, 443, 446, 450, 453, 455, and 456)

Religious Studies (all RELS)

Sociology (SOCY 122, 210, 211, 225, 226, 227, 232, 234, 235, 273, 274, 275, 276, 301, 303, 306, 309, 321, 324, 325, 326, 331, 336, 344, 352, 354, 362, 384, 387, 388, 389, 400, 401, 402, 403, 404, 405, 422, 424, 430, 431, 454, 457, 458, 472, 475, 476 and 480)

Spanish and Italian (SPAN 306, 310, 315, 330, 331, 332, 335, 344, 351, 352, 354, 380, 381, 406, 428, 450, 456, 458, 460, 495, and 496; ITLN 310, 331, 332, 357, 408, 415, and 432)

List B Linkage and Professional Issues

The courses in LIST B are designed to expose students to two inter-related areas: 1) Linkage (the impact of technology on society) and 2) Professional Issues (the role and responsibility of the professional engineer in society).

For students first registering in first year engineering in September 2010 and later:

Linkage and Professional issues content will be included as part of the Engineering Design and practice sequence courses included in each year of the program.

For all other students:

Students require a minimum of 3.5 credits in Linkage and Professional Issues. Upper year and transfer students who will not be taking courses in the Engineering Design and Practice Sequence will meet the minimum requirement of 3.5 credits in Linkage and Professional issues by taking having either APSC 190 (no longer offered). APSC 191 can be used to satisfy the required 3.5 credits of linkage by permission.

For all students:

Once these Linkage and Professional Issues requirements have been fulfilled all students may take other courses from List B below to help complete their Complementary Studies requirements. Note that these courses cannot be used to fulfill any part of the minimum Linkage and Professional Issues requirement of 3.5 credits.

NOTE: A course will be accepted as a Linkage credit only if it appears on the list of approved Linkage courses for the Academic Session in which the course is taken. The following are the courses approved as PAL credits for the Academic Session 2013-2014.

- BIOL 111 Ecology and the Environment 3
- ENSC 200 Environmental History 3
- ENSC 201 Environmental Toxicology and Chemical Risks 3
- ENSC 203 Explorations in Environmental Studies 3
- ENSC 301 Environmental Assessment 3
- ENSC 390 Sustainability 3
- ENSC 483 Special Topics in Environmental Studies II 3
- GPHY 101 Human Geography 3
- GPHY 210 Geographical Perspectives on Global Change 3
- GPHY 319 Bioenergy and Bio-refining in Canada 3
- HIST 257 Environmental History 3
- MECH 333 Gender, Engineering and Technology W | 3
- MINE 462 Occupational Health and Safety in Mining Practice F | 3.5
- SOCY 284 Sociology of Information and Communication Technology 3
- SOCY 363 Science, Technology and Society 3
- COMM 409 Sustainability Measurement, Implementation and Evaluation 3

Students must take a minimum of 6 credits in Humanities and Social Sciences from List A, and an additional 3 credits from List A, B, C or D.

LIST C - Performance Arts and Languages

Courses in LIST C deal with performance in the various arts media (e.g. art, music, drama, film, creative writing) and in languages other than English.

NOTE: A course will be accepted as a Performance Arts and Language (PAL) credit only if it appears on the list of approved PAL courses for the Academic Session in which the course is taken.

The following are the courses approved as PAL credits for the Academic Session 2013-2014:

Arabic (ARAB 100, 200)

Art (ARTF only)

Chinese Language (CHIN 100, 200 and 300)

Classics (GREK 112; LATN 110)

Creative Writing (CWRI 293-296)

Drama (DRAM 181, 220, 236, 237, 238, 239, 241, 245, 246, 247, 314, 318, 323, 331, 332, 339, 342, 344, 345, 348, 350, 351, 371, 373, 400, 439, and 451; STSC 300 and 309)

Film Studies (FILM 250, 312, 355, 365, 375, 410, 450, and 451)

French Studies (FREN 011, 012, 016, 017, 100, 101, 102, 106, 107, 111, 112, 118, 150, 219, 230, 250, 283, 320, 330, 331, 353, 373, 393, 444, 450, 463, 473, and 493) and FRST 105 and 125

German Language and Literature (GRMN 061, 101, 102, 201, 202, 203, 306, 307, 312)

Hebrew (HEBR 190, 294, 295, 301, and 390)

Interdisciplinary Studies (IDIS 200, 201, and 311)

Japanese Language (JAPN 100, 200, 301, and 302)

Languages, Literatures and Cultures (LLCU 101, 102)

Linguistics (LING 100, 110, 310, 320, 330, 340, 415, 435, and 475)

Multi-Disciplinary (MDEP 400)

Music (MUSC 052, 124, 153, 180, 181, 187, 188, 189, 191, 224, 253, 255, 270, 280, 281, 283, 285, 291, 324, 329, 351, 352, 354, 355, 392, 396, 398, 424, 439, 446, 454, and 455)

Portuguese (PORT 103 and PORT 104)

Spanish and Italian (SPAN 010, 112, 204, 205, 206, 301, 302, 303, 304 and 410; ITLN 010, 112, 204, 205)

List D – Management Courses

Courses which relate to management issues can be found in the in the School of Urban and Regional Planning (SURP) and in the School of Business (COMM). Some programs require or permit students to take one or more of these Management courses from the lists below.

Management Courses Offered by the School of Urban and Regional Planning

- APSC 223 Global Project Management S | K3

Management Courses Offered by the School of Urban and Regional Planning

- SURP 851 Environmental Policy W | 3
- SURP 853 Environmental Services W | 3
- SURP 855 Environmental Planning and Management W | 3

Management Courses Offered by the School of Business

- COMM 200 Introduction to Business 3
- COMM 211 Introduction to Financial Accounting 3
- COMM 212 Introduction to Management Accounting 3
- COMM 221 Introduction to Finance 3
- COMM 231 Introduction to Marketing 3
- COMM 251 Organizational Behaviour 3
- COMM 274 International Business Strategy 3
- COMM 310 Environmental Accounting 3
- COMM 311 Financial Accounting Practices, Principles and Concepts 3
- COMM 312 Intermediate Management Accounting 3
- COMM 313 Financial Accounting II 3
- COMM 326 The Economics of Canada's Financial System 3
- COMM 329 Management of Financial Institutions 3
- COMM 351 Leadership 3
- COMM 353 Managing in a Multicultural Environment 3
- COMM 357 Interpersonal Skills for Managers 3
- COMM 373 International Negotiations 3
- COMM 375 International Business 3
- COMM 381 Business Law I 3
- COMM 382 Business Law II 3
- COMM 387 The Behavioural Study of Unions 3
- COMM 408 Sustainability Strategies and Practices 3
- COMM 496 IS Security, Privacy and Ethics 3

Courses of Instruction

Applied Science

APSC 100 Engineering Practice I S | K11

Lecture: Yes
Lab: Yes
Tutorial: Yes

This course introduces fundamental professional engineering skills and provides an opportunity to apply engineering science and mathematics content in situations emulating professional practice. It consists of three modules: Module 1. Problem analysis and modeling; Module 2. Experimentation and measurement; Module 3: Engineering design. The course provides an introduction to personal learning styles, team dynamics, oral and written presentation skills, laboratory data collection, analysis and presentation, project management, information management, problem analysis and modeling, numeric computation, economics, design methodologies, and workplace safety.

Academic Units:
Mathematics 6
Natural Sciences 16
Complementary Studies 40
Engineering Studies 40
Engineering Design 30

APSC 101 Engineering Problem Solving and Modeling F | K4

Lecture: Yes
Lab: No
Tutorial: Yes
This course provides an opportunity for students to develop complex problem solving and critical thinking skills and to apply engineering science knowledge in modeling physical systems through computational software. Examples and project topics are chosen to complement instruction in engineering science and mathematics courses. Ethical, economic, and social factors are considered in engineering problem solving. NOTE: This course covers the content and objectives of APSC 100 Module 1, and is available by permission only. (6/0/12/18/12)

Academic Units:
Mathematics 6
Natural Sciences 0
Complementary Studies 12
Engineering Studies 18
Engineering Design 12

PREREQUISITE(S): Permission of the instructor or Associate Dean (Academic)
EXCLUSION(S): APSC 100

APSC 102 Experimentation and Design F/W | K3

Lecture: No
Lab: Yes
Tutorial: Yes
This course introduces concepts of planning and designing experiments determine or measure particular system characteristics. The course content includes error analysis, data analysis and representation in Excel, and the design of experimental investigation for simple systems. NOTE: This course covers the content and objectives of APSC 100 Module 2, and is available by permission only.

Academic Units:
Mathematics 0
Natural Sciences 16
Complementary Studies 4
Engineering Studies 16
Engineering Design 0

PREREQUISITE(S): Permission of the instructor or Associate Dean (Academic)
EXCLUSION(S): APSC 100

APSC 103 Engineering Design Project W | K4

Lecture: Yes
Lab: No
Tutorial: Yes
This is a client-based team design project which develops skills including design, project management, technical communications, and professionalism. Students work in teams to define problems, gather and identify appropriate information, work effectively with teammates, generate ideas, select ideas, and implement a solution to a presented problems from a client. NOTE: This course covers the content and objectives of APSC 100 Module 3, and is available by permission only. (0/0/24/6/18)

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 24
Engineering Studies 6
Engineering Design 18

PREREQUISITE(S): Permission of the instructor or Associate Dean (Academic)
EXCLUSION(S): APSC 100

APSC 111 Mechanics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course is an introduction to Newtonian mechanics in the context of engineering applications. Lecture topics are: vectors, motion of a particle, particle dynamics, work and energy, statics and dynamics of rigid bodies, conservation of energy, momentum, and collisions.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

APSC 112 Electricity and Magnetism W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course continues from APSC 111 to introduce electricity and further develop fundamental ideas of mechanics in the context of engineering applications. Lecture topics include: oscillations and waves, electric charge, electrical current and resistance, EMF, D.C. circuits and electrical measurements, electric field and potential, magnetic fields and their origin, and electromagnetic induction.

Academic Units:
Mathematics 0

Natural Sciences 31
Complementary Studies 0
Engineering Studies 11
Engineering Design 0

PREREQUISITE(S): APSC 111 and APSC 171

APSC 131 Chemistry and Materials F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course provides an introduction to the chemistry of materials: thermochemistry, heat, work, internal energy, enthalpy and the first law of thermodynamics; gas laws in ideal and non-ideal systems; phase equilibria in one component systems; concepts of bonding in the classification of materials; the physical, electrical and mechanical properties of metals, polymers, semiconductors and ceramics; techniques of characterizing materials.

Academic Units:
Mathematics 0
Natural Sciences 31
Complementary Studies 0
Engineering Studies 11
Engineering Design 0

APSC 132 Chemistry and its Applications W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course combines fundamentals of chemistry with the engineering issues associated with them. Areas of study are entropy and the second law of thermodynamics, thermodynamics, chemical equilibrium, electrochemistry, chemical kinetics and organic chemistry. Environmental issues associated with each of these topics will be incorporated into lectures when appropriate.

Academic Units:
Mathematics 0
Natural Sciences 31
Complementary Studies 0
Engineering Studies 11
Engineering Design 0

PREREQUISITE(S): APSC 131

APSC 142 Introduction to Computer Programming for Engineers F/W | 3

Lecture: 2
Lab: 1
Tutorial: 0
This course introduces concepts, theory and practice of computer programming. Implementation uses microcomputers. The emphasis is on the design of correct and efficient algorithms and on programming style. Applications are made to engineering problems. NOTE: The fall term delivery of this course is intended for students in the ECE direct-entry program, and enrolment in this term will require permission of the Associate Dean (Academic).

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 12

APSC 151 Earth Systems and Engineering F | 4

Lecture: 3
Lab: 1
Tutorial: 0
This course provides an introduction to the complex Earth System (which encompasses the solid earth, hydrosphere, atmosphere, and biosphere), and our interactions with it. Using the Earth System as a framework, and coupled with the over-arching theme of sustainability, key concepts/issues relevant to engineers are dealt with, including: population demographics and resource usage; geopolitics; modeling of "fuzzy" systems; risk assessment and risk management; local- and global-scale impacts of engineering works on the government; short- and long-term natural and anthropogenic changes (including global warming); moral and ethical considerations.

Academic Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 12
Engineering Studies 12
Engineering Design 0

APSC 161 Engineering Graphics F | 3.5

Lecture: 2
Lab: 1.5
Tutorial: 0
The principal objectives of the course are (1) to develop the student's ability to visualize and communicate three-dimensional shapes and (2) to acquire the skills needed to use computer-aided design software. Topics covered are orthographic projection, isometric sketching, auxiliary and section views as well as dimensioning and working drawings. Computer-aided design software is used to create solid models of the parts and assemblies as well as to generate dimensioned drawings. Students apply their learning in a project where they design their own version of a consumer product. Students learn by hands-on exercises in free-hand sketching and computer-based drawing.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 37
Engineering Design 5

APSC 171 Calculus I F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Functions, limits, derivatives; optimization, rate problems, exponentials, logarithms, inverse trigonometric functions;

exponential growth as an example of a differential equation. Fundamental Theorem of Calculus, Riemann integral; applications to problems involving areas, volumes, mass, charge, work, etc. Some integration techniques.

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

APSC 172 Calculus II W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course continues calculus concepts from APSC 171, including space curves, speed, and velocity. Functions of several variables, partial derivatives, differentials, error estimates, gradient, maxima and minima. Double and triple integrals, polar and cylindrical coordinates; applications to mass, center of mass, moment. Series, power series; Taylor polynomial approximations, error analysis.

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 171

APSC 174 Introduction to Linear Algebra W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Systems of linear equations; real vectors spaces and subspaces; linear combinations and linear spans; linear dependence and linear independence; applications to systems of linear equations and their solution via Gaussian elimination; bases and dimension of real vector spaces; linear transformations, range, kernel and Rank-Nullity theorem; matrix representation of a linear transformation; composition of linear transformations and matrix multiplication; invertible matrices and determinants; eigenvalues and eigenvectors of square matrices. Applications of the course material to engineering systems are illustrated.

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

APSC 191 Professional Engineering Skills FW | 3.5

Lecture: 1.25
Lab: 0

Tutorial: 2.25
This course is identical in content to APSC 190. The material normally delivered in APSC 190 in the first week of the winter term will be covered in evening sessions in the fall term in APSC 191. - COURSE DELETED 2016-2017

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 42
Engineering Studies 0
Engineering Design 0

APSC 200 Engineering Design and Practice II F/W | K4

Lecture: Yes
Lab: No
Tutorial: Yes
In this course students will participate constructively on teams to create solutions to open-ended complex problems, using standard design methods and tools. This project-based course provides instruction primarily in the first 6 weeks of the semester focusing on problem scoping, creativity and idea generation, decision making incorporating technical, economic, societal, and environmental factors, safety, engineering codes and regulations, and engineering ethics. The final 6 weeks of the course centre around a design project delivered by each discipline. This course is integrated with APSC 293, and coordinated by the same instructor.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Studies 0
Engineering Design 36

PREREQUISITE(S): APSC 100
COREQUISITE(S): APSC 293
EXCLUSION(S): MECH 212

APSC 202 Engineering Design and Practice II: Client-Based Design W | 3 K4

In this course students will participate constructively on teams to create solutions to client-based open-ended design problems using standard design methods and tools. This project-based course provides instruction on problem scoping, creativity and idea generation, decision making incorporating technical, economic, societal, and environmental factors, safety, engineering codes and regulations, and engineering ethics. Students work in teams to define problems, gather and identify appropriate information, work effectively with teammates, generate ideas, select ideas, and implement a solution to a presented problem from a client. This course is integrated with APSC 293, and taught by the same instructor. NOTE: This course is only open to students transferring into year 2 or above of a Queen's Engineering program.

Academic Units:
Complementary Studies 12
Engineering Design 36

PREREQUISITE(S): APSC 101 and permission of the Associate Dean (Academic)
COREQUISITE(S): APSC 293
EXCLUSION(S): APSC 100, APSC 103,APSC 200, and MECH 212

APSC 221 Economics and Business Practices in Engineering F/W/S | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course will provide the student in the Engineering program with the ability to appropriately incorporate selected economic and business practices into the practice of engineering. The practices covered include: business planning for the enterprise, enterprise economic analysis, project management process, project economic analysis, risk analysis and management, quality management and change management. Assignments and examples are based on situations from engineering based industries.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Studies 0
Engineering Design 0

EXCLUSION(S): APSC 321, COMM 244

APSC 223 Global Project Management S | K3

Lecture: Yes
Lab: Yes
Tutorial: Yes
This course will cover the knowledge areas and processes of the globally-recognized PM Body of Knowledge: integration, scope, cost, time, risk, human resources, stakeholders and procurement management. The focus will be a practical, applied approach, utilizing the global city of London, its engineering firms, experts, practitioners and massive engineering undertakings (The Shard, Cross-Rail, the Eurotunnel, the Thames Barrier, etc.) to investigate the problems, challenges and successes of managing global engineering projects. Note that the first week of instruction for this course will be held at Queen's, prior to the start of the 6-week BISC-based workshop.

Academic Units:
Complementary Studies 36
PREREQUISITE(S): APSC 221 or CHEE 310 or permission of the instructor. Students should have taken engineering economics prior to taking the Global Project Management courses, however it is not critical, if you have not yet completed APSC 221 or CHEE 310, please e-mail Lynann Clapham to discuss the possibility of a prerequisite waiver.

APSC 262 Engineering Surveying | 3.25

Lecture: 1.5
Lab: 0
Tutorial: 1.75
This introductory course in plane surveying consists of about 16 hours of lectures, the rest of the time being spent in the field. Lecture material includes distance measurement, differential, profile and indirect leveling and use of transit, traversing and mapping. Errors, corrections and balancing are also discussed. The use of available software packages for the reduction and calculation of data is encouraged throughout the course. In the field, students practice the basic techniques of instrument use through various assignments. Careful and efficient handling of instruments and proper note-keeping are stressed. The use of state-of-the-art electronic surveying instruments is included in the field assignments wherever possible. The school is held on campus immediately following the final First Year examination in April.

Academic Units:

Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 40
Engineering Design 0

EXCLUSION(S): CIVL 211

APSC 291 NOT OFFERED THIS YEAR - Engineering Communications I F | 1

Lecture: 0.5
Lab: 0
Tutorial: 0.5
This course provides an introduction to effective engineering writing and speaking skills with the emphasis on technical proposals, professional correspondence, engineering reports, and oral briefings. These skills are developed in lectures and small group tutorials.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): Permission of Instructor
EXCLUSION(S): CHEE 260, ELEC 291, GEOE 291 (GEOL 291), GEOE 292 (GEOL 292), MECH 290

APSC 292 Deleted - Engineering Communications II W | 1.25

Lecture: 0.5
Lab: 0
Tutorial: 0.75
This course continues to develop skills in engineering writing and speaking from APSC 291, focusing on product specifications and evaluations, engineering reports, and formal oral presentations. These skills are developed in lectures and small group tutorials. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 291
EXCLUSION(S): CHEE 260, ELEC 291, ELEC 391, MECH 290, GEOE 291 (GEOL 291), GEOE 292 (GEOL 292)

APSC 293 Engineering Communications I F/W | K1

Lecture: Yes
Lab: No
Tutorial: Yes
This course provides an introduction to effective engineering writing and speaking skills with the emphasis on

professional correspondence, engineering reports, oral briefings, and formal oral presentations. These skills are developed in lectures and small group tutorials. This course is integrated with APSC 200, and coordinated by the same instructor.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 100
COREQUISITE(S): APSC 200 or permission of instructor
EXCLUSION(S): APSC 292, CHEE 260, ELEC 291, ELEC 391, GEOL 291, GEOL 292, MECH 290

APSC 301 Professional Internship |

The professional internship involves spending a minimum of twelve months and a maximum of sixteen months in a paid internship position in industry or government. Students in the 12-month internship must register in APSC 302, APSC 303 and either APSC 301 or APSC 304. Students in the 16 month placement take APSC 301, APSC 302, APSC 303 and APSC 304. The nature of the work must satisfy the criteria defining professional experience for licensure as a Professional Engineer in Canada. The course includes prior workshops on interviewing, resume preparation and work performance. Successful completion of the course requires submission of a report of high quality on the experience within thirty days of completion of the work period. Career Services manage the non-academic aspects of the course.

Academic Units:
PREREQUISITE(S): Faculty English Proficiency Test, or 80% in ESLA 130 taken prior to the 2004 - 2005 academic session.

APSC 302 Professional Internship |

See APSC 301.

Academic Units:

APSC 303 Professional Internship |

See APSC 301.

Academic Units:

APSC 304 Professional Internship |

See APSC 301.

Academic Units:

APSC 321 Deleted - Economic and Business Practices in Mining and Geological Engineering |

This course will provide the student in the Mining Engineering or Geological Engineering program with the ability to appropriately incorporate selected economic and business practices into the practice of engineering. The practices covered include: business planning for the enterprise, enterprise economic analysis, project management process, project economic analysis, risk analysis and management, quality management and change management. Assignments, examples, and tutorials are based on current situations from the Mining and Geological Engineering based industries. - COURSE DELETED 2013-2014

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 42
Engineering Studies 0
Engineering Design 0

EXCLUSION(S): APSC 221, COMM 244, GEOL 472

APSC 381 Advanced Design and Skills for Innovation W | K3.5

Lecture: Yes
Lab: No
Tutorial: Yes
The objective of this multidisciplinary course is to provide students with a broad range of knowledge and skills for design and innovation. Drawing heavily from industry practice, topics span the breadth of the innovation process, including advanced topics such as risk analysis, FMEA, reliability, and elements of six sigma methodologies. Elements of project management, market and economic analysis, and other professional practice topics are interwoven. Students work in multi-disciplinary teams on relevant and realistic projects, simulating the real-world engineering environment. This course provides direct entry to the elective final year capstone project course "APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9", and will provide sound footing for those intending to pursue further design and innovation courses/programs.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 42

PREREQUISITE(S): NOTE: APSC 381 is primarily intended as a preparatory course for APSC 480 or other final year engineering project courses, and preference will correspondingly be given to third year students. If course registration is full, third year students may contact the course instructor to be added to a waiting list. Students registered in their final year must have permission from the course instructor to register in APSC 381.

APSC 400 Technology, Engineering and Management (TEAM) FW* | 6.5

Lecture: 3.5
Lab: 3
Tutorial: 0
Where appropriate, multidiscipline teams of engineering, commerce, law, and science students act as consultants to industrial and governmental clients. Projects include a phase of self-directed problem definition and project scope definition in the fall term, followed by project execution in the winter term. Typical projects involve evaluation of technical alternatives (with an emphasis on health, safety, and environmental), preparation of detailed recommendations, and both market and financial analysis. Project topics vary widely and are provided by a diverse list of fee paying clients. The course includes seminars on project management. There are several meetings during the Fall

term to organize groups and select projects, but regularly scheduled lectures do not begin until the Winter term. Teams interact regularly with clients at both a technical and a management level, and are also assigned an industrial project mentor. Students manage their own budget, travel arrangements etc. The course concludes with a comprehensive report and presentation at the client's office. The course is managed by the Department of Chemical Engineering. Further information, including a list of projects, can be found at: http://team.appsci.queensu.ca/

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 21
Engineering Studies 29
Engineering Design 28

PREREQUISITE(S): Permission of the Department.

APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9

Lecture: Yes
Lab: No
Tutorial: Yes
The objective of this course is to enhance student's design, innovation, critical thinking, and professional skills by engaging in industry-funded engineering projects. Working in multi-disciplinary teams, students are guided by experienced engineering professionals both internally and externally. Teams interface frequently with the client, including occasional external site visits and bi-weekly conference calls. Projects cover a broad range of engineering disciplines, and typically incorporate the development of physical prototype(s) or digital models/simulations for evaluation and testing. Students will integrate elements of engineering design, innovation, and professional practice from prior courses, with enhancements from occasional lectures, workshops, and guest speakers. Project funding supports all necessary travel, communication, software, equipment, prototyping components and related services. Professional engineering skills such as communication, teamwork, project management, engineering economics, ethics, and safety will be integral to the projects.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 28
Engineering Studies 0
Engineering Design 80

PREREQUISITE(S): APSC 381 or by permission from the instructor

Biochemistry

BCHM 310 General Biochemistry FW | 7.5

Lecture: 6
Lab: 1.5
Tutorial: 0
Principles of protein biochemistry, enzymology, and protein engineering. Metabolism of carbohydrates, amino acids and lipids. Role of coenzymes. Generation and storage of metabolic energy. Principles of regulatory mechanisms, membrane structure and function, hormone action, and cellular signalling.

Academic Units:

Mathematics 0
Natural Sciences 90
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENCH 281 (CHEM 281) and CHEM 282, or ENCH 211 (CHEM 211) and ENCH 212 (CHEM 212) and ENCH 245 (CHE
EXCLUSION(S): BCHM 315, BCHM 316

BCHM 315 Proteins and Enzymes F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Principles of protein biochemistry, enzymology, and protein engineering.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENCH 281 (CHEM 281) and CHEM 282, or ENCH 211 (CHEM 211) and ENCH 212 (CHEM 212) and ENCH 245 (CHEM 245), or permission of the department.
EXCLUSION(S): BCHM 310

BCHM 410 Protein Structure and Function F | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course presents an integrated approach to the study of protein function. Topics include proteomic techniques, mass spectrometry, protein purification, imaging, surface plasmon resonance, calorimetry, bioinformatics and protein evolution, protein modifications and processing, interpretation and applications of 3-D structure, and structure-function relationships. NOTE: Offered jointly with BCHM 810*.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): Permission of the Department.

Biology

BIOL 102 Introductory Biology of Cells F | 3.75

Lecture: 3
Lab: 0.75
Tutorial: 0
An introduction to the basic themes and concepts of modern biology spanning organizational levels from molecules to cells in an evolutionary context. RECOMMENDATION 4U Biology and Chemistry, or equivalent high school background are highly recommended.

Academic Units:
Mathematics 0
Natural Sciences 45
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

BIOL 103 Introductory to Biology of Organisms W | 3.75

Lecture: 3
Lab: 0.75
Tutorial: 0
An introduction to the basic themes and concepts of modern biology spanning organizational levels from organisms to ecosystems in an evolutionary context.

Academic Units:
Mathematics 0
Natural Sciences 45
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): BIOL 102

BIOL 205 Mendelian and Molecular Genetics F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
An introduction to Mendelian and molecular genetics covering the basic mechanisms of genetic transmission, gene structure and function, as well as the application of molecular genetics in medicine and biotechnology.

Academic Units:
Mathematics 0
Natural Sciences 54
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): BIOL 102, BIOL 103

BIOL 335 Limnology and Aquatic Ecology F | 4.5

Lecture: 3
Lab: 1.5

Tutorial: 0
Physics, chemistry and biology of freshwater lakes. Emphasis on: morphometry; light and temperature; water chemistry in relation to nutrients; physiological requirements; composition and interaction of algal and invertebrate populations; eutrophication; pollution; environmental change. NOTE: BIOL 200 (or BIOL 201 and BIOL 202) highly recommended.

Academic Units:
Mathematics 0
Natural Sciences 54
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): CHEM 112, or APSC 131 and APSC 132.

BIOM 300 NOT OFFERED THIS YEAR - Modeling Techniques in Biology W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Modeling will be presented in the context of biological examples drawn from ecology and evolution, including life history evolution, sexual selection, evolutionary epidemiology and medicine, and ecological interactions. Techniques will be drawn from dynamical systems, probability, optimization, and game theory with emphasis put on how to formulate and analyze models.

Academic Units:
Mathematics 31
Natural Sciences 11
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 172; APSC 174 recommended

Chemical Engineering

CHEE 209 Analysis of Process Data F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Statistical methods for analyzing and interpreting process data are discussed, with special emphasis on techniques for continuous improvement of process operations. Topics include: role of data in assessing process operation, identifying major problems, graphical and numerical summaries, principles of valid inference, probability distributions for discrete and continuous data, process capability, comparing process performance to target values, comparing performances of two processes, control charts, and an introduction to linear regression analysis.

Academic Units:
Mathematics 27
Natural Sciences 0
Complementary Studies 0
Engineering Studies 15

Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172, APSC 174
EXCLUSION(S): STAT 268, STAT 269, MTHE 367 (STAT 367)

CHEE 210 Thermodynamic Properties of Fluids W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course is an introduction to the thermodynamics of fluids for chemical engineering applications. Concepts to be learned include heat, work, internal energy, enthalpy, entropy, and state functions. Students will understand how to calculate heat and work effects arising from physical processes such as expansion and contraction of fluids and how to calculate the thermodynamic properties of fluids using equations of state, residual properties and correlations. Course concepts will be reinforced in a project.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

PREREQUISITE(S): CHEE 221 (or MINE 201)
COREQUISITE(S): None

CHEE 218 Laboratory Projects I W | 2.5

Lecture: 0.15
Lab: 2
Tutorial: 0.35
The projects provide a practical introduction to processes that occur in chemical engineering operations. Bench-scale and pilot plant equipment are used. Students plan and carry out the experiments, analyze the data and prepare written reports

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 0

PREREQUISITE(S): APSC 100, CHEE 209, or permission of the department.

CHEE 221 Chemical Processes and Systems F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Introduction to the fundamentals and principles of chemical engineering, with applications to chemical and biochemical processes, via an analysis of processing units including distillation, crystallization and combustion. Specific topics include conservation equations for mass and energy, process flow diagrams, material and energy balances, chemical

reaction fundamentals, and applications of the First Law of Thermodynamics.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

PREREQUISITE(S): APSC 131, APSC 132, APSC 172, or permission of the department

CHEE 222 Process Dynamics and Numerical Methods W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Time-varying operation of chemical and biochemical processes is introduced. Dynamic mathematical models are formulated using material and energy balances. Effects of operational and design parameters on steady-state and dynamic operations are investigated. Numerical techniques are introduced to solve systems of algebraic and differential equations. Numerical and symbolic computation tools are used to analyze dynamic and steady-state process behaviour.

Academic Units:
Mathematics 22
Natural Sciences 0
Complementary Studies 0
Engineering Studies 20
Engineering Design 0

PREREQUISITE(S): APSC 142, CHEE 221, MTHE 225 (MATH 225) or permission of the department

CHEE 223 Fluid Mechanics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Principles of momentum and energy transport are applied to the analysis of fluid systems commonly encountered in chemical engineering practice. This approach is via the macroscopic and differential balances of mass, momentum and energy. Topics include fluid statics; incompressible flow in closed conduits; flow and pressure measurement; transportation of fluids; laminar, turbulent and creeping flows; boundary layer effects; sizing of commercial components (piping, tubing, valves, pressure and flow meters and other fittings, as well as pumps) for fluid transport systems in industrial settings.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

PREREQUISITE(S): CHEE 221, MTHE 225
COREQUISITE(S): None

CHEE 224 Transport Phenomena Fundamentals F | 3

Lecture: 2
Lab: 0
Tutorial: 1
The theory and mathematical framework of transport phenomena are introduced. Mass, energy and momentum balances are developed using the integral and differential methods of analysis. The tools used to formulate and solve the problems include representation of physical entities in vector form, multivariable functions and vector operations in 2D and 3D. Specific topics of Chemical Engineering interest include moments of a force, work done by a force, moments of inertia, control surfaces and control volumes and fluid kinematics.

Academic Units:
Mathematics 18
Natural Sciences 0
Complementary Studies 0
Engineering Studies 18
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172

CHEE 229 Cell Based Engineering Principles F | 4

Lecture: 3
Lab: 0.75
Tutorial: 0.25
Introduction to the Biological, Biochemical and Life Science principles of cell/ enzyme based engineering systems and processes. The emphasis will be placed on microbial cell culture, but comparisons will be drawn to related systems including viral, plant and animal cell culture as it relates to medicine, industrial practice or the environment.

Academic Units:
Mathematics 0
Natural Sciences 35
Complementary Studies 0
Engineering Studies 13
Engineering Design 0

PREREQUISITE(S): APSC 131 and APSC 132; or equivalents or permission of the Department.
EXCLUSION(S): MICR 221

CHEE 310 Fundamentals of Engineering Innovation and Entrepreneurship F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course provides a basic understanding of the innovation process, entrepreneurial thinking, and the financial and market contributors to successful technology-based business opportunities. Course topics include: identifying opportunities, project management skills and intellectual property issues, understanding customers to define potential markets and arrive at clear value propositions, product positioning, competitive analysis, fundamental financial principles and financial statements, performance of financial feasibility analyses and identification of appropriate business models for commercialization. Using a multidisciplinary approach, students craft business strategy and make tactical and commercial decisions using an on-line business simulation game and evaluate the commercial feasibility of innovative research by developing a business case for an innovation in their concentration area.

Academic Units:
Mathematics 0

Natural Sciences 0
Complementary Studies 42
Engineering Studies 0
Engineering Design 0

CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course is concerned with the application of thermodynamics to practical problems of the chemical industry. Emphasis is placed on the study of phase equilibrium, including vapour-liquid equilibrium and liquid-liquid equilibrium. Contemporary methods of calculating the thermodynamic properties of non-ideal vapours and liquids will be presented and applied. The principles of chemical reaction equilibrium will also be studied. The design component of the course will require students to perform theoretical vapour-liquid equilibrium calculations and recommend proper operating conditions for a single-stage unit (flash drum) that separates a non-ideal binary mixture.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 12

PREREQUISITE(S): CHEE 210

CHEE 315 Laboratory Projects II F/W | 4

Lecture: 0.25
Lab: 3
Tutorial: 0.75
The main objectives are to develop skill in using process and analytical equipment, to examine the strengths, weaknesses, and limitations of current theory, to improve the student's ability to obtain and interpret data, to demonstrate the value of planning experiments, to develop engineering judgement, and to provide experience in oral and written reporting.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 48
Engineering Design 0

PREREQUISITE(S): CHEE 222 and CHEE 223

CHEE 319 Process Dynamics and Control W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The dynamic behaviour and automatic control of processes are studied. Mathematical tools for analyzing the transient behaviour of open and closed-loop systems are presented. The steps of controller development are treated: process

characterization (using mathematical models), controller design, and implementation. Methods for assessing system stability and performance are investigated, and are used in the design of controllers. Frequency response methods are introduced, as is the development and implementation of controller enhancements including feedforward and cascade control.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 12

PREREQUISITE(S): CHEE 210, CHEE 222 or MINE 201, MTHE 225 (MATH 225), CHEE 321 or permission of the department.

CHEE 321 Chemical Reaction Engineering F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introduction to the principles of chemical kinetics, and reactor analysis and design. The topics in chemical kinetics include: rate constants, reaction order, rate equations for elementary and complex reactions, kinetic data analysis, and product distribution. In reactor analysis and design, discussion is focused on ideal reactor systems and arrangements, including batch reactors, plug flow reactors, continuous stirred tank reactors, and recycle reactors. The last part of the course considers homogeneous and heterogeneous catalytic reactions. The design component consists of how to make an appropriate choice of reactor type and operating conditions to optimize a desired product; sizing such reactors and determining conversion levels under various conditions of temperature and pressure; determination of reaction kinetics from experimental data.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 29
Engineering Design 13

PREREQUISITE(S): CHEE 210, (CHEE 222 or MINE 201), or permission of the department.

CHEE 323 Industrial Catalysis W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Students will learn, discuss and apply knowledge of the chemical structure and reactivity of industrial catalytic compounds, with particular emphasis placed upon the integration of fundamental catalytic chemistry with the principles of transport phenomena and thermodynamics. The design component of the course will require students to work in teams to develop three catalytic processes. These projects from examples covered in class, and may include encapsulated enzyme bioreactors, catalytic distillation units, fluidized-bed olefin polymerization reactors and/or multi-phase olefin oligomerization processes.

Academic Units:
Mathematics 0
Natural Sciences 11

Complementary Studies 0
Engineering Studies 11
Engineering Design 20

PREREQUISITE(S): ENCH 245, CHEE 321, or permission of the Chemical Engineering department

CHEE 324 Organic Process Development W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Students will expand their knowledge of functional group interconversions and C-C bond forming reactions learned in ENCH 245, and apply retrosynthetic analysis to propose multi-step syntheses of organic target molecules. Selection of reagents, solvents and reaction conditions will be examined in the context of process safety, reaction yield, product isolation, and profitability. This will be followed by studies of target molecule recovery by extraction, recrystallization, distillation and chromatography. The design component of the course is a series of two-hour design challenges in which student teams generate solutions to process development problems. This includes proposing reaction sequences for producing a target molecule, conducting safety analyses of hazardous reactions, choosing from multiple synthetic routes, and recommending separation trains for product isolation.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 10
Engineering Design 20

PREREQUISITE(S): ENCH 245 and CHEE 311
EXCLUSION(S): ENCH 345

CHEE 330 Heat and Mass Transfer F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course follows a unified approach to introduce the physical origins and rate equations of heat and mass transfer. The principal topics covered include identification of the driving forces for heat and mass diffusion, development of transport models from first principles, steady state and transient solutions, and convective transfer. The boundary layer analogies are introduced. Closed form analytical solutions and correlations derived from dimensional analysis are used to estimate the heat and mass transfer convection coefficients.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

PREREQUISITE(S): CHEE 210, CHEE 223, or permission of the department.

CHEE 331 Design of Unit Operations W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
CHEE 331, CHEE 332 and CHEE 333 share a core component that introduces the concept and approach to design in engineering practice, and the design and scale-up of unit operations and use of equilibrium stage concepts in process design. Emphasis will be placed on instrumentation, economics, safety and environmental responsibility. A major component of this course is a design project. Enrolment is restricted to students in the Chemical Engineering CHE1 Option.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 42

PREREQUISITE(S): APSC 200, APSC 293, CHEE 311, CHEE 321, CHEE 330, or permission of the department.
COREQUISITE(S): CHEE 360

CHEE 332 Design of Unit Operations W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
CHEE 331, CHEE 332 and CHEE 333 share a core component that introduces the concept and approach to design in engineering practice, and the design and scale-up of unit operations and use of equilibrium stage concepts in process design. Emphasis will be placed on instrumentation, economics, safety and environmental responsibility. A major component of this course is a design project. Enrolment is restricted to students in the Chemical Engineering CHE2 Option.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 42

PREREQUISITE(S): APSC 200, APSC 293, CHEE 311, CHEE 321, CHEE 330, or permission of the department.
COREQUISITE(S): CHEE 360

CHEE 333 Design of Unit Operations W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
CHEE 331, CHEE 332 and CHEE 333 share a core component that introduces the concept and approach to design in engineering practice, and the design and scaleup of unit operations and use of equilibrium stage concepts in process design. Emphasis will be placed on instrumentation, economics, safety and environmental responsibility. A major component of this course is a design project. Enrolment is restricted to students in the Engineering Chemistry Option.

Academic Units:
Mathematics 0
Natural Sciences 0

Complementary Studies 0
Engineering Studies 0
Engineering Design 42

PREREQUISITE(S): APSC 200, APSC 293, CHEE 311, CHEE 321, CHEE 330, or permission of the department.
COREQUISITE(S): CHEE 360

CHEE 340 Biomedical Engineering W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The objective of the course is to introduce the student to the fundamentals necessary to understand and appreciate the issues involved in engineering in the body and to provide a framework for upper level studies in the area. Topics include: History of Biomedical Engineering, Anatomy and Physiology, Materials in Medicine, Transport Phenomena in the Body, Biomechanics, and Tissue Engineering.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 30
Engineering Design 0

EXCLUSION(S): CHEE 442

CHEE 342 Environmental Biotechnology F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course gives a broad perspective of the use of microbial systems to treat environmental pollutants and of microorganisms as potential environmental contaminants. Biogeochemical cycles and their applications to processes such as the desulphurization of coal and crude oil, biocorrosion, mineral (eg. uranium, copper and iron) leaching, the degradation of organic compounds, and nitrate removal from drinking water will be studied. Microbial waste disposal systems such as composting and soil bioremediation and the role of biotechnology in waste minimization will be examined. Microorganisms found in air, soil and water, their detection, enumeration and control will be discussed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

CHEE 360 Technical Communications W | 1.5

Lecture: 0.75
Lab: 0
Tutorial: 0.75
This course provides advanced instruction and practice in effective technical writing and oral presentation. Most exercises will be linked to required oral and written communications tasks in other courses. Open to Chemical

Engineering and Engineering chemistry students only.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 18
Engineering Studies 0
Engineering Design 0

COREQUISITE(S): CHEE 331 or CHEE 332 or CHEE 333, or permission of the Department

CHEE 361 Engineering Communications,Ethics & Professionalism W | K1

Lecture: X
Lab: X
Tutorial: X
This course provides advanced instruction and practice in engineering communications, engineering ethics and professionalism. Effective engineering writing and speaking skills are developed with an emphasis on engineering reports and oral presentations. Students will learn how to gather literature sources, apply appropriate citation styles, write effective resumes, and present data effectively. Activities include case studies involving the application of codes, engineering ethics, equity and professionalism. This course is integrated with CHEE 331/CHEE 332/CHEE 333

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 200 or APSC 202, APSC 293 or permission of the Department.
COREQUISITE(S): CHEE 331 or CHEE 332 or CHEE 333, or permission of the Department.

CHEE 370 Waste Treatment Processes W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The sources and characteristics of liquid waste streams emanating from chemical and related industries are reviewed as the basis for developing appropriate abatement and treatment strategies. Treatment processes utilizing individual operations as well as integrated systems of physical, chemical and biological treatment are covered. Waste treatment process designs and sensitivity analyses of alternatives are undertaken with the help of Computer Aided Design software. Canadian guidelines, regulations and industrial case studies are presented.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 17
Engineering Design 25

PREREQUISITE(S): CHEE 221 or MINE 201, or permission of the department
EXCLUSION(S): CIVL 372, CIVL 470

CHEE 371 Mitigation of Industrial Pollution W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Sources and characteristics of waste streams emanating from chemical and related industries are reviewed as the basis for developing appropriate abatement and treatment strategies. Treatment processes utilizing individual operations as well as integrated systems of physical, chemical and biological treatment are covered. Treatment process designs and sensitivity analyses of alternatives are undertaken for case studies involving industrial solid, liquid and gaseous wastes. Canadian guidelines and regulations are presented and implemented within the context of environmental and human health.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 12

PREREQUISITE(S): CHEE 221 or MINE 221, or permission of the Department.

CHEE 380 Biochemical Engineering F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Biochemical Engineering involves the application of Chemical Engineering principles and approaches to biologically-based systems and processes. Biochemical Engineering is central to the area of environmental engineering, and to biotechnology processes which produce pharmaceuticals, fine chemicals and genetically engineered products. The course involves a systematic and quantitative description of medium formulation and sterilization, microbial kinetics and bioreactor design, product isolation and purification, and examples of current industrial practices and processes.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 12

CHEE 400 Technology, Engineering & Management (TEAM) FW | K7

Lecture: X
Lab: X
Tutorial: X
Multidiscipline teams of engineering, commerce, law, and/or science students, as appropriate, act as consultants to industrial and governmental clients. Projects include a phase of self-directed problem definition and project scope definition in the fall term, followed by project execution in the winter term. Typical projects involve evaluation of technical alternatives (with an emphasis on health, safety, and environmental), preparation of detailed recommendations, and both market and financial analysis. Project topics vary widely and are provided by a diverse list of fee paying clients. The course includes seminars on project management. There are several meetings during the fall term to organize groups and select projects, but regularly scheduled lectures do not begin until the Winter term. Teams interact regularly with clients at both a technical and a management level, and are also assigned an industrial project mentor. Students master project management skills, by managing their own budget, travel arrangements etc. The course

concludes with a comprehensive report and presentation to the client. The course is managed by the Department of Chemical Engineering

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 42
Engineering Studies 0
Engineering Design 42

PREREQUISITE(S): Permission of the instructor

CHEE 405 Biochemical/Biomedical Research Project FW | 7

Lecture: 0.25
Lab: 6
Tutorial: 0.75
Students will conduct research on a Biochemical/Biomedical Engineering related project. Based on the project objective provided by their faculty supervisor, the students will work independently to develop an experimental and/or modeling methodology, conduct experiments or simulations and generate data. Students will submit interim oral and written progress reports and a final oral presentation and technical report. They will be expected to present and defend their results in a conference/seminar setting. Students enrolling for this course are advised to consult with the faculty member supervisor concerned late in the winter term of their 3rd year of study.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 84
Engineering Design 0

CHEE 406 Bioenvironmental Research Project FW | 7

Lecture: 0.25
Lab: 6
Tutorial: 0.75
Students will conduct research on a Bioenvironmental Engineering related project. Based on the project objective provided by their faculty supervisor, the students will work independently to develop an experimental and/or modeling methodology, conduct experiments or simulations and generate data. Students will submit interim oral and written progress reports and a final oral presentation and technical report. They will be expected to present and defend their results in a conference/seminar setting. Students enrolling for this course are advised to consult with the faculty member supervisor concerned late in the winter term of their 3rd year of study.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 84
Engineering Design 0

CHEE 407 Deleted - Biochemical/Biomedical/Bioenvironmental Research Seminar W | 3

Lecture: 1
Lab: 0
Tutorial: 2
Students will attend and report on a series of seminars presented by researchers in the field of Biochemical Engineering. Each student will deliver interactive seminar presentations, based on assigned topics in the field. After conducting a literature review, students will submit a review term paper, or a case study based on their reading and understanding of the literature. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 14
Engineering Studies 22
Engineering Design 0

CHEE 408 Bioengineering Research Project FW | 7

Lecture: 0.25
Lab: 6
Tutorial: 0.75
Students will conduct research on a Biochemical/Biomedical/Bioenvironmental Engineering related project. Based on the project objective provided by their faculty supervisor, the students will work independently to develop an experimental and/or modeling methodology, conduct experiments or simulations and generate data. Students will submit interim oral and written progress reports and a final oral presentation and technical report. They will be expected to present and defend their results in a conference/seminar setting. Students enrolling for this course are advised to consult with the faculty member supervisor concerned late in the winter term of their 3rd year of study.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 84
Engineering Design 0

CHEE 412 Transport Phenomena in Chemical Engineering W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The course advances the fundamentals of material, momentum and energy transfer. Emphasis is placed on the theory and analysis of diffusion, convection and interphase transport of material in laminar and turbulent streams. Applications in engineering and environmental transport processes are presented, and the modelling of complex processes is considered. A design project is an integral part of the course.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 12

PREREQUISITE(S): CHEE 223 and CHEE 330, or permission of the department
EXCLUSION(S): CHEE 452

CHEE 418 Strategies for Process Investigations F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The roles of designed experiments and data analysis procedures in process investigations are discussed. Applications of two-level factorial and fractional factorial designs in screening studies and higher-order designs for response surface characterization and exploration are examined. Least squares procedures for fitting and testing mathematical models, and for assessing model predictions, are described. Empirical in-plant optimization procedures are also considered. Established and evolving approaches for quality and productivity improvement are examined. The design component of this course is the planning and execution of an experimental investigation, the analysis of the resulting data, and the formulation of recommendations on the basis of those results.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Studies 18
Engineering Design 12

PREREQUISITE(S): CHEE 209, or permission of the department
EXCLUSION(S): STAT 361

CHEE 420 Laboratory Projects III F/W | 4

Lecture: 0.25
Lab: 3
Tutorial: 0.75
Students will work as teams to tackle projects that require bench and pilot plant equipment, and computer packages that simulate commercial processes. The projects will be more extensive and integrated than in previous laboratories, and will require a thorough and comprehensive analysis of processes and operations. A strong emphasis is placed on project planning and management, as well as professional communication with supervisors. The design component of this course is found in the application of process analysis skills to solve problems. The projects require the students to apply critical and problem solving skills in the operation or simulation of laboratory and process equipment with the goal of solving a problem for a fictitious industrial client. The projects may involve analysis or troubleshooting of existing equipment, or an investigation of the applicability of a concept to a new area.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 24

PREREQUISITE(S): CHEE 311, CHEE 321, CHEE 330, CHEE 315, CHEE 319, or permission of the department

CHEE 421 Research Project FW | 7

Lecture: 0.25
Lab: 6
Tutorial: 0.75
This course provides an opportunity for students to work on an individual basis with faculty members of the department. Students will submit interim oral and written progress reports and a final oral presentation and technical

report. They will be expected to present and defend their results in a conference/seminar setting. The projects may be concerned with engineering design and development work or may be of a more fundamental research nature. Students enrolling for this course are advised to consult with the faculty member concerned late in the winter term of their 3rd year of study.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 84
Engineering Design 0

PREREQUISITE(S): ECGPA of 3.20 or permission of the Department.

CHEE 434 NOT OFFERED THIS YEAR - Process Control II W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course presents methods for dynamic analysis and controller design for multivariable process control problems, and discrete time control. Control techniques, including feedforward and cascade control, are discussed further, and the concept of model predictive control is presented. Multivariable controller design and the problem of control loop interaction are examined. State space models for processes are introduced. Mathematical tools for analyzing the dynamics of sampled data systems are developed, and the design of discrete time controllers is introduced. Techniques discussed in the course are applied to the control of various chemical process units. This course is offered jointly with CHEE 821.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 29
Engineering Design 13

PREREQUISITE(S): CHEE 319, or permission of the department

CHEE 436 NOT OFFERED THIS YEAR - System Identification F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The course focuses on the theory and application of linear time series methods for system identification. Time domain and frequency domain methods for analyzing dynamic data will be presented. Standard process plus disturbance models encountered in the identification literature will be investigated from both statistical and physical perspectives. Methods for structural identification, incorporation of exogenous variables, parameter estimation, inference and model adequacy will be examined in detail. The design of dynamic experiments and incorporation of model uncertainty into the intended model and use, such as prediction or control, will be discussed. Assignments will include the analysis of industrial data sets. Dynamic modelling using neural networks and nonlinear time series methods will be introduced.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0

Engineering Studies 30
Engineering Design 0

PREREQUISITE(S): CHEE 209, CHEE 418, or permission of the department.

CHEE 440 Pharmaceutical Technology W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Introduction to pharmaceutics and the industrial manufacture of pharmaceutical dosage forms. Topics include the design and preparation of a successful dosage form with respect to the route of administration, and large scale manufacture in a sterile and clean environment. Aspects of chemical kinetics, physical chemistry, physiology, cell biology, mass and heat transfer, and fluid dynamics will be described as they relate to the manufacture of effective dosage forms.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 30
Engineering Design 0

CHEE 450 NOT OFFERED THIS YEAR - Engineering Biology W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Topics include: biosynthesis of biologically based products: properties of biologically active materials including enzymes, polynucleotides and polypeptides; enzyme reaction kinetics; cell and tissue growth and production kinetics; cell and tissue culture engineering; diffusion and reaction involved immobilized cells and enzymes; bioprocess instrumentation. The course project will require the design of a biological reactor or downstream unit operation, or the specification of instrumentation for a particular bioprocess.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 12

PREREQUISITE(S): ENCH 245 (CHEM 245)

CHEE 452 Transport Phenomena in Physiological Systems F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course is an introduction to the area of mass, momentum and heat transfer processes in physiological systems. In this course the student will appreciate the role of transport phenomena in the function of organs and organ systems in the body, and develop the skills necessary to analyze models of biological transport processes in the context of the design of biomedical devices.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 12

PREREQUISITE(S): CHEE 223 and CHEE 330, or permission of the department
EXCLUSION(S): CHEE 412

CHEE 460 NOT OFFERED THIS YEAR - Applied Surface and Colloid Science F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The course covers four major topics. 1. The thermodynamic properties of interfaces (surface energy, wetting, surface area and porosity, capillary effects, work of adhesion/cohesion). 2. Models of adsorption/desorption phenomena. 3. The amphiphilic behaviour of surfactants. 4. The stability and characterization of colloidal systems. Student appreciation for the importance of these phenomena is cultivated using examples drawn from industrial processes/products including inks, paints, foods, polymer blends, and nanocomposites.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 30
Engineering Design 0

PREREQUISITE(S): CHEE 210 or permission of the department.
EXCLUSION(S): ENCH 347 (CHEM 347)

CHEE 461 Electrochemical Engineering W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This engineering science course covers aspects of technological applications of electrochemistry. It can be considered as overlap between electrical engineering, electrochemistry and chemical engineering. The course addresses the following 6 major topics of electrochemical engineering: 1) Introduction to Electrochemical Engineering: Electrostatics, Electrodynamics, Electrical Circuit Theory, Faradays Law; 2) Elements of Electrochemical Systems I Electrolyte: Transport processes, electrolyte conductivity, pH and buffer solutions; 3) Elements of Electrochemical Systems II Electrodes: Electrochemical Thermodynamics, Nernst Equation, Reference Electrodes, Cell Potential (Electromotive Force), Electrode Kinetics 4) Electrical Double Layers: Theory & Models, Electrokinetic Phenomena; 5) Electrochemical Energy Engineering: Batteries, Fuel Cells, Electrical & Electrochemical Capacitors; 6) Industrial Electrochemical Processes: Fundamentals, Reactor Design & Parameter, Chlor-Alkali Process, Electrochemical Extraction of Metals, Hall Heroult Process.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30

Engineering Design 12

PREREQUISITE(S): CHEE 210, CHEE 321, or permission of the department.

CHEE 470 Design of Manufacturing Processes F | 6.25

Lecture: 3
Lab: 3
Tutorial: 0.25
This course will consolidate the necessary skills essential to carrying out a comprehensive industrial process design including a technical and financial analysis. The simulation software, and the scope of the design problem will be introduced during extra classes in the first week. Class workshops will deal with such diverse topics as health, safety and environmental compliance, optimization techniques and capital cost estimation. The students will develop a competency in the use of and a recognition of the limitations of "State-of-the-Art" simulation software. In addition to the process design, which will represent current technology, a capital cost estimate will be prepared as part of a rigorous assessment of the profitability of the project. In lieu of a final exam, student groups will be expected to prepare a formal design report and make a formal presentation.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 75

PREREQUISITE(S): CHEE 223, CHEE 311, CHEE 330, (CHEE 331 or CHEE 332 or CHEE 333), CHEE 321, or permission of the department.

CHEE 481 NOT OFFERED THIS YEAR - Air Quality Management W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Fluid-particle systems and mass transfer principles are presented with application to air pollution control in industrial processes. The selection and design of equipment for the control of particulate and gaseous emission sources are examined. The problem of odorous emissions, stack sampling techniques and dispersion calculations are discussed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 18

PREREQUISITE(S): One of CHEE 223, CIVL 250, or MECH 241, or permission of the department

CHEE 484 NOT OFFERED THIS YEAR - Bioremediation W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Bioremediation as an option to treat contaminated soils and ground water. Advantages and disadvantages of

bioremediation compared to nonbiological processes. Factors affecting choice of in situ or ex situ processes. Assessment of biodegradability; biostimulation vs bioaugmentation; mineralization vs. partial degradation; factors affecting microbial activity (choice of electron acceptor, toxicity of pollutant, C/N/P ratio, co-substrates, soil humidity, pH and temperature); bioavailability of pollutant. Biodegradation of specific contaminants (e.g. diesel fuel, polychlorinated biphenyls, dyestuffs, aromatic and polyaromatic hydrocarbons) will be studied in detail. The design component of this course consists of learning design of appropriate laboratory and field experiments to obtain data on microbial degradation of an organic pollutant to be able to calculate bioremediation design parameters such as mass and delivery rate requirements of electron acceptors and nutrients and degradation rates in reactor and non-reactor based systems; and to be aware of limitations of these calculations.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

CHEE 490 Polymer Formulations and Processing Technology W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The design and manufacture of polymer products is reviewed, with particular emphasis on material selection and processing technology. The engineering properties of elastomers, thermoplastics, adhesives, fibres and coatings are discussed in terms of processing characteristics and end-use performance. Industrial processing operations such as extrusion, molding, mixing and film manufacture are presented in detail. The design component of the course requires students to select appropriate materials and processing methods for an engineering application. Examples include medical catheters, engine gaskets, drug capsules and biodegradable packaging.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 12

PREREQUISITE(S): CHEE 223 or MECH 241, or permission of the department

Civil Engineering

CIVL 200 Civil Week I - Professional Skills F | 2.5

Lecture: 0.5
Lab: 1
Tutorial: 1
Within a team structure involving second, third, and fourth year Civil Engineering students and a faculty advisor, students will engage in a range of exercises designed to promote written and verbal communication, decision making, team building and engineering design skills. Lectures, workshops, design charettes and both individual and team assignments will be utilized to enhance learning.

Academic Units:
Mathematics 0

Natural Sciences 0
Complementary Studies 14
Engineering Studies 7
Engineering Design 7

CIVL 201 Professional Skills F/W | 2.5

Lecture: 0.5
Lab: 1
Tutorial: 1
Within a team structure potentially involving second, third, and fourth year Civil Engineering students and a faculty advisor, students will engage in a range of exercises designed to promote written and verbal communication, decision making, team building and engineering design skills. Lectures, workshops, design charettes and both individual and team assignments will be utilized to enhance learning. This course is available only to select students, under exceptional or extenuating circumstances, at the discretion of the Head of the Department and the Undergraduate Chair. (This course may not be offered every year).

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 14
Engineering Studies 7
Engineering Design 7

PREREQUISITE(S): Permission of the Department
EXCLUSION(S): CIVL 200

CIVL 210 Chemistry for Civil Engineers F | 4.5

Lecture: 3
Lab: 1
Tutorial: 0.5
Application of fundamental chemistry principles with respect to their sources, reactions, effects and fates in civil and environmental engineering systems. Topics will include chemical equilibria, stoichiometry and reaction kinetics; electrochemistry and corrosion; adsorption and ion exchange; solubility and precipitation; coagulation; microbiological reactions and kinetics; biochemical, chemical and theoretical oxygen demand; acidity, alkalinity and hardness; as well as biogeochemical cycles. These concepts will be further developed and applied in tutorial and laboratory modules. A design-based laboratory is conducted as part of this course. Personal Protective Equipment (PPE) will be required for this course at student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 20
Complementary Studies 0
Engineering Studies 20
Engineering Design 15

PREREQUISITE(S): APSC 132

CIVL 215 Materials for Civil Engineers W | 4.5

Lecture: 3
Lab: 1
Tutorial: 0.5
The basic engineering properties, micro/macro structure, behaviour and applications of various civil engineering materials will be studied including materials used in structural engineering, hydrotechnincal engineering, geotechnical engineering and environmental engineering. This will include concrete, steel, timber, polymers, composites and soil. Interaction between materials will be examined. Laboratory experiments will be used to demonstrate material behaviour. PPE will be required for this course student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 32
Engineering Design 10

PREREQUISITE(S): APSC 151

CIVL 220 NOT OFFERED THIS YEAR - Statics and Solid Mechanics F | 4

Lecture: 3
Lab: 0.25
Tutorial: 0.75
Review of statics, forces and equilibrium, internal forces in simple structures; axial, torsion, shear and moment diagrams; concepts of stress and strain; mechanical properties of materials; centroids and moments of areas; axial stress; flexural stress; shear stress in shafts and beams; calculation of displacement by integration; introduction to combined loading; introduction to column buckling. This course is designed primarily for mechanical engineering students.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 48
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 171. Permission of the department for students not registered in Mechanical Engine

CIVL 222 Numerical Methods for Civil Engineers W | 5

Lecture: 4
Lab: 1
Tutorial: 0
This course introduces the basics of numerical analysis and the use of computer software (MATLAB) for civil engineering analysis. Error analysis, numerical differentiation and integration, root finding, derivation and numerical solution of partial differential equations using finite difference methods, and optimization are among the topics covered. All problems emphasize engineering applications.

Academic Units:
Mathematics 45
Natural Sciences 0
Complementary Studies 0

Engineering Studies 15
Engineering Design 0

PREREQUISITE(S): MTHE 224 (MATH 224) or MTHE 225 (MATH 225) or MTHE 226 (MATH 226)

CIVL 230 Solid Mechanics I F | 4.25

Lecture: 3
Lab: 0.5
Tutorial: 0.75
Review of statics, forces, and equilibrium, internal forces in simple structures; axial, torsion, shear and moment diagrams; concepts of stress and strain; mechanical properties of materials; centroids and moments of areas; axial stress; flexural stress; shear stress in shafts and beams; calculation of displacement by integration; introduction to combined loading; introduction to column buckling. PPE will be required for this course at student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 50
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 171
EXCLUSION(S): CIVL 220 and MECH 221

CIVL 231 Solid Mechanics II W | 4.5

Lecture: 3
Lab: 0.5
Tutorial: 1
Calculation of bending displacements using moment-area methods; introduction to statically indeterminate systems; combined loading; stress and strain transformations; columns; energy methods; non-linear material behaviour; two-dimensional elasticity; advanced torsion problems.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 54
Engineering Design 0

PREREQUISITE(S): CIVL 230

CIVL 250 Hydraulics I W | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
Fluid properties, fluid statics, basic equations of fluid flow: Continuity, Momentum, Euler's Equation of Motion, Linear Momentum Equation and Bernoulli's Equation. Flow of real fluid in closed conduits: friction losses and local energy losses. Pipeline flows in engineering practice. PPE will be required for this course at student's cost (see course

materials for details)

Academic Units:
Mathematics 0
Natural Sciences 4
Complementary Studies 0
Engineering Studies 22
Engineering Design 22

PREREQUISITE(S): APSC 172, APSC 174

CIVL 260 Deleted - Civil Engineering Design I F | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
The objectives of this introductory course are: to introduce students to engineering design and the challenges and excitement of the civil engineering profession; to develop written and oral communications skills; to develop an appreciation and ability for teamwork, creativity and time/project management; to develop skills in idea generation, creative problem solving, and research; and to develop skills in using computer applications in engineering design and analysis. The course exposes students to civil engineering design through case studies and group projects. Students are expected to learn about the design process through practice and, where possible, through implementation. Design projects are team-based and as such students need to learn how to work effectively with their peers. Sketching and AutoCAD are also be introduced and used. The design principles and concepts introduced will be used in follow-on courses throughout students' degrees. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Studies 12
Engineering Design 24

CIVL 300 Civil Week - Professional Skills F | 2.5

Lecture: 0.5
Lab: 1
Tutorial: 1
Within a team structure involving second, third, and fourth year Civil Engineering students and a faculty advisor, students will engage in a range of exercises designed to promote written and verbal communication, decision making, team building and engineering design skills. Lectures, workshops, design charettes and both individual and team assignments will be utilized to enhance learning.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 14
Engineering Studies 7
Engineering Design 7

PREREQUISITE(S): CIVL 200

CIVL 330 Structural Analysis F | 3.75

Lecture: 3
Lab: 0.5
Tutorial: 0.25
Analysis of statically determinate structures such as trusses and plane frames, calculation of deflections by virtual work. Flexibility and stiffness methods for analyzing statically indeterminate structures. Computer applications of the above methods.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 44
Engineering Design 0

PREREQUISITE(S): CIVL 230, CIVL 231

CIVL 331 Structural Steel Design W | 4

Lecture: 3
Lab: 0
Tutorial: 1
Introduction to Limit States Design, load paths. Dead and live loads for design as specified in the National Building Code of Canada. Design assumptions regarding material properties of structural steel. Design of tension members; bolted connections; design of simple columns; design of beams (laterally supported and laterally unsupported) for flexure and shear; design of bearing stiffeners; design of steel-concrete composite beams; stability analysis; design of beam-columns. Sustainability for building materials; introduction to LEED.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 12
Engineering Design 36

PREREQUISITE(S): CIVL 330

CIVL 340 Geotechnical Engineering I F | 3.75

Lecture: 3
Lab: 0.5
Tutorial: 0.25
An introductory course focussing on the fundamental mechanics of soil materials (gravel, sand, silt and clay) applied to geotechnical engineering problems. Topics studied include: phase relationships; index properties of coarse and fine grained soils; one-dimensional steady state seepage; effective stress; one-dimensional compression and consolidation; drained and undrained shear strength; and lateral earth pressure. Theoretical material is applied to examine real engineering issues with a particular focus on developing design skills and engineering judgement. Students will conduct physical experiments to explore soil behaviour. The important role of geology on the mechanics of geotechnical materials is emphasized through classroom discussions and problem sets. PPE will be required for this course at student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 0

Complementary Studies 0
Engineering Studies 32
Engineering Design 12

PREREQUISITE(S): CIVL 215 or GEOE 281 (GEOL 281), CIVL 230

CIVL 341 Geotechnical Engineering II W | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
A course focusing on design issues and methods of analysis for practical geotechnical engineering problems. Topics studied include: site investigation; capacity and settlement of shallow and deep foundations; two-dimensional steady state seepage; landslides and slope stability. Commercial software will be introduced to perform stability, deformation and seepage analyses. Students will conduct physical experiments to explore how design methods compare with real soil behaviour. The important role of geology in geotechnical design is emphasized through classroom discussions and problem sets. PPE will be required for this course at student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 12
Engineering Design 36

PREREQUISITE(S): CIVL 340

CIVL 350 Hydraulics II F | 3.75

Lecture: 3
Lab: 0.5
Tutorial: 0.25
Topics in open channel flow including friction, specific energy, free-surface profiles, culverts and hydraulic-jump energy dissipaters. Lake dynamics and environmental hydraulics will be introduced. The basic underlying concepts of water resources and hydrology will be discussed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 14
Engineering Design 30

PREREQUISITE(S): CIVL 250

CIVL 360 Civil Engineering Design and Practice III W | K4

Lecture: Yes
Lab: Yes
Tutorial: Yes
Students will develop and employ Engineering Design and Practice skills to resolve a complex, open-ended design task. This will involve the iterative application of Civil Engineering technical knowledge to identify and evaluate

design options. The economic, environmental and societal implications of the preferred solution(s) will be assessed. Students will select, detail and communicate their final design in a logical, traceable and defendable manner. Ethical, legal and other relevant professional issues will be studied and discussed through case studies. Students will also develop and enhance written, graphical and oral communications skills.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Design 36

PREREQUISITE(S): APSC 200

CIVL 370 Deleted - Fundamentals of Environmental Engineering |

This course provides an introduction to the science and engineering of environmental issues and problems, with the main goal being the protection of the health and well-being of humans and their surroundings. Topics may include an examination of human-induced environmental problems, and the role of technology in dealing with these; the scientific aspects of environmental engineering which are used to quantify and qualify environmental problems; and the technological control of environmental problems. Health and safety issues relating to human and ecosystem exposure to environmental contaminants are emphasized, and local and global examples of environmental problems and solutions are used. - COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 32
Engineering Design 16

PREREQUISITE(S): CIVL 210, or ENCH 211 (CHEM 211)

CIVL 371 Groundwater Engineering F | 3.75

Lecture: 3
Lab: 0.5
Tutorial: 0.25
This course introduces students to the fundamentals of groundwater systems with an emphasis on the engineering design of extraction systems for water supply, site dewatering, and parameter estimation tests. Source water protection methods will be discussed. Equations governing the flow of groundwater, flownets, and capture zones are presented. Detailed case histories are presented. Laboratories make extensive use of commercial grade software for surface and groundwater flow simulation.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 14

PREREQUISITE(S): MTHE 224 or MTHE 225 or MTHE 232

CIVL 372 Water and Wastewater Engineering W | 4

Lecture: 3
Lab: 1
Tutorial: 0
This course introduces general concepts of water/wastewater engineering for the protection of human and ecosystem health, and focuses on the fundamental design and operation of unit operations and processes for provision of safe drinking water and the treatment and disposal of wastewaters and accumulated solids to meet source water protection regulations and requirements. Topics include water quality problems; reactors and reactions; the quality of water supplies and the characteristics of wastewater; the chemical, physical and/or biological treatment of drinking water and wastewater; and biosolids stabilization and management. Alternative and innovative urban water management strategies will be discussed and emerging issues for water managers will be introduced. The laboratories will illustrate standard and advanced analytical methods and data analysis for design of some of these systems. PPE will be required for this course at the student's cost.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 20
Engineering Design 16

PREREQUISITE(S): CIVL 210
EXCLUSION(S): CHEE 370

CIVL 380 Deleted - Applied Sustainability and Public Health in Civil Engineering |

This course introduces concepts and tools to undertake the sustainable design of infrastructure systems. Emphasis is placed on the prevention of environmental and human health damage at the design stage of civil engineering systems. Key concepts of sustainability, natural capital, humanmade capital are defined. The rules of "weak" and "strong" sustainability are introduced. Life-cycle analysis, environmental input-output analysis, and quantitative risk assessment are introduced as systems-level approaches and applied to material selection and design decisions of civil engineering systems. Students will apply these techniques in a design project. - COURSE DELETED 2014-2015

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 12

PREREQUISITE(S): CIVL 215, CIVL 250, or permission of the Department

CIVL 400 Civil Week - Professional Skills F | 2.5

Lecture: 0.5
Lab: 1
Tutorial: 1
Within a team structure involving second, third, and fourth year Civil Engineering students and a faculty advisor, students will engage in a range of exercises designed to promote written and verbal communication, decision making, team building and engineering design skills. Lectures, workshops, design charettes and both individual and team assignments will be utilized to enhance learning.

Academic Units:
Mathematics 0

Natural Sciences 0
Complementary Studies 14
Engineering Studies 7
Engineering Design 7

PREREQUISITE(S): CIVL 300
COREQUISITE(S): CIVL 460

CIVL 409 Deleted - Engineering Report F | 3.5

Lecture: 0.5
Lab: 0
Tutorial: 3
The primary purpose of this course is to provide students with the opportunity to write and present an engineering report, a task they will often have to fulfil during their careers as practicing engineers. The exact nature of these reports varies, but may include proposals, assessments, feasibility studies, evaluations and specifications and communication of results. Since the student will not be expected to have at hand all information normally available to the practicing engineer, it is expected that the report will take one of the following forms: a critical review and discussion of the literature on an engineering problem; a report on an engineering project on which the student has worked; or a report on an experimental undertaking. A number of drafts of the report will be submitted according to a fixed time schedule, before the final version is ready for publication. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 30
Engineering Studies 5
Engineering Design 5

PREREQUISITE(S): CIVL 204

CIVL 430 Reinforced Concrete Design F | 3.75

Lecture: 3
Lab: 0.25
Tutorial: 0.5
Flexural design of reinforced concrete beams including singly reinforced sections, doubly reinforced sections, T-sections, and one-way slabs. Control of cracking in reinforced concrete beams as specified for design. Design of continuous beams and one-way slabs; short and slender columns; footings deflections; development of reinforcement. A laboratory design project is undertaken in this course. PPE will be required for this course at student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 11
Engineering Design 33

PREREQUISITE(S): CIVL 215, CIVL 330, CIVL 331

CIVL 431 Infrastructure Rehabilitation W | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
This course deals with evaluation of the deterioration of the infrastructure and the design of rehabilitation measures. Items discussed include corrosion of reinforcement in concrete, microbiological corrosion of buried pipelines, asphalt deterioration and repair, deterioration of timber in buildings, and issues of sustainability of infrastructure. Design techniques to reduce deterioration in new construction are also discussed. The laboratory portion involves some of the test methods used to evaluate deterioration and field trips to observe some common forms of deterioration. PPE will be required for this course at student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 32
Engineering Design 16

PREREQUISITE(S): CIVL 430

CIVL 436 Prestressed Concrete W | 4

Lecture: 3
Lab: 0
Tutorial: 1
Behaviour, analysis and design of pretensioned and post-tensioned concrete systems including simply-supported and continuous beams, and two-way slabs. Considerations of prestress losses, cracking and deflection. A design project is undertaken in this course. Three term-hours, winter; lectures and tutorials.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 24

PREREQUISITE(S): CIVL 430

CIVL 442 Geotechnical Design F | 3.75

Lecture: 3
Lab: 0
Tutorial: 0.75
A design-based course where geotechnical principles are applied to study the design of a variety of geotechnical engineering structures. Topics studied include: design of a site investigation program, interpretation of site stratigraphy, estimation of soil parameters, design of shallow and/or deep foundations, design of earth retaining structures, and construction issues such as dewatering schemes or temporary excavations. Students will conduct practical design tasks to experience a range of aspects of the geotechnical design process, to utilize common models used in geotechnical design, and to communicate with project partners such as structural consultants, site investigation companies, and construction contractors. The important role of geology in geotechnical problems is emphasized through classroom discussions, planning a site investigation and constructing a geologic model.

Academic Units:
Mathematics 0

Natural Sciences 0
Complementary Studies 0
Engineering Studies 10
Engineering Design 35

PREREQUISITE(S): CIVL 341

CIVL 443 Geoenvironmental Design W | 4

Lecture: 3
Lab: 1
Tutorial: 0
A design-based course where geotechnical and hydrogeologic principles are applied to study environmentally sustainable disposal of solid waste. Topics studied include: source and nature of waste: disposal options; environmental legislation and regulations; public impact and perception; contaminant transport; use of geosynthetic materials; and design issues and tradeoffs. Students will conduct practical design tasks to investigate the planning, design, construction, operation and post-closure of phases of an engineered waste disposal facility. The important role of geology in geoenvironmental problems is emphasized through classroom discussions, planning a site investigation and constructing a geologic model.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 12
Engineering Design 36

PREREQUISITE(S): CIVL 340 or permission of the department

CIVL 450 Municipal Hydraulics F | 3.75

Lecture: 3
Lab: 0
Tutorial: 0.75
The course will present concepts and tools to analyze and design water services, including storm sewers, sanitary sewers, and water mains, at the site- and sub-division level. Many of the concepts and tools are used in the fields of land-development engineering and municipal engineering. The course will provide an introduction to hydrological processes, design rainfall prediction with intensity-duration-frequency curves, estimation of time of concentration, peak runoff prediction in small drainage areas with the Rational Method and the unit hydrograph method, reservoir routing and storm water management tank and pond design, storm sewer analysis and design with Manning's equation, wastewater flow prediction, sanitary sewer analysis and design, water demand prediction, steady-state analysis of pressurized pipes, water main design, and designing water services according to municipal design standards.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Studies 20
Engineering Design 12

PREREQUISITE(S): CIVL 350

CIVL 451 Lake, Reservoir and Coastal Engineering F | 3.75

Lecture: 3
Lab: 0.5
Tutorial: 0.25
The fundamental hydraulic processes affecting coastal engineering and water reservoir operation are discussed. Topics include wave theory, wave measurement, wave record analysis, wave transformation, seiches, tides, storm surges, turbulent mixing and transport of pollutants. Student projects are assigned on computational water reservoir modelling, analysis of field data and reservoir operation as well as the design of breakwaters and ocean structures and the use of hydraulic and numerical coastal models.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 22
Engineering Design 22

PREREQUISITE(S): CIVL 350, or permission of the department

CIVL 455 River Engineering W | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
A course in the basics of river engineering including the study of alluvial processes, the prediction and consequences of sediment transport, the design of measures to control erosion and accretion, and the design of dams, spillways and diversions. Critical aspects in the design of river engineering structures and assessment of environmental impact of river engineering projects are discussed. The use of physical and numerical models in the practice of river engineering is illustrated. The principles of natural channel design, stream restoration, and bioengineering in river environments are also addressed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 24

PREREQUISITE(S): CIVL 350 or permission of instructor

CIVL 460 Civil Engineering Design and Practice IV FW | K6

Lecture: Yes
Lab: Yes
Tutorial: Yes
This fourth year design capstone course has student teams undertake a comprehensive engineering design project which involves the creative, interactive process of designing a structure/system to meet a specified need subject to economic, health, safety and environmental constraints. The teams will work in collaboration with an industry partner. Each team will submit an engineering report and make an oral presentation PPE will be required for this course at student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 0

Complementary Studies 12
Engineering Studies 0
Engineering Design 60

PREREQUISITE(S): APSC 200, APSC 293
COREQUISITE(S): CIVL 400

CIVL 470 Deleted - Municipal Water Engineering |

Continuing from the introductory material in CIVL 370, this course describes the engineering aspects of the provision of potable water, and the collection, treatment and disposal of wastewater in the urban environment. Topics include the quality of water supplies and the characteristics of wastewater; estimation of water consumption and sewage generation; the chemical and physical treatment of water for drinking purposes; design of water distribution and wastewater collection systems; physical, chemical and biological wastewater treatment; and effluent and sludge disposal. Alternative urban development strategies are discussed (i.e. water conservation and urban reuse). The laboratories illustrate basic analytical methods which provide data for design of these systems. PPE will be required for this course at student's cost (see course materials for details) - COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 16
Engineering Design 16

PREREQUISITE(S): CIVL 370, or permission of the department

CIVL 471 Subsurface Contamination W | 4

Lecture: 3
Lab: 0
Tutorial: 1
This course deals with subsurface contamination by hazardous industrial liquids such as PCB oils, gasoline, jet fuel, chlorinated solvents and coal tars. The fundamentals of multiphase/multicomponent flow and transport in soil and groundwater are outlined followed by specific treatment of both dense and light non-aqueous phase liquids. The course will examine the subsurface distribution of these liquids, site characterization methods, indoor air intrusion, regulatory apsects, remediation technologies, and selected case histories.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 34
Engineering Design 14

PREREQUISITE(S): CIVL 371, or GEOE 343 (GEOL 343), or permission of the department

CIVL 472 Deleted - ENV TE II: Waste Management |

This course deals with municipal and hazardous waste management. Waste sources, composition and potential impacts are outlined followed by specific treatments collection and transport, recycling and reuse. A large portion of the course will focus on the processing of municipal and industrial wastes, including biochemical (composting, anaerobic digestion, hydrolysis, fermentation) and thermochemical (combustion, gasification, pyrolysis) treatments, and isolation as management strategies. The course will also examine diversion and energy recovery approaches, and integrated waste management planning. - COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 24

PREREQUISITE(S): CIVL 210. CIVL 370, or equivalent, or permission of the department

CIVL 473 Water Resources Systems F | 3.75

Lecture: 3
Lab: 0
Tutorial: 0.75
This course will present concepts and tools for designing and modelling large-scale water resources systems in urban catchments. Focus will be placed on the design and analysis of urban drainage systems and urban water supply/distribution systems at the catchment level. Hydrologic, hydraulic, and statistical modelling tools used in industry will be used to evaluate the performance of water resources systems. Topics will include: the urban water cycle, environmental considerations in master planning of drainage and water supply systems, climate change impacts on water resources systems, floodplain analysis and flood control, statistical analysis of rainfall and stochastic hydrology, continuous simulation modelling, planning and modelling of large-scale urban drainage systems, planning and modelling of large-scale water distribution systems, reliability analysis and water quality analysis of water distribution systems, and the master planning process for urban drainage and drinking water systems.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Studies 20
Engineering Design 12

PREREQUISITE(S): CIVL 350

CIVL 500 Civil Engineering Thesis FW | K4

Lecture: Yes
Lab: Yes
Tutorial: Yes
Working closely with a faculty member, students will conduct research on a civil engineering or related applied science topic. Students will: identify a problem; formulate a research question; and devise and implement a research plan. The nature of the research may involve obtaining experimental measurements, performing field testing and/or numerical analysis, and analysing and interpreting research results. Students will prepare a comprehensive, written technical report and will defend their research in an oral examination. Registration is limited to a maximum of twenty (20) students PPE will be required for this course at student's cost (see course materials for details).

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 24

Engineering Studies 24
Engineering Design 0

PREREQUISITE(S): successful completion of 3rd year civil engineering with a minimum sessional average of 70%

Computer Engineering

CMPE 204 Logic for Computing Science W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Elements of mathematical logic with computing applications. Formal proof systems for propositional and predicate logic. Interpretations, validity, and satisfiability. Introduction to soundness, completeness and decidability.

Academic Units:
Mathematics 36
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ELEC 270 or CISC 203

CMPE 212 Introduction to Computing Science II F/W | 4

Lecture: 3
Lab: 1
Tutorial: 0
Introduction to object-oriented design, architecture, and programming. Use of packages, class libraries, and interfaces. Encapsulation and representational abstraction. Inheritance. Polymorphic programming. Exception handling. Iterators. Introduction to a class design notation. Applications in various areas.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 26
Engineering Design 22

PREREQUISITE(S): APSC 142, ELEC 278
EXCLUSION(S): CISC 124

CMPE 223 Software Specifications W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Introduction to techniques for specifying the behaviour of software, with applications of these techniques to design, verification and construction of software. Logic-based techniques such as loop invariants and class invariants. Automata and grammar-based techniques, with applications to scanners, parsers, user-interface dialogs and embedded systems. Computability issues in software specifications.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 12

PREREQUISITE(S): ELEC 278, ELEC 270
EXCLUSION(S): CISC 366

CMPE 271 Scientific Computing W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Introduction to scientific computing: floating point arithmetic, algorithm design, error analysis, ill-conditioning. Zero-finding. Linear equations. Interpolation. Integration. Least-squares fitting. Effective use of library programs, with discussion of their limitations and some aspects of their design and implementation.

Academic Units:
Mathematics 21
Natural Sciences 0
Complementary Studies 0
Engineering Studies 15
Engineering Design 0

PREREQUISITE(S): APSC 142, APSC 172, APSC 174
EXCLUSION(S): ENPH 213

CMPE 320 Fundamentals of Software Development W | 4

Lecture: 3
Lab: 0
Tutorial: 1
Introduction to management of small and medium-scale software projects. Advanced programming methodology using the programming language C++. Includes a significant programming project.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 26
Engineering Design 22

PREREQUISITE(S): ELEC 278
EXCLUSION(S): CMPE 322

CMPE 322 Software Architecture F | 4

Lecture: 3
Lab: 0

Tutorial: 1
Abstractions and patterns of interactions and relationships among modules. Design recovery; relationship of architecture to requirements and testing.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 26
Engineering Design 22

PREREQUISITE(S): ELEC 270, CMPE 223 (CISC 223), ELEC 278

CMPE 324 Operating Systems W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Layered operating systems for conventional shared memory computers: Concurrent processes, Synchronization and communication, Concurrent algorithms, Scheduling Deadlock, Memory management, Protection. File systems. Device management. Typical layers.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 36
Engineering Design 0

PREREQUISITE(S): ELEC 274, ELEC 278
EXCLUSION(S): ELEC 377

CMPE 325 Human-Computer Interaction W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Developing usable software requires that human factors be considered throughout the design and development process. This course introduces a series of techniques for development and evaluating usable software, and shows how these techniques can be integrated into a process for software development. Alternately offered as CISC 325.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 12

PREREQUISITE(S): ELEC 278

CMPE 326 Game Architecture F | 3

Lecture: 3
Lab: 0
Tutorial: 0
An introduction to software architectural design through the application domain of game development. Topics will include notations for expressing static and dynamic aspects of software architecture, design patterns, interface design, and application of these techniques to 3D games, mobile games and web-based games.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 19
Engineering Design 17

PREREQUISITE(S): ELEC 270, ELEC 278, ELEC 377
EXCLUSION(S): CMPE 322

CMPE 327 Software Quality Assurance F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Validation of software throughout the life cycle. Comparative effectiveness in defect removal of formal methods (proofs of correctness), inspection (walkthroughs and reviews), and testing (unit, integration, and system testing; white box versus black box). Alternately offered as CISC 327.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 12

PREREQUISITE(S): CMPE 223 (CISC 223)

CMPE 330 Computer-Integrated Surgery F | 3

Lecture: 2.75
Lab: 0.25
Tutorial: 0
Concepts of computer-integrated surgery systems and underlying techniques such as medical-image computing, robotics, and virtual reality, learned through real-life applications and problems. Techniques learned in class will be applied in a hands-on surgery session where students perform minimally invasive surgery with virtual-reality navigation tools. Enrolment is limited.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 36
Engineering Design 0

PREREQUISITE(S): CMPE 212, CMPE 271 (CISC 271) or MTHE 272 (MATH 272)
EXCLUSION(S): COMP 230

CMPE 332 Database Management Systems W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Data models: relational, entity-relationship. Relational query languages: relational algebra and SQL. Relational database design. Application interfaces and embedded SQL. Storage and indexing.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 12

PREREQUISITE(S): ELEC 278, ELEC 270 or MTHE 217 (MATH 217)

CMPE 333 Introduction to Data Mining F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Supervised and unsupervised learning, neural networks, support-vector machines, decision trees, metric-based clustering, distribution-based clustering, rule-based techniques, genetic algorithms. Applications to information retrieval, web mining, customer-relationship management, recommender systems, science and engineering. The main objective of this course is ensure that students know enough about the algorithms, strengths and limitations of mainstream data-mining techniques that they can use data-mining software appropriately, and can understand the results that are produced. In particular, they should be able to see how to model a real-world problem, choose appropriate algorithms, analyse the results, and explain their implications for the original problem. A smaller objective is to make students aware that not all problems in computing have a single cut-and-dried, correct solution. A major component is a 6-week design project in which students are given a real-world dataset, and are asked to solve an open-ended data-mining problem related to it.

Academic Units:
Mathematics 10
Natural Sciences 0
Complementary Studies 0
Engineering Studies 14
Engineering Design 12

PREREQUISITE(S): CMPE 212 (CISC 212) or CISC 121, ELEC 270 or CISC 203 or MTHE 217 (MATH 217), STAT 263 or STAT 261 or MTHE 351 (STAT351) or ELEC 326

CMPE 365 Algorithms I F | 4

Lecture: 3
Lab: 1
Tutorial: 0
Principles of design, analysis and implementation of efficient algorithms. Case studies from a variety of areas illustrate

divide and conquer methods, the greedy approach, branch and bound algorithms and dynamic programming.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 24

PREREQUISITE(S): ELEC 278, any discrete mathematics course

CMPE 422 Formal Methods in Software Engineering F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Mathematical methods for describing software behaviour and structure. Topics include (but are not limited to) the following: requirements specification; Module specification: axiomatic, algebraic, and trace specification; program specification: abstract models; verification; specification-based validation.

Academic Units:
Mathematics 14
Natural Sciences 0
Complementary Studies 0
Engineering Studies 12
Engineering Design 10

PREREQUISITE(S): CMPE 204 (CISC 204), CMPE 223 (CISC 223), SOFT 327

CMPE 425 Advanced User Interface Design F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Advanced user interface styles such as multimedia, support for collaboration over the Internet, virtual reality and wearable computers. Processes supporting the design of advanced user interfaces. Implementation techniques. Alternately offered as CISC 425.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 12

PREREQUISITE(S): SOFT 325 or permission of the instructor

CMPE 432 Advanced Database Systems F | 3

Lecture: 3
Lab: 0
Tutorial: 0

Topics include the presentation and storage of data, implementation concerns, and the integration of databases with other areas of computer science.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 12

PREREQUISITE(S): CMPE 332 (CISC 332), ELEC 278

CMPE 434 Distributed Systems W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Operating systems for distributed architectures: distributed system characteristics, process synchronization and communication. Basic distributed algorithms. Principles of fault tolerance. Reliable broadcast. Naming. File systems. Load balancing. Layering, Security.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 12

PREREQUISITE(S): ELEC 377

CMPE 452 Neural and Genetic Computing F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Introduction to neural and genetic computing. Topics include associative memory systems, neural optimization strategies, supervised and unsupervised classification networks, genetic algorithms, genetic and evolutionary programming. Applications are examined, and the relation to biologic systems is discussed.

Academic Units:
Mathematics 9
Natural Sciences 15
Complementary Studies 0
Engineering Studies 12
Engineering Design 0

PREREQUISITE(S): ELEC 278, and permission of the instructor

CMPE 454 Computer Graphics W | 3

Lecture: 3
Lab: 0

Tutorial: 0
An introduction to computer graphics, including a review of current hardware; modelling and transformations in two and three dimensions; visual realism; perspective, hidden surface elimination, and shading; colour models; applications in several fields.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 12

PREREQUISITE(S): ELEC 278

CMPE 457 Image Processing and Computer Vision F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Fundamental concepts and applications in image processing and computer vision. Topics include image acquisition, convolution. Discrete Fourier Transform, image enhancement edge detection, segmentation, image registration, human contrast perception, colour perception and reproduction, and stereo vision.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 12

PREREQUISITE(S): Any first-year algebra course, any first-year calculus course, ELEC 278

CMPE 458 Programming Language Processors W | 4

Lecture: 3
Lab: 0
Tutorial: 1
Introduction to the systematic construction of a compiler: grammars and languages, scanners, top-down and bottom-up parsing, runtime organization, symbol tables, internal representations; Polish notation, syntax trees, semantic routines, storage allocation, code generation, interpreters.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 18

PREREQUISITE(S): (CISC 121 or CMPE 212 (CISC 212)) and ELEC 274

CMPE 471 Computational Biology F | 4

Lecture: 3
Lab: 1
Tutorial: 0
Introduction to computational approaches to the problems in molecular biology. This will include the study of areas such as techniques and algorithms for sequence analysis and alignment; molecular databases; protein structure prediction and molecular data mining.

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0
Engineering Studies 18
Engineering Design 12

PREREQUISITE(S): CMPE 365 (CISC 365), OR ELEC 278, MBIO 218
COREQUISITE(S): BCHM 315

CMPE 472 Medical Informatics W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Current topics in the application of information technology to medicine, including computed tomography and x-ray imaging: 2D and 3D ultrasound; computer-assisted planning of interventional procedures; image registration; computer-assisted surgery; bioelectric signals; picture archiving and communication systems (PACS).

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0
Engineering Studies 18
Engineering Design 0

PREREQUISITE(S): CMPE 365 (CISC 365), ELEC 278, and permission of the instructor

SOFT 423 NOT OFFERED THIS YEAR - Software Requirements W | 3

Lecture: 3
Lab: 0
Tutorial: 0
An integrated approach to discovering and documenting software requirements. Identification of stakeholders; customer, operator, analyst, and developer perspectives. Requirements elicitation. Transition from initial (informal) requirements to semi-formal and formal representations. Requirements analysis process; analysis patterns. Requirements analysis process; analysis patterns. Requirements specification techniques. Relation to architecture and user interface design; traceability of requirements. Alternately offered as CISC 423.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 12

PREREQUISITE(S): CMPE 322 (CISC 322), SOFT 325 or CISC 325, or permission of the instructor

SOFT 437 NOT OFFERED THIS YEAR - Performance Analysis W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Analytic and empirical evaluation of the performance of software systems. Performance modeling. Experimental design and statistical techniques for empirical performance analysis. Alternately offered as CISC 437.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 12

PREREQUISITE(S): CMPE 324 (CISC 324) or ELEC 377, or permission of the instructor

Electrical Engineering

ELEC 210 Introductory Electric Circuits and Machines W | 4.25

Lecture: 3
Lab: 0.75
Tutorial: 0.5
An introductory course for engineering students in disciplines other than electrical or computer engineering. The course begins with a review of the concepts of resistance, capacitance, and inductance. Circuit analysis techniques are then applied to characterize the behaviour of commonly used electrical energy conversion devices such as transformers, dc machines, and induction and synchronous machines.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 51
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 112, APSC 171, APSC 172, APSC 174

ELEC 221 Electric Circuits F | 4.25

Lecture: 3
Lab: 0.75
Tutorial: 0.5
This course introduces the circuit analysis techniques which are used in subsequent courses in electronics, power, and signals and systems. Circuits containing resistance, capacitance, inductance, and independent and dependent voltage and current sources will be studied. Emphasis is placed on DC, AC, and transient analysis techniques.

Academic Units:
Mathematics 0

Natural Sciences 0
Complementary Studies 0
Engineering Studies 51
Engineering Design 0

PREREQUISITE(S): APSC 112, APSC 171, APSC 172, APSC 174
COREQUISITE(S): MTHE 235 or MTHE 237 or MTHE 225 or MTHE 232

ELEC 252 Electronics I W | 4.25

Lecture: 3
Lab: 0.75
Tutorial: 0.5
This course is an introduction to semiconductor electronics for students in the Electrical Engineering program and related programs. Topics studied include: operational amplifiers; dc and small signal models for diodes, basic principles of bipolar transistors and field effect transistors, dc analysis of electronic circuits and practical applications of the devices to the design of power supplies, amplifiers and digital logic circuits.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 36
Engineering Design 15

PREREQUISITE(S): ELEC 221

ELEC 270 Discrete Mathematics with Computer Engineering Applications W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Introduction to the mathematics of representing and manipulating discrete objects. Topics include numbers, modular arithmetic, counting, relations and graph theory. Methods of proof and reasoning - such as induction and mathematical logic - will also be covered. Some applications to cryptosystems, hashing functions, job scheduling, and coding will be included.

Academic Units:
Mathematics 31
Natural Sciences 0
Complementary Studies 0
Engineering Studies 11
Engineering Design 0

PREREQUISITE(S): APSC 142

ELEC 271 Digital Systems F | 4.25

Lecture: 3
Lab: 0.75
Tutorial: 0.5
Boolean algebra applied to digital systems; logic gates; combinational logic design; electronic circuits for logic gates;

arithmetic circuits; latches and flipflops, registers and counters; synchronous sequential logic and state machine design; implementation in programmable logic chips.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 23
Engineering Design 28

PREREQUISITE(S): APSC 171, APSC 172, APSC 174

ELEC 273 Numerical Methods and Optimization W | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
A balance of theory and practice in numerical methods and optimization. Topics include numerical representations, error analysis, iteration, linear algebraic tools such a singular value and QR decompositions, interpolation, curve-fitting, approximation, least squares, single and multivariable optimization, constraint optimization, integration, differentiation, and solving ordinary differential equations. Extensive computer programming using MATLAB.

Academic Units:
Mathematics 21
Natural Sciences 0
Complementary Studies 0
Engineering Studies 21
Engineering Design 0

PREREQUISITE(S): APSC 142, APSC 174, MTHE 235
EXCLUSION(S): MTHE 272, CIVL 222, CMPE 271

ELEC 274 Computer Architecture W | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
Number and data representation. Overview of the logical structure of computers, instruction set architecture, instruction execution sequencing. Assembly language programming, assembly versus high-level languages. Datapath and control unit design. Principles of memory hierarchy, I/O, and interrupts. Introduction to pipelining and parallelism.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 26
Engineering Design 22

PREREQUISITE(S): APSC 142, ELEC 271 or MTHE 217 (MATH 217) or permission of instruction
EXCLUSION(S): CISC 221

ELEC 278 Fundamentals of Information Structures F | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
Fundamentals of Data Structures and Algorithms: arrays, linked lists, stacks, queues, deques, asymptotic notation, hash and scatter tables, recursion, trees and search trees, heaps and priority queues, sorting, and graphs. Advanced programming in the C language. Introduction to object oriented programming concepts in the context of data structures.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 12

PREREQUISITE(S): APSC 142
EXCLUSION(S): CISC 235

ELEC 280 Fundamentals of Electromagnetics W | 3.75

Lecture: 3
Lab: 0.25
Tutorial: 0.5
A study of the fundamental aspects of electromagnetic fields. The following topics are covered: the Maxwell's equations and the 3-dimentional wave equation for transmission lines; vector analysis, including orthogonal coordinate systems, and the calculus of field quantities; electrostatic fields including the concepts of electric potential, capacitance, and current and current density; magnetostatic fields including inductance; time-varying fields and the complete form of Maxwell's equations; basic transmission line phenomena including steady-state sinusoidal behaviour and standing waves, transient performance and impedance matching.

Academic Units:
Mathematics 11
Natural Sciences 20
Complementary Studies 0
Engineering Studies 14
Engineering Design 0

PREREQUISITE(S): APSC 112, APSC 171, APSC 172, APSC 174

ELEC 293 Deleted - Electrical and Computer Engineering Laboratory I |

In this laboratory course, students will explore practical concepts in electric circuits and digital logic circuits. Students will investigate electric circuit operation through circuit simulation, prototyping and testing; and design, implement and test digital logic circuits. The experiments complement material covered in the fall term second year courses on electric circuits and digital systems. - COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 15
Engineering Design 0

COREQUISITE(S): ELEC 221 and ELEC 271

ELEC 294 Deleted - Electrical and Computer Engineering Laboratory II |

This course is a continuation of ELEC 293. In this course, students will explore concepts in electromagnetics, electric motors and electronic circuits. Students will investigate electromagnetic effects in circuits, the operation of electric motors, the characteristics of electronic devices, and simulate, construct and test electronic circuits. The experiments complement material covered in the winter term second year courses on electromagnetics and electronics. - COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 11
Engineering Design 4

PREREQUISITE(S): ELEC 293
COREQUISITE(S): ELEC 252

ELEC 299 Mechatronics Project W | K1.5

Lecture: Yes
Lab: Yes
Tutorial: Yes
A team design project based around an autonomous, programmable, robotic vehicle, following on from project activity in APSC 200. Students explore different sensors and software strategies for vehicle control and navigation, in addition to wiring up sensor and motor circuits. The design goal is to configure and program a vehicle to take part in a year-end competition in which robots compete head-to-head on a pre-defined playfield under established competition rules. A final project report must be produced that documents the experimentation, design, and testing. A final exam tests knowledge of sensors and software.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 18

PREREQUISITE(S): ELEC 221, ELEC 271
COREQUISITE(S): ELEC 252, ELEC 280

ELEC 310 Introductory Analog Electronic and Digital Circuits F | 4.5

Lecture: 3
Lab: 1
Tutorial: 0.5
This is an introductory course on the design of analog electronic and digital logic circuits, using commonly available devices and integrated circuits. The properties of linear circuits, with particular reference to the applications of feedback, are discussed; operational amplifiers are introduced as the fundamental building block for the design of linear filters and amplifiers. Fundamentals of digital circuits including Boolean algebra, logic gates, combinational logic, sequential logic concepts and implementation are presented. Data acquisition and conversion is introduced, and the issues of noise and electromagnetic compatibility are discussed. Laboratory work is linked with lectures and provides practical experience of the subjects covered in lectures.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 27
Engineering Design 27

PREREQUISITE(S): ELEC 210 or ELEC 221
EXCLUSION(S): ENPH 334 (PHYS 334)

ELEC 323 Continuous-Time Signals and Systems F | 3.75

Lecture: 3
Lab: 0.25
Tutorial: 0.5
This is a first course on the basic concepts and applications of signals and systems analysis. Continuous time signals and systems are emphasized. Topics include: representations of continuous-time signals; linear time invariant systems; convolution, impulse response, step response; review of Laplace transforms with applications to circuit and system analysis; transfer function; frequency response and Bode plots; filtering concepts; Fourier series and Fourier transforms; signal spectra; AM modulation and demodulation; introduction to angle modulation.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Studies 33
Engineering Design 0

PREREQUISITE(S): ELEC 221, MTHE 235 (MATH 235) or MTHE 237 (MATH 237)

ELEC 324 Discrete-Time Signals and Systems W | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
This is a second course on the basic concepts and applications of signals and systems analysis. Discrete time signals and systems are emphasized. Topics include: sampling and reconstruction; discrete-time signals and systems; difference equations; Z-transform and solutions to difference equations; discrete Fourier series and discrete time Fourier transform; filtering concepts; applications to pulse amplitude modulation, delta modulation, and speech coding.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Studies 36
Engineering Design 0

PREREQUISITE(S): ELEC 323

ELEC 326 Probability and Random Processes W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course provides an introduction to probabilistic models and methods for addressing uncertainty and variability in engineering applications. Topics include sample spaces and events, axioms of probability, conditional probability, independence, discrete and continuous random variables, probability density and cumulative distribution functions, functions of random variables, and random processes.

Academic Units:
Mathematics 24
Natural Sciences 0
Complementary Studies 0
Engineering Studies 18
Engineering Design 0

PREREQUISITE(S): APSC 171
EXCLUSION(S): MTHE 351 (STAT 351)

ELEC 333 Electric Machines F | 4.5

Lecture: 3
Lab: 0.75
Tutorial: 0.75
An introduction to the basic principles, operating characteristics, and design of electric machines. Topics to be studied include: three-phase circuits; magnetic circuits; transformers; steady state behaviours of dc generators and motors; rotating magnetic fields; steady state operation of induction machines and synchronous machines; introduction to fractional horsepower machines; speed control of electric motors.

Academic Units:
Mathematics 0
Natural Sciences 14
Complementary Studies 0
Engineering Studies 26
Engineering Design 14

PREREQUISITE(S): ELEC 221

ELEC 344 Sensors and Actuators F | 3.25

Lecture: 3
Lab: 0.25
Tutorial: 0
This course provides an introduction to sensing and actuation in mechatronic systems. The topics include sensing principles for the measurement of motion, force, torque, pressure, flow, temperature using analog and digital transducers; actuating principles using for continuous drive actuators and stepper motors; power transmission systems; and methods for signal collection, conditioning and analysis. Various components will be experimentally tested and analyzed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 39

Engineering Design 0

PREREQUISITE(S): ELEC 221, ELEC 271, ELEC 299

ELEC 353 Electronics II F | 4.5

Lecture: 3
Lab: 0.75
Tutorial: 0.75
Transistor-level modeling and design of analog and digital electronic circuits. Differential amplifiers, current mirrors, multi-stage amplifiers, frequency response of amplifiers, high-frequency transistor models, feedback amplifier configurations, two-port networks, CMOS logic gates. Students learn the basics of computer aided design (CAD) of integrated circuits including schematic simulation, layout, design rules, layout versus schematic verification and extracted circuit simulation. Laboratory work is design oriented and complements the lecture material.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 27
Engineering Design 27

PREREQUISITE(S): ELEC 252
COREQUISITE(S): ELEC 323 or MTHE 326

ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4.5

Lecture: 3
Lab: 1
Tutorial: 0.5
Embedded systems organization; interfacing with sensors and actuators; integration in microcontrollers and programmable logic chips; memory interfaces; serial and parallel input/output interfaces; timers; interrupts and exceptions; software organization; embedded application case studies; application of concepts in programmable logic controllers.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 40
Engineering Design 14

PREREQUISITE(S): ELEC 271, CISC 231 or ELEC 274

ELEC 374 Digital Systems Engineering W | 4.25

Lecture: 3
Lab: 1
Tutorial: 0.25
High-performance logic design for arithmetic circuits; memory system designs based on static and dynamic RAMs; computer bus protocols and standard I/O interfaces; mass storage devices; hardware description languages (VHDL, Verilog); fault testing, design for testability, built-in self-test, memory testing, and boundary-scan architectures;

asynchronous sequential circuit design; introduction to GPU architectures and GPU computing. The course is supplemented by a CPU design project that allows students to become proficient with Field Programmable Gate Array (FPGA) devices and associated CAD tools, as well as with GPU computing through nVidia CUDA or OpenCL languages.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 28
Engineering Design 23

PREREQUISITE(S): ELEC 252, ELEC 271, ELEC 274 or permission of the instructor

ELEC 377 Operating Systems F | 4

Lecture: 3
Lab: 1
Tutorial: 0
Operating systems for conventional shared memory computers. System services and system calls, concurrent processes and scheduling, synchronization and communication, deadlock. File systems and protection, memory management and virtual memory, device management and drivers. Unix operating system. Real-time and distributed systems. Security.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 26
Engineering Design 22

PREREQUISITE(S): ELEC 274 or CISC 221 and ELEC 278 or CISC 235
EXCLUSION(S): CMPE 324 (CISC 324)

ELEC 381 Applications of Electromagnetics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
al differential equation solutions to Maxwell's Equations; Introduction to the Smith chart; uniform plane waves; reflection of plane waves; normal and oblique incidence; analysis and applications of rectangular waveguides; resonant cavities; optical fibres; introduction to antennas; aperture antennas.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 18

PREREQUISITE(S): ELEC 280 or ENPH 231 (PHYS 231) or PHYS 235

ELEC 390 Electrical and Computer Engineering Design W | K2.25

Lecture: Yes
Lab: Yes
Tutorial: Yes
This course prepares the student for ELEC49x, the fourth-year capstone design project course. Students will practice engineering design in the context of one or two mini-projects relevant to Electrical and Computer Engineering. In the second half of the course, students will form project groups, each of which will formulate a project plan. The groups will execute their plans in ELEC 49X in the subsequent year (students going away on internship must join up to form groups that will continue when they return). Through an investigative, ranking and matching, and approval process, groups will be assigned a project from a list of proposed design projects. Each group then prepares a proposal document that describes their project and schedules its milestones for the coming academic year. The lecture material will be augmented by design exercises, project management, and discussions around social, environmental, economic, ethical and legal factors. Students are expected to integrate these factors with their projects and ELEC 49x proposal.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 6
Engineering Studies 0
Engineering Design 21

PREREQUISITE(S): Successful completion of Fall term 3rd year studies in either the Eletrical Engineering program, or the Computer Engineering program.

ELEC 408 Biomedical Signal and Image Processing F | 3

Lecture: 3
Lab: 0
Tutorial: 0
This is an introductory course in biomedical signal and image processing. Topics include: biopotential generation; biosignal detection using metal electrodes; electrocardiogram; amplifiers and filter design for biosignal recording; and design consideration; 2D and 3D image formation; fluoroscopy, ultrasound, computed tomography, and magnetic resonance imaging; spatial and frequency-domain filtering and feature extraction; applications in diagnostics, therapeutics, and interventions.

Academic Units:
Mathematics 0
Natural Sciences 9
Complementary Studies 0
Engineering Studies 18
Engineering Design 9

COREQUISITE(S): ELEC 323 or permission of the instructor

ELEC 409 NOT OFFERED THIS YEAR - Bioinformatic Analytics W | 3

Lecture: 3
Lab: 0
Tutorial: 0
The course surveys: microarray data analysis methods; pattern discovery, clustering and classification methods; applications to prediction of clinical outcome and treatment response; coding region detection and protein family prediction. At the end of this course, students should be able to appreciate some approaches related to individualizing medical treatment, as well as to apply some of the methods, such as alternatives to PCA, to more traditional engineering problems.

Academic Units:
Mathematics 9
Natural Sciences 0
Complementary Studies 0
Engineering Studies 18
Engineering Design 9

PREREQUISITE(S): APSC 174, and ELEC 323
COREQUISITE(S): ELEC 326

ELEC 421 Digital Signal Processing: Filters and System Design F | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
Sampling theorem, filter realization structures, quantization errors and finite word length effects, digital signal processor programming, finite and infinite impulse response filter design techniques, discrete and fast Fourier transform.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 24

PREREQUISITE(S): ELEC 323 and ELEC 324 or MTHE 334 (MATH 334) and MTHE 335 (MATH 335)

ELEC 422 NOT OFFERED THIS YEAR - Digital Signal Processing: Random Models and Applications F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Recent DSP topics including: bandpass sampling, oversampling A/D conversion, quantization noise modelling, multi-rate signal processing, filterbanks, quadrature mirror filters, applications to communications systems, speech and image compression; processing of discrete-time random signals.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 12
Engineering Design 24

PREREQUISITE(S): ELEC 323 and ELEC 324 or MTHE 334 (MATH 334) and MTHE 335 (MATH 335), ELEC 326, or MTHE 351 (STAT

ELEC 431 Power Electronics F | 3.25

Lecture: 3
Lab: 0.25
Tutorial: 0
This course introduces the basic concepts of power electronics, which include power semiconductor devices and switching power converters. Emphasis is placed on the analysis and design of various power electronics circuits. Their industrial application, such as in telecommunications and computing, will also be discussed. More specifically, the course will cover the characteristics of switching devices, especially that of MOSFET. The course will also cover the operation of various switching converters such as phase controlled ACto- DC converters, AC voltage controllers, DC-to-DC switching converters, DC-to-AC inverters and switching power supplies. The requirements and configurations of power systems for telecommunications will be introduced. The techniques to analyze and design these power systems using available components will also be discussed. Computer simulation will be used to analyze the detailed operation of switching converters.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 15
Engineering Design 24

PREREQUISITE(S): ELEC 252

ELEC 433 Energy and Power Systems W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Energy resources and electric power generation with particular emphasis on renewable energy systems such as solar, wind, and biomass; review of balanced and unbalanced 3-phase systems; review of per-unit systems; real and reactive power, sequence networks and unsymmetrical analysis; transmission line parameters; basic system models; steady state performance; network calculations; power flow solutions; symmetrical components; fault studies; short circuit analysis; economic dispatch; introduction to power system stability, operating strategies and control; modern power systems and power converters; DC/AC and AC/DC conversion; and introduction to DC transmission.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 18

PREREQUISITE(S): ELEC 333

ELEC 436 NOT OFFERED THIS YEAR - Electric Machines and Control W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Review of basic electric machines. Salient pole synchronous machines. Transient and dynamic behaviour of electric machines. Characteristics and applications of special motors such as servo motors, stepper motors, PMmotors, brushless dc motors, switched reluctance motors and linear motors. Solid state speed and torque control of motors.

Academic Units:

Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 18
Engineering Design 18

PREREQUISITE(S): ELEC 431

ELEC 443 Linear Control Systems F | 4

Lecture: 3
Lab: 0.75
Tutorial: 0.25
Introduction to linear systems and feedback control. Topics include introduction to automatic control, overview of Laplace transformation, linear models of dynamic systems, time-domain specifications of first and second order systems, stability analysis using Routh-Hurwitz criterion, steady-state error and disturbance rejection, PID control, stability analysis and linear controller design using root locus method, Nyquist criterion, and Bode plots, and introduction to state-space analysis. These methods are applied and tested using software such as MATLAB/Simulink, and laboratory experiments.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 12
Engineering Design 36

PREREQUISITE(S): ELEC 323 or MTHE 335 (MATH 335)

ELEC 444 Modeling and Computer Control of Mechatronic Systems W | 3.25

Lecture: 3
Lab: 0.25
Tutorial: 0
This course provides an introduction to modeling and analysis of the dynamics of mechatronic processes and computer control of such systems. Topics include modeling and simulation of mechanical, electrical, thermal, and fluid systems, sampled-data systems and equivalent discrete system, overview of Z-transform, dynamic response of second-order discrete systems, stability analysis and design of linear discrete-time control systems using root locus and frequency response methods. The modeling and controller design methods are implemented and tested using MATLAB/Simulink and laboratory experiments.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 29
Engineering Design 10

PREREQUISITE(S): ELEC 324, ELEC 344, ELEC 443

ELEC 448 NOT OFFERED THIS YEAR - Introduction to Robotics: Mechanics and Control W | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
Robotics is an interdisciplinary subject concerning areas of mechanics, electronics, information theory, control systems and automation. This course provides an introduction to robotics and covers fundamental aspects of modeling and control of robot manipulators. Topics include history and application of robotics in industry, rigid body kinematics, manipulator forward, inverse and differential kinematics, workspace, singularity, redundancy, manipulator dynamics, trajectory generation, actuators, sensors, and manipulator position and contact force control strategies. Applications studied using MATLAB/Simulink software simulation and laboratory experiments.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 16
Engineering Design 26

COREQUISITE(S): ELEC 443 or MTHE 332 (MATH 332) or MECH 350
EXCLUSION(S): MECH 456

ELEC 451 NOT OFFERED THIS YEAR - Digital Integrated Circuit Engineering F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Review of MOS transistor structure and operation; overview of wafer processing and device implementation, layout and design rules. CMOS gate design; static and dynamic logic; modelling of transients and delays. Clocked circuits; interconnect effects, and I/O. Memory and programmable logic arrays. Technology scaling effects; design styles and flow.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 18
Engineering Design 18

COREQUISITE(S): ELEC 353

ELEC 454 Analog Electronics W | 3.25

Lecture: 3
Lab: 0
Tutorial: 0.25
Topics include; an introduction to noise and distortion in electronic circuits, analysis and design of biasing circuits, references, ADCs and DACs, power amps, mixers, modulators and PLLs along with a short introduction to analog filter design.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 20

Engineering Design 19

PREREQUISITE(S): ELEC 323 or MTHE 332 (MATH 332), ELEC 353

ELEC 457 NOT OFFERED THIS YEAR - Integrated Circuits and System Applications W | 3

Lecture: 3
Lab: 0
Tutorial: 0
In the first part of this course modern microelectronic circuits are covered and in the second part these circuits are used in new and emerging applications. Topics include: active and passive filtering circuits, baseband and high-frequency signal generation, low phase-noise oscillators using Quartz crystals and dielectric resonators, power amplifiers, discussion of power gain, linearity, and efficiency, frequency mixers and multipliers, A/D and D/A converters, phase locked loops, clock recovery circuits, biological sensors, neurostimulator circuits, biotelemetry communications systems, backscatter modulators and RF-to-DC power converters for radiofrequency identification (RFID), radar imaging systems, radiometer circuits for earth surface mapping.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 18
Engineering Design 18

PREREQUISITE(S): ELEC 353, ELEC 323 or MTHE 335 (MATH 335)
EXCLUSION(S): ELEC 363

ELEC 461 Digital Communications F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Representation of signals and noise, Gaussian processes, correlation functions and power spectra. Linear systems and random processes. Performance analysis and design of coherent and noncoherent communication systems, phase-shift-keying, frequency-shift,-keying, and M-ary communication systems. Optimum receivers and signal space concepts. Information and its measure, source encoding, channel capacity and error correcting coding.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 21
Engineering Design 21

PREREQUISITE(S): ELEC 324 or (MTHE 334/MATH 334, MTHE 335/MATH 335), ELEC 326 or MTHE 351 (STAT 351), or permission of instructor

ELEC 464 Wireless Communications W | 3

Lecture: 3
Lab: 0

Tutorial: 0
Introduction to the basic concepts and design techniques in radio, mobile radio and personal communication systems; frequency allocations: cellular radio; frequency reuse, handoff and interference; mobile radio propagation; reflection, refraction, and diffraction of radio waves; indoor and outdoor propagation models; multipath fading channels; Raleigh and Rican models, coherence bandwidth and doppler fading rate of time varying fading; modulation and multiple access; FDMA, TDMA, CDMA, FDMA/TDMA and multi-carrier access; QPSK and MSK modulation, coded modulation and antenna diversity; selected wireless standards; IS-136, IS-95 and PCS 1800.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 18
Engineering Design 18

PREREQUISITE(S): ELEC 461

ELEC 470 NOT OFFERED THIS YEAR - Computer System Architecture W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course provides an overview of advanced topics in computer design with a quantitative perspective. Topics include: instruction set design, pipelining, instruction-level parallelism, memory-hierarchy design, storage systems, and multiprocessors.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 10
Engineering Design 32

PREREQUISITE(S): ELEC 371, CISC 231 or ELEC 274
EXCLUSION(S): CISC 441

ELEC 471 Computer Networks I F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Communication networks architecture, physical layer, data link layer and protocol design, introduction to queuing theory, network layer, routing and interworking and performance evaluation and monitoring.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 10
Engineering Design 26

PREREQUISITE(S): ELEC 371, CISC 231 or ELEC 274

COREQUISITE(S): ELEC 326 or MTHE 351 (STAT 351) or Permission of Instructor
EXCLUSION(S): CISC 435

ELEC 474 Machine Vision F | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
Image acquisition and representation, histogramming, spatial- and frequency-domain filtering, edge detection, motion segmentation, color indexing, blob detection, interest operators, feature extraction, camera models and calibration, epipolar geometry and stereovision. The lab and assignments will emphasize practical examples of machine vision techniques to industrial and mechatronic applications.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

PREREQUISITE(S): ELEC 278 or CISC 235
EXCLUSION(S): CISC 457

ELEC 476 NOT OFFERED THIS YEAR - Modelling and Systems Simulation W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Overview of techniques for the performance evaluation of computer systems and networks. Discrete event digital simulation of stochastic processes. Simulation methodology. Design of simulation experiments. Analysis and validation of simulation models and results. Operational analysis.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 12
Engineering Design 30

PREREQUISITE(S): ELEC 326 or MTHE 351 (STAT 351)

ELEC 478 NOT OFFERED THIS YEAR - Computer Networks II W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Introduction to communication networks design principles, data encoding, media access sublayer, local area networks, protocol analysis, mobile communication networks and network security.

Academic Units:
Mathematics 0
Natural Sciences 0

Complementary Studies 0
Engineering Studies 10
Engineering Design 26

PREREQUISITE(S): ELEC 326 or MTHE 351 (STAT 351), ELEC 471 or CISC 435

ELEC 483 NOT OFFERED THIS YEAR - Microwave and RF Circuits and Systems W | 4.5

Lecture: 3
Lab: 0.75
Tutorial: 0.75
This course introduces the analysis and design of microwave components and systems. Topics include: modeling of high frequency circuits; transmission lines; scattering parameters; impedance matching; passive microwave components; amplifiers, mixers and oscillators; noise in receivers; elemental antennas and simple and phased arrays; communication links - microwave land, cellular and satellite systems; performance and link budget analysis. The laboratory work is design oriented and implements the lecture material.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 27
Engineering Design 27

PREREQUISITE(S): ELEC 353, ELEC 381 or ENPH 332 (PHYS 332)

ELEC 486 Fiber Optic Communications W | 3.75

Lecture: 3
Lab: 0.25
Tutorial: 0.5
This course introduces fundamental principles and applications of fiber optic communication systems. Topics include Fabry-Perot and distributed feedback semiconductor lasers, planar dielectric waveguides, propagation characteristics of single-mode optical fibers, p-i-n and avalanche photodiodes, and digital receiver performance. Device technology and system design applications are considered.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 21
Engineering Design 24

PREREQUISITE(S): ELEC 381 or ENPH 332 (PHYS 332)

ELEC 487 Deleted - Microwave and Fiber Optic Laboratory W | 0.75

Lecture: 0
Lab: 0.75
Tutorial: 0
This course is taken by students enrolled in ELEC 483 or ELEC 486 (does not count as a separate technical elective).

Laboratory experiments are based on measurement techniques, which apply to both microwave and fiber optic communication systems. Topics include network analysis, spectrum analysis, bit error ratio measurements, fault location on guided transmission media, and transmission line probe measurements. - COURSE DELETED 2011-2012

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 6
Engineering Design 3

ELEC 490 Electrical Engineering Project FW | K7

Lecture: Yes
Lab: Yes
Tutorial: Yes
Students work in groups of three on the design and implementation of electrical engineering projects, with the advice of faculty members. This course is intended to give students an opportunity to practice independent design and analysis. Each group is required to prepare an initial engineering proposal, regular progress reports, and a final report together with a formal seminar on the project and its results.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 21
Engineering Studies 0
Engineering Design 63

PREREQUISITE(S): ELEC 323, ELEC 324, ELEC 326, ELEC 353, ELEC 371, ELEC 381, ELEC 390, or permission of the department

ELEC 491 Advanced ECE Thesis I S | 6

Lecture: 0
Lab: 6
Tutorial: 0
Students will be assigned individual Research Topics. Students must work under the supervision of a faculty member. Grade will be based on the progress in arriving at a solution to the assigned problem.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 54
Engineering Design 18

PREREQUISITE(S): Permission of Thesis Supervisor

ELEC 492 Advanced ECE Thesis II FW | 6

Lecture: 0
Lab: 6

Tutorial: 0
The students continue working on their assigned problems in ELEC 491 under the supervision of the same faculty member. Upon completion of their thesis, students must give oral and written presentations. Grades will be based on the quality of the analysis of the problem, the proposed solution, and written and oral presentations. Demonstration of effective written and oral communications skills is required.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 54
Engineering Design 18

PREREQUISITE(S): ELEC 491

ELEC 497 Research Project FW/S | 3.5

Lecture: 0
Lab: 3
Tutorial: 0.5
The student registered in this course works on a research project under the supervision of an ECE faculty member. The project is designed for completion in one session, with a project proposal describing the research submitted at the beginning, and a major report and presentation of the work at the end of the session. Subject to Department approval.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

ELEC 498 Computer Engineering Project FW | K7

Lecture: Yes
Lab: Yes
Tutorial: Yes
Students work in groups of three on the design and implementation of computer engineering projects, with the advice of faculty members. This course is intended to give students an opportunity to practice independent design and analysis. Each group is required to prepare an initial engineering proposal, regular progress reports, and a final report together with a formal seminar on the project and its results.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 21
Engineering Studies 0
Engineering Design 63

PREREQUISITE(S): ELEC 326, ELEC 371, ELEC 374, ELEC 377, ELEC 390, CMPE 223 (CISC 223) or CMPE 320 (CISC 320), or permission of the department

Engineering Chemistry

ENCH 211 Main Group Chemistry F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
An introduction to chemistry of main group inorganic and organic compounds with the use of fundamental quantum mechanics, molecular orbital diagrams and Lewis structures to describe the structure and bonding. The stereochemistry and chirality of organic compounds, solidstate inorganic chemistry, and descriptive chemistry of compounds of the main group elements will be covered. The laboratory will introduce skills in inorganic and organic synthesis. NOTE: Laboratory consumables: estimated cost $20.

Academic Units:
Mathematics 0
Natural Sciences 54
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 131, APSC 132

ENCH 212 Principles of Chemical Reactivity F | 3.75

Lecture: 3
Lab: 0.75
Tutorial: 0
An introduction to the kinetics and mechanisms of reactions in gaseous and condensed phases, including acid-base and nucleophilic substitution reactions at carbon and other main group centers. Other topics will include molecular dynamics and reactions in solution. The laboratory illustrates measurement techniques and develops laboratory skills. NOTE: Laboratory consumables: estimated cost $20.

Academic Units:
Mathematics 0
Natural Sciences 45
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 112, APSC 131, APSC 132

ENCH 213 Introduction to Chemical Analysis F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
Introduction to analytical chemical methods and science. Topics include statistical analysis of data, titrations and equilibrium theory, spectrophotometry and instrumental elemental analysis. NOTE: Laboratory consumables: estimated cost $20.

Academic Units:
Mathematics 0
Natural Sciences 40
Complementary Studies 0
Engineering Studies 14

Engineering Design 0

PREREQUISITE(S): APSC 131, APSC 132

ENCH 222 Methods of Structure Determination W | 3.75

Lecture: 3
Lab: 0
Tutorial: 0.75
A survey of practical spectroscopic and spectrometric methods for the determination of the structures of organic and inorganic compounds. Methods will include nuclear magnetic resonance, electronic, infrared/ Raman spectroscopy, and mass spectrometry. Tutorials will involve solving compound structures using spectroscopic data, and include an introduction to computational methods in spectroscopy.

Academic Units:
Mathematics 0
Natural Sciences 45
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENCH 211 (CHEM 211) or ENCH 212 (CHEM 212)

ENCH 245 Applied Organic Chemistry I W | 3.5

Lecture: 3
Lab: 1.5
Tutorial: 0
A survey of organic functional group reactivity from a mechanistic perspective, including substitution, addition, elimination, rearrangement and redox reactions; extensive use of examples from industrial process chemistry. The laboratory provides experience in organic synthesis, including the preparation, purification and characterization of organic compounds. NOTE: Laboratory consumables: estimated cost $20.

Academic Units:
Mathematics 0
Natural Sciences 38
Complementary Studies 0
Engineering Studies 16
Engineering Design 0

PREREQUISITE(S): ENCH 211 (CHEM 211), ENCH 212 (CHEM 212)
EXCLUSION(S): CHEM 223

ENCH 281 Deleted - General Organic Chemistry I F | 4.5

Lecture: 3
Lab: 0.75
Tutorial: 0.75
An introduction to the basic principles of organic chemistry with emphasis on bonding, stereochemistry, reaction intermediates and reaction mechanisms, and structure-reactivity correlations. Intended for students in biological and life sciences. Students in chemistry or biochemistry programs should not enrol in this course. Also offered as a distance course. Consult Continuing and Distance Studies. COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 54
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 131, APSC 132
EXCLUSION(S): ENCH 211 (CHEM 211), ENCH 212 (CHEM 212)

ENCH 311 Mechanistic Organic Chemistry F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Fundamental mechanistic concepts of organic reactions, structureactivity relationships, solvent effects and catalysis. Mechanistic aspects of substitution, addition, elimination and pericyclic reactions.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENCH 245 (CHEM 245)

ENCH 312 Transition Metal Chemistry F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Introduction to the chemistry, bonding and structures of coordination compounds of the transition metals; transition metals in the solid state and in biological systems; industrial and environmental aspects of transition metal chemistry.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENCH 211 (CHEM 211)

ENCH 321 Instrumental Chemical Analysis W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Overview of instrumental methods of chemical analysis. Topics include gas and liquid chromatography, mass spectrometric detection, new separations methods, electrochemical analysis, inductively coupled plasma-based

elemental analysis.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENCH 213 (CHEM 213)
EXCLUSION(S): ENSC 471

ENCH 322 The Chemical Bond: Computation and Spectroscopy W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The application of quantum mechanics to the structures and internal motions of molecules. The foundations of electronic, vibrational, rotational and NMR spectroscopy will be discussed together with their applications.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENCH 346 (CHEM 346)

ENCH 323 Biological Chemistry W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Introduction to the chemical basis of biological systems and biomolecules; protein structure and synthesis, enzyme catalysis, nucleic acids (DNA, RNA), carbohydrates, membranes, cell signalling, biosynthetic and metabolic pathways.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENCH 345 (CHEM 345)

ENCH 326 Environmental and Green Chemistry W | 3

Lecture: 3
Lab: 0
Tutorial: 0
The first part examines chemical contaminants in the atmosphere, water, soils and sediments, including sources,

behaviour, transport, and distribution among these environments. The second part introduces Green chemistry, examining industrial sources of contaminants and the modification of industrial processes in order to minimize environmental impact.

Academic Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Studies 12
Engineering Design 0

PREREQUISITE(S): ENCH 211 (CHEM 211), ENCH 212 (CHEM 212), ENCH 245 (CHEM 245)

ENCH 345 Applied Organic Chemistry II W | 3

Lecture: 3
Lab: 0
Tutorial: 0
A detailed study of organic reactions and processes of industrial and economic importance, with application of the principles developed in ENCH 245 (CHEM 245). Case studies involving process development in the pharmaceutical industry are used extensively.

Academic Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Studies 12
Engineering Design 0

PREREQUISITE(S): ENCH 245 (CHEM 245) or permission of the instructor

ENCH 346 Quantum Mechanics and Molecular Simulation F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course introduces quantum mechanics and molecular simulation as engineering tools for the understanding and design of molecular structure and properties. It is aimed at providing an overview of the principles of quantum mechanical theory and molecular simulation with strong emphasis on applications to engineering problems. Key mathematical concepts will be discussed and applied using state-of-the-art modeling software. NOTE: Offered in conjunction with CHEM 313

Academic Units:
Mathematics 0
Natural Sciences 21
Complementary Studies 0
Engineering Studies 21
Engineering Design 0

PREREQUISITE(S): CHEE 210, MTHE 225 (MATH 225)

ENCH 398 Experimental Chemistry I F | 3.5

Lecture: 0
Lab: 3
Tutorial: 0.5
Laboratory course. In consultation with the course coordinator, and subject to availability, students may select experiments as are relevant to their degree program including synthesis, analytical instrumentation and computational methods. The integration of several methods will be emphasized in the design and characterisation of molecules.
NOTE: Laboratory consumables: estimated cost $40.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): At least 6 units at the 200-level in ENCH/CHEM or permission of the Department.
COREQUISITE(S): At least 3 units at the 300-level in ENCH/CHEM or permission of the Department.

ENCH 399 Experimental Chemistry II W | 3.5

Lecture: 0
Lab: 3
Tutorial: 0.5
Laboratory course. In consultation with the course co-ordinator, and subject to availability, students may select experiments as are relevant to their degree program including synthesis, analytical instrumentation and computational methods. The integration of several methods will be emphasized in the design and characterization of molecules.
NOTE: Laboratory consumables: estimated cost $40.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): At least 6 units at the 200-level in ENCH/CHEM
COREQUISITE(S): At least 3 units at the 300-level in ENCH/CHEM

ENCH 411 Advanced Analytical Chemistry F | 3

Lecture: 3
Lab: 0
Tutorial: 0
A discussion of recent advances in analytical chemistry and its applications to the environmental, materials and biomedical fields. At least four topics will be covered from sample preparation, separation methods, multidimensional chromatography, elemental spectroscopy, mass spectroscopy, and surface analysis methods. Additional topics will be selected from the current literature.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Studies 0

Engineering Design 0

PREREQUISITE(S): ENCH 321 (CHEM 321)

ENCH 412 Statistical Mechanics W | 3

Lecture: 3
Lab: 0
Tutorial: 0
The fundamentals of statistical mechanics with applications to thermodynamic properties of gases, liquids and solids and to chemical equilibrium in dilute gases. Offered alternating years with ENCH 413 (CHEM 413).

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENCH 346 (CHEM 346)
EXCLUSION(S): CHEM 435

ENCH 413 NOT OFFERED THIS YEAR - Computational Chemistry W | 3

Lecture: 3
Lab: 0
Tutorial: 0
The application of quantum mechanics to chemical structures, energetics, internal motions of molecules, and chemical reactions. An introduction to the use of modern electronic structure software in chemistry. Offered alternating years with ENCH 412 (CHEM 412).

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENCH 346 (CHEM 346)

ENCH 414 Catalysis F | 3

Lecture: 3
Lab: 0
Tutorial: 0
An advanced treatment of the concepts and applications of catalysis, including the kinetics of catalysis and topics selected from the areas of homogeneous, heterogeneous, and biocatalysis. Offered in alternating years.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0

Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENCH 245 (CHEM 245) and ENCH 312 (CHEM 312)

ENCH 415 Electrochemistry and Electrocatalysis F | 3

Lecture: 3
Lab: 0
Tutorial: 0
The course covers concepts of equilibrium electrochemistry and examines the structure of the electrode-solution interface. It discusses the basics of electron transfer and derives electrochemical kinetics equations. It shows examples of several electrochemical reactions and overviews experimental methods used to study electrochemical phenomena.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): CHEE 210

ENCH 417 Research Project FW* | 9

Lecture: 0
Lab: 9
Tutorial: 0
In this course, projects will be assigned requiring design and synthesis in the solution of problems in engineering chemistry, using principles and concepts discussed in previous courses. Originality and innovation are encouraged. Students are required to significantly contribute to the design of original experiments, and independently analyze, interpret and communicate the results, both orally and in writing.

Academic Units:
Mathematics 0
Natural Sciences 76
Complementary Studies 0
Engineering Studies 32
Engineering Design 0

ENCH 421 Advanced Methods in Physical Chemistry W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Modern spectroscopic methods for the structural and electronic characterisation of molecules will be discussed, including: NMR, X-ray and synchrontron-based spectroscopies, laser spectroscopy, surface spectroscopic methods, and scanning probe methods.

Academic Units:
Mathematics 0
Natural Sciences 36

Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENCH 346 (CHEM 346)

ENCH 422 Synthetic Organic Chemistry F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Modern synthetic methods in organic chemistry. Principles of strategy in planning organic syntheses based on simple classifications of reagents and reactions, and on the control of stereochemistry.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENCH 345

ENCH 423 Topics in Inorganic and Organometallic Chemistry F | 3

Lecture: 3
Lab: 0
Tutorial: 0
An examination of aspects of modern inorganic and organometallic chemistry. Topics will include metal-ligand bonding in organometallic complexes, applications of organometallics in organic synthesis, metal-metal bonding in dinuclear and polynuclear metal complexes, and may include reaction mechanisms of transition metal complexes, bioinorganic chemistry and symmetry.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENCH 312 (CHEM 312)

ENCH 424 Polymer Chemistry W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Specific properties of polymers (glass transition, crystallinity, polydispersity, etc) and their dependence on macromolecular structure and isomerism. Polymer synthesis overview: step and chain polymerization (free-radical, ionic and insertion mechanisms) and reactions on polymers. Examples of polymers and their uses. Offered alternating years with ENCH 425 (CHEM 425).

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): CHEM 223 or ENCH 245 (CHEM 245)

ENCH 425 NOT OFFERED THIS YEAR - Self-Assembly and Materials W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Four topics covering a range of self-assembled molecular systems will be discussed: monolayers and bilayers, block co-polymers, nanoparticles, and liquid crystals. Material properties, synthetic methods and application of these systems in current and emerging technologies, including nanotechnologies, will be covered. Offered Alternating years with ENCH 424 (CHEM 424).

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): CHEE 210 and ENCH 245 (CHEM 245), or CHEM 221 and CHEM 223

Engineering Physics

ENPH 211 Applied Physics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course stresses the creation of physical models for real systems. Applications of vibrational motion are developed and a basic description of the properties of elastic media given. The methods required to predict the performance of physical or engineering systems are demonstrated using examples drawn from various fields of science and engineering with emphasis on mechanics and vibrations, waves and optics.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Studies 31
Engineering Design 0

COREQUISITE(S): ENPH 225

ENPH 213 Computational Engineering Physics W | 4

Lecture: 2
Lab: 1.5
Tutorial: 0.5
Introduction to the use of numerical methods in solving physics and engineering problems. A high-level language appropriate for engineering, such as MATLAB, will be introduced and used throughout the course. Possible topics to be covered include numerical differentiation and integration, root finding and optimization problems, solution of linear systems of equations, finite-element modelling, fast Fourier transforms and Monte Carlo simulations.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Studies 21
Engineering Design 15

PREREQUISITE(S): APSC 142, MTHE 227 (MATH 227), MTHE 237 (MATH 237), ENPH 242 (PHYS 242)
COREQUISITE(S): ENPH 211 (PHYS 211), ENPH 225 (PHYS 225), ENPH 239
EXCLUSION(S): CMPE 271

ENPH 225 Mechanics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Extension of classical mechanics and engineering applications. Plane dynamics, relative motion and forces in moving and accelerated reference frames. Introduction to general three-dimensional motion of a rigid body, inertia tensor and steady-state precession. The laws of conservation of mass, momentum and energy.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 112, APSC 171, APSC 172, APSC 174

ENPH 239 Electricity and Magnetism W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The experimental basis and mathematical description of electrostatics, magnetostatics and electromagnetic induction, together with a discussion of the properties of dielectrics and ferromagnetics, are presented. Both the integral and vector forms of Maxwell's equations are deduced.

Academic Units:
Mathematics 0
Natural Sciences 17
Complementary Studies 0
Engineering Studies 25
Engineering Design 0

PREREQUISITE(S): MTHE 227 (MATH 227) or MTHE 280 (MATH 280); APSC 111 and APSC 112

ENPH 242 Relativity and Quanta F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Evidence for relativistic effects. Kinematics and dynamics in special relativity, Minkowski diagram, applications. Evidence for quanta, spectra, Bohr atom, quantum statistics. Descriptive nuclear physics, radioactivity, elementary particles.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 112
EXCLUSION(S): PHYS 342

ENPH 251 Deleted - Engineering Physics Laboratory and Statistics FW | 4.25

Lecture: 1
Lab: 3
Tutorial: 0.25
The demonstration of the basic techniques of the engineering physicist in the measurement of electric, magnetic, thermal and mechanical properties. The emphasis is on correct measurement techniques, treatment of results and the presentation of data. Error and uncertainties in experimental measurement, the propagation of errors. Probability and the Binomial, Poisson and Gaussian distribution functions, fitting of Poisson and Gaussian distributions to a sample population. Linear least squares fit, chi-squared. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 8
Natural Sciences 8
Complementary Studies 6
Engineering Studies 28
Engineering Design 0

COREQUISITE(S): ENPH 225, ENPH 239 and ENPH 274
EXCLUSION(S): ENPH 252 (PHYS 252)

ENPH 252 Management of Experimental Data W | 1.25

Lecture: 1
Lab: 0
Tutorial: 0.25
Error and uncertainties in experimental measurement, the propagation of errors. Probability and the Binomial, Poisson and Gaussian distribution functions, fitting of Poisson and Gaussian distributions to a sample population. Linear least-squares fitting, chi-squared. The graphical treatment and presentation of data; regression and power law analyses.

Academic Units:
Mathematics 8
Natural Sciences 0
Complementary Studies 0
Engineering Studies 6
Engineering Design 0

ENPH 253 Engineering Physics Laboratory W | K3.5

Lecture: Yes
Lab: Yes
Tutorial: Yes
The demonstration of the basic techniques of the engineering physicist in the measurement of electric, magnetic and mechanical properties. The emphasis is on correct measurement techniques, error analysis, treatment of results and the presentation of data.

Academic Units:
Mathematics 0
Natural Sciences 15
Complementary Studies 12
Engineering Studies 15
PREREQUISITE(S): ENPH 252 (PHYS 252)
COREQUISITE(S): ENPH 211, ENPH 225, ENPH 239

ENPH 274 Deleted - Thermodynamics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Thermodynamics applied to engineering systems. Ideal gas properties and real thermodynamic working substances. First law using control mass and control volume. Second law, entropy, Carnot cycle, power and refrigeration cycles. Reversible flow processes. Introduction to fluid mechanics and flow measurement. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 6
Complementary Studies 0
Engineering Studies 28
Engineering Design 8

PREREQUISITE(S): APSC 111, APSC 112, APSC 171, APSC 172, APSC 174

ENPH 312 Mathematical Methods in Physics FW | 7

Lecture: 6
Lab: 0
Tutorial: 1
Methods of mathematics important for physicists. Functions of a complex variable, contour integration, partial differential equations, orthogonal functions, Green functions, Fourier series, Fourier and Laplace transforms, finite difference methods, numerical solution of ordinary and partial differential equations.

Academic Units:

Mathematics 63
Natural Sciences 21
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): MTHE 227 (MATH 227), MTHE 237 (MATH 237), ENPH 211 (PHYS 211)

ENPH 316 Mathematical Methods in Physics I F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Methods of mathematics important for physicists. Complex arithmetic, series expansions and approximations of functions, Fourier series and transforms, vector spaces and eigenvalue problems, ordinary differential equations and Green's functions.

Academic Units:
Mathematics 31
Natural Sciences 11
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): MTHE 227 (MATH 221 or MATH 280), MTHE 237 (MATH 225 or MATH 231)
EXCLUSION(S): ENPH 312 (PHYS 312), MTHE 338 (MATH 338), MTHE 334 (MATH 334), MTHE 335 (MATH 335)

ENPH 317 Mathematical Methods in Physics II W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A continuation of PHYS 316. Partial differential equations, functions of a complex variable and contour integration, and special topics such as probability and statistics, group theory and non-linear dynamics

Academic Units:
Mathematics 31
Natural Sciences 11
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENPH 316 (PHYS 316)
EXCLUSION(S): ENPH 312 (PHYS 312), MTHE 338 (MATH 338), MTHE 334 (MATH 334), MTHE 335 (MATH 335)

ENPH 321 Advanced Mechanics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5

An introduction to the equations of mechanics using the Lagrange formalism and to the calculus of variations leading to Hamilton's principle. The concepts developed in this course are applied to problems ranging from purely theoretical constructs to practical applications. Links to quantum mechanics and extensions to continuous systems are developed.

Academic Units:
Mathematics 11
Natural Sciences 20
Complementary Studies 0
Engineering Studies 11
Engineering Design 0

PREREQUISITE(S): ENPH 211 (PHYS 211), MTHE 226 (MATH 226) or MTHE 237 (MATH 237), MTHE 227 (MATH 227)

ENPH 332 Deleted - Electromagnetic Theory W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introduction to electromagnetic theory and some of its applications. Topics are: Maxwell's equations, properties of waves in free space, dielectrics, conductors and ionized media, reflection and refraction at the surfaces of various media, radiation of electromagnetic waves, antennae, wave-guides, and optical fibers. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 21
Complementary Studies 0
Engineering Studies 21
Engineering Design 0

PREREQUISITE(S): ENPH 239 (PHYS 239) or PHYS 235 or ELEC 280, MTHE 226 (MATH 226) or MTHE 235 (MATH 235) or MTHE

ENPH 333 Deleted - Electronics for Scientists and Engineers |

The design of electronic circuits and systems, using commonly available devices and integrated circuits. The properties of linear circuits are discussed with particular reference to the applications of feedback; operational amplifiers are introduced as fundamental building blocks. Digital circuits are examined and the properties of the commonly available I.C. types are studied; their use in measurement, control and signal analysis is outlined. Laboratory work is closely linked with lectures and provides practical experience of the subjects covered in lectures. - COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 27
Engineering Design 27

PREREQUISITE(S): ELEC 210 or ELEC 221
EXCLUSION(S): ENPH 334 (PHYS 334)

ENPH 334 Electronics for Applied Scientists F | 5

Lecture: 3
Lab: 1.5
Tutorial: 0.5
The design of electronic circuits and systems, using commonly available devices and integrated circuits. The properties of linear circuits are discussed with particular reference to the applications of feedback; operational amplifiers are introduced as fundamental building blocks. Digital circuits are examined and the properties of the commonly available I.C. types are studied; their use in measurement, control and signal analysis is outlined. Laboratory work is closely linked with lectures and provides practical experience of the subjects covered in lectures.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 27
Engineering Design 27

PREREQUISITE(S): ELEC 221
EXCLUSION(S): ENPH 333 (PHYS 333)

ENPH 336 Solid State Devices W | 3.25

Lecture: 3
Lab: 0
Tutorial: 0.25
This course deals with the fundamental concepts of solid state materials and the principles of operation of modern electronic and optoelectronic devices. Topics in materials include crystal structure, energy bands, carrier processes and junctions. Topics in device operation include p-n junction diodes, bipolar junction transistors, field-effect junction transistors, metaloxide- semiconductor field-effect transistors, and double heterojunction lasers.

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0
Engineering Studies 21
Engineering Design 0

PREREQUISITE(S): ELEC 252, ELEC 280 or ENPH 239 (PHYS 239)
EXCLUSION(S): PHYS 335

ENPH 344 Introduction to Quantum Mechanics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Brief introduction to Hamiltonian dynamics. Matter waves. Postulates of quantum mechanics. Stationary states. One-dimensional potentials. Particle tunnelling and scattering states. Introduction to matrix mechanics and Dirac notation: the simple harmonic oscillator and angular momentum.

Academic Units:
Mathematics 11
Natural Sciences 31

Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): MTHE 237 (MATH 237), MTHE 227 (MATH 227), ENPH 242 (PHYS 242), ENPH 211 (PHYS 211)

ENPH 345 Quantum Physics of Atoms, Nuclei and Particles W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Quantum mechanical treatment of two and three dimensional systems. Hydrogen atom. Spin. Many-electron atoms and the periodic table. Introduction to perturbation theory. Fermi's golden rule. Introduction to nuclear and particle physics.

Academic Units:
Mathematics 11
Natural Sciences 20
Complementary Studies 0
Engineering Studies 11
Engineering Design 0

PREREQUISITE(S): ENPH 344 (PHYS 344)

ENPH 351 Deleted - Engineering Physics Laboratory F | 2

Lecture: 0
Lab: 2
Tutorial: 0
Selected experiments in electron physics, quantum physics, nuclear physics, optics, and heat illustrating the development of modern physics concepts. The laboratory work introduces advanced measurement techniques and includes an experimental project in modern physics with oral presentations. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 4
Complementary Studies 6
Engineering Studies 4
Engineering Design 10

COREQUISITE(S): PHYS 342 or ENPH 344 (PHYS 344)

ENPH 352 Deleted - Measurement, Instrumentation and Experiment Design W | 4

Lecture: 3
Lab: 1
Tutorial: 0
Methods of measurement of a wide range of quantities are discussed with particular reference to instrumentation and equipment used in current physics and engineering practice. The emphasis is on experiment and system design including the use of analog and digital signal processing methods for signal to noise enhancement. A major section of the course covers the use of nuclear and x-ray methods in applied physics. Current legislation related to health and safety is reviewed. An associated laboratory provides experience in modern instrumentation. COURSE DELETED

2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 2
Engineering Studies 22
Engineering Design 24

PREREQUISITE(S): ENPH 239 (PHYS 239) or PHYS 235, PHYS 342 or ENPH 344 (PHYS 344)
COREQUISITE(S): PHYS 343 or ENPH 345

ENPH 353 Engineering Physics Laboratory II F | 2.5

Lecture: 1
Lab: 1.5
Tutorial: 0
Selected experiments in electron physics, quantum physics, nuclear physics and optics illustrating the development of modern physics concepts. The lectures cover methods of measurement of a wide range of quantities, with emphasis on instrumentation and equipment used in current physics and engineering practice. The laboratory work introduces advanced measurement techniques and important concepts in modern physics.

Academic Units:
Mathematics 0
Natural Sciences 8
Complementary Studies 8
Engineering Studies 14
Engineering Design 0

PREREQUISITE(S): ENPH 251 (PHYS 251) OR ENPH 253
COREQUISITE(S): ENPH 344
EXCLUSION(S): ENPH 351 (PHYS 351)

ENPH 354 Engineering Physics Design Project W | 3.5

Lecture: 1
Lab: 2.5
Tutorial: 0
Students will apply technical knowledge, models, and computer-aided design tools to solve an open-ended design problem. The students will work in teams to design, built, and test a prototype device. The lectures provide background on the physics and engineering of the device and introduce the design tools and techniques that will be required to complete the project.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 11
Engineering Design 31

PREREQUISITE(S): APSC 200, APSC 293, ENPH 253 or ENPH 251 (PHYS 251)
COREQUISITE(S): APSC 221, ENPH 213 or CMPE 271, ENPH 334 or ELEC 252

ENPH 372 Thermodynamics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Temperature, equations of state, internal energy, first and second laws, entropy and response functions. Application to heat engines and refrigerators. Free energies, Legendre transformations, changes of phase. Introduction to the Boltzmann factor and statistical mechanics. First offering in winter 2013.

Academic Units:
Mathematics 0
Natural Sciences 31
Complementary Studies 0
Engineering Studies 11
Engineering Design 0

PREREQUISITE(S): ENPH 242 (PHYS 242)
EXCLUSION(S): ENPH 274 (PHYS 274)

ENPH 380 Deleted - Electrical and Optical Properties of Solids W | 3.25

Lecture: 3
Lab: 0
Tutorial: 0.25
An introduction to the electrical and optical properties of insulators, semiconductors and metals. Introduction to Fermi-Dirac statistics, crystal structures, band theory, and electron transport. The physics behind diodes, field effect and bipolar transistors, and other discrete devices. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 10
Complementary Studies 0
Engineering Studies 27
Engineering Design 2

PREREQUISITE(S): ENPH 239 (PHYS 239), ENPH 344 (PHYS 344)

ENPH 414 Introduction to General Relativity F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Einstein's theory of gravity is developed from fundamental principles to a level which enables the student to read some of the current literature. Includes an introduction to computer algebra, an essential element of a modern introduction to Einstein's theory.

Academic Units:
Mathematics 12
Natural Sciences 24
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENPH 321 (PHYS 321), ENPH 312 (PHYS 312) or MTHE 338 (MATH 338)

ENPH 422 Deleted - Fluid Mechanics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A survey of the physics of fluids. The fundamental principles and the range of validity of the usual approximation methods are stressed. Topics include a study of incompressible flow, both laminar and turbulent, boundary layers, stratified flow and waves, with a brief introduction to gas dynamics, magnetohydrodynamics and plasma physics. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0
Engineering Studies 24
Engineering Design 0

PREREQUISITE(S): ENPH 225 (PHYS 225), MATH 436 or MTHE 338 (MATH 338)

ENPH 431 Electromagnetic Theory F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introduction to electromagnetic theory and some of its applications. Topics are: Maxwell's equations, properties of waves in free space, dielectrics, conductors and ionized media, reflection and refraction at the surfaces of various media, radiation of electromagnetic waves, antennae, wave-guides, and optical fibers.

Academic Units:
Mathematics 0
Natural Sciences 21
Complementary Studies 0
Engineering Studies 21
Engineering Design 0

PREREQUISITE(S): MTHE 226 (MATH 226) or MTHE 235 (MATH 235) or MTHE 237 (MATH 237), MTHE 227 (MATH 227), ENPH 239 (PHYS 239)
EXCLUSION(S): ENPH 332 (PHYS 332), PHYS 432

ENPH 444 Advanced Quantum Physics W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Perturbation theory. Scattering theory. Addition of angular momentum. Special topics: Many electron systems. Path integral formulation of quantum mechanics. Entanglement and quantum computing.

Academic Units:
Mathematics 0

Natural Sciences 36
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENPH 345 (PHYS 345)

ENPH 450 Deleted - Advanced Physics Laboratory and Project FW | 8

Lecture: 0
Lab: 8
Tutorial: 0
This course provides advanced physics and engineering physics students with experience in a wide range of modern experimental techniques and the design of scientific or engineering apparatus. The course is evenly divided between group projects and set experiments. Experiments incorporate measurement and design in applied physics, solid state physics, low temperature physics, nuclear physics and optics. Students spend the winter term undertaking a large group design project demonstrating their knowledge of physics and engineering. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 8
Complementary Studies 6
Engineering Studies 30
Engineering Design 52

PREREQUISITE(S): PHYS 343 or ENPH 345 (PHYS 345), PHYS 350 or ENPH 351 (PHYS 351)

ENPH 453 Advanced Physics Laboratory W | 3.5

Lecture: 0
Lab: 3.5
Tutorial: 0
This course provides students in Engineering Physics with experience in a range of advanced experimental techniques and analysis. A balanced selection of experiments are performed from fields including nuclear physics, applied physics, solid state physics, low temperature physics, and optics.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 11
Engineering Studies 20
Engineering Design 0

PREREQUISITE(S): ENPH 344 (PHYS 344), ENPH 345 (PHYS 345), ENPH 351 (PHYS 351) or ENPH 353
EXCLUSION(S): ENPH 450 (PHYS 450), ENPH 453 (PHYS 453)

ENPH 454 Advanced Engineering Physics Design Project F | 4.5

Lecture: 0
Lab: 4.5
Tutorial: 0
This course provides engineering physics students with a complete experience in advanced design and implementation.

Working in groups, students undertake a large design project of their choice that reflects and further develops their knowledge of physics and engineering design. The students then build a prototype of their design to demonstrate the feasibility of project within the design constraints.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 14
Engineering Studies 0
Engineering Design 40

PREREQUISITE(S): ENPH 344 (PHYS 344), ENPH 351 (PHYS 351) OR ENPH 354
EXCLUSION(S): ENPH 450 (PHYS 450)

ENPH 455 Engineering Physics Thesis FW | 4

Lecture: 0
Lab: 0
Tutorial: 4
Students will be assigned individual design topics of the type a practicing engineering physicist might expect to encounter. They must develop a solution under the supervision of a faculty member, and give oral and written presentations to an examining committee. Grades will be based on the quality of the analysis of the problem, the proposed solution, and the written and oral presentations. The demonstration of effective written and oral communications skills is required.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Studies 0
Engineering Design 36

PREREQUISITE(S): ENPH 351 (PHYS 351) OR ENPH 354

ENPH 456 Advanced Engineering Physics Thesis I S | 2

Lecture: 0
Lab: 0
Tutorial: 2
Students will be assigned individual research topics. Students must work under the supervision of a faculty member. Grade will be based on the progress in arriving at a solution to the assigned problem.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 14
Engineering Design 10

PREREQUISITE(S): Permission of supervisor

ENPH 457 Advanced Engineering Physics Thesis II FW | 9

Lecture: 0
Lab: 0
Tutorial: 9
Continuation of ENPH 456. Upon completion of their thesis, students must give oral and written presentations to an examining committee. Grades will be based on the quality of the analysis of the problem, the proposed solution, and written and oral presentations. Demonstration of effective written and oral communications skills is required.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 28
Engineering Studies 48
Engineering Design 32

PREREQUISITE(S): ENPH 456
EXCLUSION(S): ENPH 455

ENPH 460 Laser Optics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Topics and applications in modern physical optics, culminating with the development of the laser and its current applications. Topics include: Gaussian beam propagation, optical resonators, Fourier optics, fiber optics, holography, light-matter interaction using classical and semi-classical models, and the basic theory and types of lasers.

Academic Units:
Mathematics 0
Natural Sciences 21
Complementary Studies 0
Engineering Studies 21
Engineering Design 0

PREREQUISITE(S): ENPH 239 (or PHYS 239), ENPH 344 (PHYS 344), or permission of the instructor
COREQUISITE(S): ENPH 332 or permission of instructor

ENPH 472 Statistical Mechanics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Phase space, the ergodic hypothesis and ensemble theory. Canonical and grand canonical ensembles. Partition functions. Ideal quantum gases. Classical gases and the liquid vapour transition. Introduction to techniques for interacting systems, including Monte Carlo simulations.

Academic Units:
Mathematics 0
Natural Sciences 32
Complementary Studies 0
Engineering Studies 10
Engineering Design 0

PREREQUISITE(S): ENPH 213 and ENPH 372
EXCLUSION(S): ENCH 412

ENPH 480 Solid State Physics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introduction to the properties of insulators, semiconductors and metals. Topics include: crystal structure, X-ray and neutron scattering, the reciprocal lattice, phonons, electronic energy bands, and the thermal, magnetic, optical and transport properties of solids.

Academic Units:
Mathematics 0
Natural Sciences 31
Complementary Studies 0
Engineering Studies 11
Engineering Design 0

PREREQUISITE(S): ENPH 239 (PHYS 239), ENPH 345 (PHYS 345)
EXCLUSION(S): ENPH 380 (PHYS 380), ENPH 481 (PHYS 481)

ENPH 481 Solid State Device Physics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A course in the physics underlying solid state electronic and optical devices. The course presents an introduction to the electrical and optical properties of insulators, semiconductors and metals, including crystal structure, band theory, and electron transport. This is applied to obtain a physical understanding of the physics governing the behaviour of diodes, field effect and bipolar transistors, and other discrete optical and electronic devices.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 30
Engineering Design 0

PREREQUISITE(S): ENPH 239 (PHYS 239), ENPH 344 (PHYS 344)
EXCLUSION(S): ENPH 336 (PHYS 336), ENPH 380 (PHYS 380), ENPH 480 (PHYS 480)

ENPH 483 Nanoscience and Nanotechnology W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An examination of the key ideas, techniques and technologies in the fields of nanoscience and nanotechnology. Emphasis will be placed on the physics involved, measurement techniques, and technological applications. Topics covered are selected from the following: electrical and optical properties of quantum dots, quantum wires and nanotubes; quantum information technology; mesoscopic electronics; nanostructures on surfaces; and scanning-probe and optical microscopy.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 30
Engineering Design 0

PREREQUISITE(S): ENPH 344 (PHYS 344), ENPH 336 (PHYS 336) or ENPH 380 (PHYS 380) or ENPH 480 (PHYS 480) or ENPH 481

ENPH 487 Deleted - Surface Engineering and Analysis F | 3

Lecture: 3
Lab: 0
Tutorial: 0
An outline of the fundamental concepts and applications of modern techniques for the production and analysis of surfaces and thin films. Topics include ultra-high vacuum principles, surface thermodynamics and adsorption, electron and ion microscopy and spectroscopy, electron and x-ray diffraction, scanning probe microscopy, and growth of thin films by vapour deposition. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 8
Complementary Studies 2
Engineering Studies 16
Engineering Design 10

PREREQUISITE(S): ENPH 344 (PHYS 344) or permission of the instructor

ENPH 490 Nuclear Physics F | 3.5

Lecture: 3
Tutorial: 0.5
A systematic introduction to low energy nuclear physics for advanced physics students. Lecture topics are: nucleon-nucleon forces, structure of nuclei, nuclear models, radioactivity, detection of nuclear radiation, electromagnetic, weak and strong interactions and an introduction to particle physics.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): ENPH 345 (PHYS 345)

ENPH 491 Physics of Nuclear Reactors F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5

The fundamental physics associated with a nuclear reactor. Emphasis will be on the interaction of neutrons, reactor kinetics and calculations required in reactor design. Topics discussed include: brief review of basic nuclear physics, neutron interactions and cross-sections, neutron diffusion, neutron moderation, theory of reactors, changes in reactivity, control of reactors.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 12

COREQUISITE(S): ENPH 242 or PHYS 342

ENPH 495 Introduction to Medical Physics W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Production and measurement of x-rays and charged particles for radiation therapy and nuclear medicine, interactions of radiation with matter and biological materials, interaction coefficients and radiation dosimetry, radiation safety, physics of medical imaging with examples from nuclear medicine ultrasound and magnetic resonance imaging.

Academic Units:
Mathematics 0
Natural Sciences 9
Complementary Studies 0
Engineering Studies 27
Engineering Design 0

Geological Engineering

GEOE 107 Deleted - History of Life F | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
The history of life, from its inception four billion years ago to the present day, focusing on the inter-relationship between organic evolution and global change. Coevolution of early life and the atmosphere; development of marine animals and their ecosystems; invasion of the land; dinosaurs and their world; mass extinctions; the Age of Mammals; and hominid evolution. Lectures plus four three-hour laboratories. COURSE DELETED in 2012-2013

Academic Units:

GEOE 207 History of Life F | 3.5

Lecture: 3
Lab: 0.5
The history of life, from its inception four billion years ago to the present day, focusing on the inter-relationship between organic evolution and global change. Coevolution of early life and the atmosphere; development of marine animals and their ecosystems; invasion of the land; dinosaurs and their world; mass extinctions; the Age of Mammals; and hominid evolution. Lectures plus four three-hour laboratories.

Academic Units:
Natural Sciences 42

GEOE 211 Deleted - Geological Engineering Field Methods F | 4.5

Lecture: 2
Lab: 2.5
Tutorial: 0
A field-based course stressing methods used in geological engineering site investigation. Includes field characterization of engineering properties and behaviour of earth materials and their structures. Student teams conduct eight site investigations that address geological engineering problems. Two of these involve the design of an infrastructure improvement project, with geological considerations. Results are presented in weekly engineering reports illustrated with maps and sections.

Academic Units:
Mathematics 0
Natural Sciences 14
Complementary Studies 0
Engineering Studies 26
Engineering Design 14

PREREQUISITE(S): APSC 151

GEOE 221 Geological Engineering Field Methods F | 4.5

Lecture: 2
Lab: 2.5
Tutorial: 0
A field-and-lab-based course stressing methods used in geological engineering site investigation. Includes field characterization of engineering properties and behaviour of earth materials and their structures. Student teams conduct site investigations that address geological engineering problems, some of which involve the design of an infrastructure improvement project (for example), with geological considerations. Results are presented in engineering reports illustrated with maps and sections.

Academic Units:
Mathematics 0
Natural Sciences 14
Complementary Studies 0
Engineering Studies 26
Engineering Design 14

PREREQUISITE(S): APSC 151

GEOE 232 Mineralogy F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
Characterization of rock- and soil-forming silicate and non-silicate minerals (their crystallography, optical and physical behaviour, and crystal chemistry). The structural, chemical and genetic aspects of the crystalline state as displayed by minerals are considered. Implications of mineral properties for the engineering behaviour of soils and rocks, and for

human needs, are discussed.

Academic Units:
Mathematics 0
Natural Sciences 40
Complementary Studies 0
Engineering Studies 14
Engineering Design 0

PREREQUISITE(S): APSC 151

GEOE 235 Genesis and Characterization of Solid Earth Materials W | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
Macroscopic and microscopic characterization of igneous, sedimentary and metamorphic rocks. Processes by which rocks are formed and transformed, and influence of genesis on shape, distribution, and rock-mass character of rock bodies. Implications and consequences of rock-forming processes for mineral exploration and production, fossil-fuel exploration and production, and engineering site investigation.

Academic Units:
Mathematics 0
Natural Sciences 32
Complementary Studies 0
Engineering Studies 22
Engineering Design 0

PREREQUISITE(S): GEOE 232 (GEOL 232), or permission of instructor

GEOE 238 Surficial Processes, Sedimentation and Stratigraphy W | 4

Lecture: 3
Lab: 1
Tutorial: 0
An examination of the genetic link between surficial geological processes and the sedimentary record produced by these processes. Students obtain an integrated overview of the nature and operation of the Earth-surface environment. Topics include origin of sedimentary rocks and their sedimentary structures, depositional environments and stratigraphic successions; stratigraphic principles and their application to sedimentary basins, with implications for hydrocarbon genesis; interaction of natural; processes with human society. A half-day field trip may be required.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Studies 12
Engineering Design 0

PREREQUISITE(S): APSC 151

GEOE 249 Geophysical Characterization of the Earth W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The application of physical principles to examine and characterize the Earth at all scales. The Earth's physical properties and dynamic processes will be assessed and evaluated by integrating such topics as gravity, seismology, magnetism, geochronology, and heat flow, as related to scientific and engineering problems.

Academic Units:
Mathematics 12
Natural Sciences 12
Complementary Studies 0
Engineering Studies 18
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 151, APSC 171, APSC 172

GEOE 262 Geological Aspects of Mineral Deposits W | 3.75

Lecture: 3
Lab: 0.75
Tutorial: 0
The basic mineralogy and petrology of mineral deposits are examined. The formation and classification of mineral deposits, considering such aspects as tectonic setting, age, rock composition, geometry, and mineralogy are investigated. Emphasis is placed on the processes by which mineral deposits are formed and transformed, and their influence on mining and production. Laboratory work integrates geological information from the scale of hand samples to regional maps as tools to assist with mine design, estimation of ore grade and evaluation of issues related to ore processing.

Academic Units:
Mathematics 0
Natural Sciences 20
Complementary Studies 0
Engineering Studies 25
Engineering Design 0

PREREQUISITE(S): APSC 151 or equivalent
EXCLUSION(S): GEOE 232 (GEOL 232), GEOE 362 (GEOL 362)

GEOE 281 Earth Systems Engineering F | 3.5

Lecture: 3
Tutorial: 0.5
Introduction to all of the integrated fields of Geological Engineering and the essence of engineering design in an earth-systems context. Focus is on geological engineering properties and processes. Projects involve engineering design problems with a particular focus on dealing with scale dependency, sampling confidence, natural variability and risk-assessment related to the quantification of engineering properties for geomaterials. Introductory geotechnical engineering, applied geophysics, resource engineering and geo-environmental engineering is highlighted with emphasis on site investigation and design related to mining, tunnelling, infrastructure development, natural-hazard mitigation and environmental remediation and resource exploration and management. A one day field trip is required.

Academic Units:
Engineering Studies 26
Engineering Design 16

PREREQUISITE(S): APSC 151
COREQUISITE(S): GEOE 221, or permission of the instructor

GEOE 282 Earth Systems Engineering II: Resources and Environment W | 3.5

Lecture: 2
Lab: 1.5
Tutorial: 0
An earth-system engineering perspective on the nature and acquisition of energy, mineral and water resources, with particular emphasis on the environment considerations in their extraction, processing, and use. Criteria for designing resource exploration programmes are examined. Practical exercises, projects and seminars (team and individual) deal with these issues, and include the design of risk-management plans, environmental life-cycle assessments, sustainable systems, and ore-reserve estimations.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Studies 18
Engineering Design 12

PREREQUISITE(S): GEOE 232 (GEOL 232) and GEOE 221 (GEOL 211), or permission of the instructor

GEOE 300 Geological Engineering Field School S | 5

Lecture: 0
Lab: 5
Tutorial: 0
An intensive two-week course taken immediately after final examinations in second year. Teams of students apply geological field methods and geological engineering assessment techniques learned during second year, as the basis for an engineering assessment of overburden and bedrock for a suite of specific engineering design outcomes. These outcomes include mineral resource evaluation, mine design, geotechnical stability and environmental baseline assessment related to future engineering works. In addition the students are expected to optimize the design of their own site investigation program to maximize the practical value of information obtained. A final site investigation and engineering report, including design solutions for the aforementioned problems, is presented and defended. Field safety regulations and safe practice are emphasized.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 15
Engineering Design 45

PREREQUISITE(S): GEOE 221 or GEOL 211, GEOE 235 or GEOL 235, or permission of instructor

GEOE 301 Field Studies in Geology F | 1.5

Lecture: 0
Lab: 1.5
Tutorial: 0

A multi-day field trip that uses stratigraphic, sedimentological, and paleontological data to interpret rock successions in a paleoenvironmental and tectonic context. Enrolment is limited. NOTE: The course runs during the week of Canadian Thanksgiving. Students are responsible for the cost of transportation, accommodation and food during the trip. Please see the Departmental web page for more information.

Academic Units:
Mathematics 0
Natural Sciences 14
Complementary Studies 0
Engineering Studies 4
Engineering Design 0

COREQUISITE(S): GEOE 321 or GEOE 337 or GEOE 368

GEOE 310 Deleted - Geological Engineering Field School |

An intensive two-week course taken immediately after final examinations in second year. Teams of students apply geological field methods and geological engineering assessment techniques learned during second year, as the basis for an engineering assessment of overburden and bedrock for a suite of specific engineering design outcomes. These outcomes include mineral resource evaluation, mine design, geotechnical stability and environmental baseline assessment related to future engineering works. In addition the students are expected to optimize the design of their own site investigation program to maximize the practical value of information obtained. A final site investigation and engineering report, including design solutions for the aforementioned problems, is presented and defended. Field safety regulations and safe practice are emphasized. COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 15
Engineering Design 45

PREREQUISITE(S): GEOE 211 (GEOL 211) and GEOE 235 (GEOL 235), or permission of the instructor.

GEOE 319 Applied Geophysics W | 3

Lecture: 3
Geophysical tools and methods (including gravity, magnetic, electrical, and seismic) applied to engineering problems, including resource exploration and site investigation. Design of field programs using these methods including consideration of physical principles, instrumentation, field procedures and data interpretation. Field projects with geophysical equipment are undertaken.

Academic Units:
Natural Sciences 12
Engineering Studies 24
PREREQUISITE(S): GEOE 249 (GEOL 232), MTHE 232 (MATH 232), GEOE 359 or permission of instructor

GEOE 321 Analysis of Rock Structures F | 4

Lecture: 3
Lab: 1
Material mechanics related to rock deformation and fracture of rocks, applied to site-investigation and resource

exploitation. Topics include geometric, kinematic and dynamic analysis; mechanical analysis (stress and strain theory); geologic mapping and map interpretation; engineering rockmass classification and rock engineering in structurally controlled ground, introduction to geotectonics with examination of selected tectonic associations. Application of structural geology and geomechanics to design issues related to construction, mining, natural hazards, and resource exploitation. Required full-day field trip.

Academic Units:
Natural Sciences 24
Engineering Studies 24
PREREQUISITE(S): GEOE 300 (GEOL 310) or permission of the instructor

GEOE 323 Deleted - Quaternary Glacial Geology |

Quaternary paleoclimates and ice ages. Glacial and proglacial processes, environments and landforms. Dating techniques. Glacial interglacial history and stratigraphy of selected areas in Canada. One or more one-day field trips may be required. Offered next in 2012/13, and every second year thereafter. COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 35
Complementary Studies 0
Engineering Studies 13
Engineering Design 0

PREREQUISITE(S): GEOE 238 (GEOL 238) or permission of the instructor

GEOE 333 Terrain Evaluation W | 4

Lecture: 3
Lab: 1
Tutorial: 0
An introduction to the principles of geomorphology relevant go Geological Sciences and Geological Engineering. An emphasis is made on the evaluation of terrain features using analog and digital imagery using traditional and digital (GIS) methods. Terrain analysis using computational methods, generation of surface models from LiDAR and imagery, and integration into simulations.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 24
Engineering Design 12

PREREQUISITE(S): APSC 151 or permission of the instructor

GEOE 337 Paleontology F | 4

Lecture: 3
Lab: 1
Tutorial: 0
Review of the major groups of invertebrate fossils, emphasizing morphology, taxonomy and geological significance; introduction to paleoecology and biostratigraphy; analysis of major trends and processes in organic evolution.

Academic Units:
Mathematics 0
Natural Sciences 48
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): GEOE 238 (GEOL 238)

GEOE 340 Problems in Geological Engineering F/W | 3

Lecture: 0
Lab: 0
Tutorial: 3
Each student investigates a problem in geological engineering that is not covered in any of the available courses, and submits a written report on the topic. This course is open to students only if a suitable faculty member is available.

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0
Engineering Studies 18
Engineering Design 0

GEOE 341 Special Topics in Applied Geology S | 3

Lecture: 0
Lab: 0
Tutorial: 3
This course provides intensive coverage of a special topic in applied geology and will be offered periodically in conjunction with visiting faculty and professionals. Consult the department homepage for opportunities.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 36
Engineering Design 0

PREREQUISITE(S): GEOE 300 (GEOL 310)

GEOE 343 Applied Hydrogeology F | 3.75

Lecture: 2.75
Lab: 0
Tutorial: 1
Development of the equations governing flow and transport; sensitivity to sub-surface complexities. Field instrumentation, installation and sampling protocols, elements of groundwater investigation. Assessment of measurement techniques and interpretation of fundamental hydrogeological properties. Groundwater occurrence, flow system analysis, with a focus on designing extraction schemes. During the required field activities, students investigate a groundwater problem by taking measurements to be reduced and interpreted in report form. Given jointly with GEOL

833.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 18
Engineering Design 15

PREREQUISITE(S): Completion of 2nd year Geological Engineering or permission of instructor

GEOE 345 Site Investigation & Geological Engineering Design W | 4

Lecture: 3
Lab: 1
Tutorial: 0
The course provides involves a team approach to tackling current geological engineering problems and developing innovative solutions. Critical site investigation and site selection decisions are proposed, undertaken and tested with consideration of "downstream" engineering issues and constraints. The course relies on student consultation with guest participants, most of whom are practicing professional engineers. Additionally, topics such as professional liability and ethics, environmental legislation, and the Occupational Health and Safety Act are presented and discussed. In addition, formalized design tools including FMEA, QRA will be utilized. Course may include a field exercise in modern engineering investigation methods.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Studies 0
Engineering Design 36

PREREQUISITE(S): Completion of 2nd-year GEOE ENG or permission of instructor
EXCLUSION(S): GEOE 445 (GEOL 445)

GEOE 349 Deleted - Applications of Quantitative Analysis in Geological Engineering W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A course in the application of quantitative mathematical methods to solve a variety of geological engineering problems. The utility, significance, and widespread applicability of analytical and numerical techniques will be illustrated in the evaluation and solution of practical problems taken from environmental science, geology, geohydrology, and geophysics. COURSE DELETED 2012-2013

Academic Units:
Mathematics 8
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 10

PREREQUISITE(S): APSC 142, GEOE 249 (GEOL 249), MTHE 227 (MATH 227), MTHE 226 (MATH 226) or MTHE 232 (MATH 232),

GEOE 359 Applied Quantitative Analysis in Geological Engineering F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The theory and use of numerical computational procedures to solve geo-engineering problems. The utility, significance and widespread applicability of analytical and numerical techniques will be illustrated in the evaluation and solution of practical problems. Methods for: solution of simultaneous linear equations, curve fitting, solution of the algebraic eigenvalue problem, interpolation, least-squares, error propagation and geostatistics are included.

Academic Units:
Mathematics 15
Engineering Studies 15
Engineering Design 12

PREREQUISITE(S): GEOE 249, MTHE 232, MTHE 225
COREQUISITE(S): CHEE 209
EXCLUSION(S): MTHE 272

GEOE 362 Resource Engineering W | 3.5

Lecture: 2
Lab: 1.5
Tutorial: 0
An earth-system engineering perspective on the nature and acquisition of energy, mineral and water resources, with particular emphasis on the environment considerations in their extraction, processing, and use. Criteria for designing resource exploration program are examined. Practical exercises, projects and seminars (team and individual) deal with these issues, and include the design of risk-management plans, environmental life-cycle assessments, sustainable systems, and ore-reserve estimations.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Studies 18
Engineering Design 12

PREREQUISITE(S): GEOE 221 or GEOL 211, GEOE 232 or GEOL 232, or permission of the instructor
EXCLUSION(S): GEOL 382

GEOE 365 Geochemical Characterization of the Earth W | 4

Lecture: 3
Lab: 1
Tutorial: 0
The application of thermodynamics and kinetics to the understanding of geological processes in the Earth Sciences. Distribution of the elements, and practical uses of isotopes and elemental tracers. Geochemical actions and transactions within, and among, the lithosphere, hydrosphere, atmosphere and biosphere, including the impact of human evolution and environmental geochemistry. Practical application of geochemistry to solving problems in natural systems will be

emphasized. A practical involving problems, laboratory experience and field experience will be part of the course.

Academic Units:
Mathematics 0
Natural Sciences 27
Complementary Studies 0
Engineering Studies 21
Engineering Design 0

PREREQUISITE(S): APSC 131, GEOE 232 (GEOL 232), GEOE 235 (GEOL 235), or permission of the instructor

GEOE 368 Carbonate Sedimentology F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
The origin, composition and diagenesis of carbonate rocks. Study of modern carbonate sediments and depositional environments; development and design of facies models; petrographic and geochemical analysis of limestones and dolostones.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Studies 18
Engineering Design 0

PREREQUISITE(S): GEOE 238 (GEOL 238) or permission of the instructor

GEOE 401 Field Studies in Geology II F | 1.5

Lecture: 0
Lab: 1.5
Tutorial: 0
A multi-day field trip that uses stratigraphic, sedimentological, paleontological, and structural data to interpret shallow- and deep-marine rock successions in a paleoenvironmental and tectonic context. Enrollment is limited. NOTE: The course runs during the week of Canadian Thanksgiving. Students are responsible for the cost of transportation, accommodation and food during the trip. Please see the Departmental web page for more information.

Academic Units:
Mathematics 0
Natural Sciences 9
Complementary Studies 0
Engineering Studies 9
Engineering Design 0

PREREQUISITE(S): (A GPA of 2.90 in GEOE 221, GEOE 238 and GEOE 321) or permission of the Department.
COREQUISITE(S): GEOE 488

GEOE 402 Deleted - Exploration and Mining Geology Field School (two weeks) |

A two-week, intensive field course. Design and application of field data collection methods in exploration and mining projects, and in environment site remediation. Elements of design include: surface mapping and underground surveying in mining camps, drill core logging, determination of geological properties, 3D geological projections, integration of scientific literature and mining industry reports. Production of a final report with design solutions. Offered next in Spring 2010. Students should consult with course instructors regarding field trip costs. COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 10
Engineering Design 50

PREREQUISITE(S): GEOL 300 or GEOE 310 (GEOL 310), and GEOE 362 (GEOL 362), or permission of the instructor

GEOE 403 Deleted - Geotechnical and Geo-Environmental Field School F | 3

Lecture: 0.5
Lab: 2
Tutorial: 0.5
Technical discussions and working tours of sites involving exposure to major geotechnical and geoenvironmental design projects in various stages of development, with a focus on mining engineering, mine waste management and civil engineering works. The key geological engineering and design issues associated with each project are examined, from preliminary engineering design through engineering control of construction through long-term monitoring and maintenance. Students evaluate current design issues and develop engineering design solutions which are presented in the form of engineering reports and presentations. Preference given to students in the G5 and G6 Options.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 6
Engineering Design 30

PREREQUISITE(S): GEOE 281 (GEOL 281), GEOE 310 (GEOL 310)

GEOE 409 Deleted - Applied Geophysics: Laboratory F | 5

Lecture: 1
Lab: 1.5
Tutorial: 2.5
Local field exercises and laboratory assignments using a wide variety of geophysical site-investigation and exploration methods. Lectures will be used to teach basic instrument theory, and to teach the principles of exploration program design. The course includes a four-day field exercise to design and carry out an integrated geophysical site investigation. Evaluation is based on submitted technical reports arising from the practical assignments. Offered next in 2010/11. Students should consult with course instructors regarding estimated field trip costs.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0

Engineering Studies 18
Engineering Design 42

PREREQUISITE(S): GEOE 319 (GEOL 319) or permission of the instructor

GEOE 410 Geological Engineering Field School F | 4

Lecture: 1
Lab: 3
Tutorial: 0
A one week intensive field course with associated discussions and project work during the term. Design and application of field data collection methods in exploration and mining projects, underground and surface mine works and for site remediation.. The key geological engineering and design issues associated with each project are examined, from preliminary engineering design through engineering control of construction through long-term monitoring and maintenance. Students evaluate current design issues and develop engineering design solutions which are presented in the form of engineering reports and presentations.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 24

PREREQUISITE(S): GEOE 300 (GEOL 310), GEOE 345 (GEOL 345), permission of instructor

GEOE 413 Engineering Geology and Rock Engineering Design F | 3.5

Lecture: 2
Lab: 1
Tutorial: 0.5
Rigorous application of geomechanics and rock engineering principles to open-ended design problems related to surface and underground excavation, construction and geo-hazard mitigation. Presentation and discussion of design methodologies and case histories are followed up by related analysis and design problems incorporating industry standard software. Emphasis on the inherent variability of geomaterials and implications for integrated site-investigation planning, quantitative risk assessment, design decision-making and performance-monitoring. A field excursion will be included.

Academic Units:
Engineering Studies 12
Engineering Design 30

PREREQUISITE(S): GEOE 281 (GEOL 281), GEOE 300 (GEOL 310) and GEOE 321 (GEOL 321), or permission of the instructor

GEOE 418 NOT OFFERED THIS YEAR - Petroleum Geology F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
The origin, migration and accumulation of petroleum resources, emphasizing typical reservoir styles, potential reservoir lithologies, methods of exploration and basic concepts of formation evaluation. Concepts and applications equip

students with the basic principles necessary to undertake petroleum industry exploration and production. Laboratory exercises include a major exploration design problem and presentation. Offered next in 2012-2013, and every second year thereafter.

Academic Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Studies 30
Engineering Design 0

PREREQUISITE(S): GEOE 238
COREQUISITE(S): GEOE 321

GEOE 419 Geophysics Field School S | 4

Lecture: 0
Lab: 0
Tutorial: 4
This eight day, intensive field course focuses on field and laboratory techniques using a wide array of geophysical site investigation and exploration methods. Lectures are used to review basic instrument theory, and to teach the principles of exploration program design. The course culminates in an exercise to design and implement an integrated geophysical site investigation. Students should consult with course instructors regarding estimated field trip costs.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 12
Engineering Design 24

PREREQUISITE(S): GEOE 319,completion of third year, or permission of instructor

GEOE 421 Deleted - Igneous Petrology |

Rock classification and tectonic associations, petrochemistry, petrogenesis, the origin and differentiation of primary magmas, plate tectonics and magmatic evolution. Phase diagrams of igneous minerals. Laboratory study of rock suites and special projects. Offered next in 2011/12, and every second year thereafter. COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 30
Complementary Studies 0
Engineering Studies 12
Engineering Design 0

PREREQUISITE(S): GEOE 235 (GEOL 235) or GEOL 335

GEOE 422 Deleted - Metallogeny and Mineral Exploration |

Integration of geological, mining and metallurgical engineering, economic, political, social and environmental issues, and application of ore deposit modeling and geophysical and geochemical exploration methods, in the design of comprehensive exploration programs for the discovery and development of Earth materials in an economic and environmentally responsible manner. Offered next in 2014/15, and every second year thereafter. COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 14
Engineering Design 28

PREREQUISITE(S): GEOE 362 or permission of the instructor
COREQUISITE(S): GEOE 362 or permission of the instructor

GEOE 429 Deleted - Geophysical Signal Analysis and Inverse Theory W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Underlying theory and guiding principles of digital geophysical data collection and processing system design. Discrete Fourier and sampling theory; filter poles and zeros, signal shaping, least-squares and prediction filters; causality implications. Applications to processing of potential field map data and waveform time series. Theory and practice of geophysical inversion culminating in the design and construction of optimized quantitative Earth models. Discrete linear problems, maximum likelihood, Lanczos decomposition, uniqueness and accuracy. Nonlinear problems from seismic imaging. Offered next in 2009-2010, and every second year thereafter. COURSE DELETED 2012-2013

Academic Units:
Mathematics 6
Natural Sciences 7
Complementary Studies 0
Engineering Studies 21
Engineering Design 8

PREREQUISITE(S): MTHE 338 (MATH 338) and GEOE 319 (GEOL 319), or permission of the instructor

GEOE 439 Advanced Applied Geophysics W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Advanced theory and techniques for acquisition, processing and interpretation of geophysical data. Students solve a geophysical problem from the initial idea through strategy development, data acquisition, processing, to interpretation, communication and deliverables. Design projects will exploit seismic, gravity, magnetic, electromagnetic, geodetic and GPR techniques but the emphasis is on problem solving using integrated data from multiple methods/sources. Target areas include oil/gas/mineral exploration, near-surface prospecting and site investigation. Processing will use both available and student designed software.

Academic Units:
Mathematics 12
Engineering Studies 24
PREREQUISITE(S): MTHE 232, GEOE 249, GEOE 319 or permission of instructor

GEOE 445 Deleted - Site Investigation and Case Histories F | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
The course provides an overview of current geological engineering problems and innovative solutions, and relies on guest speakers, most of whom are practicing professional engineers. Topics such as professional practice and liability, engineering ethics, provincial and national environmental legislation, and the Occupational Health and Safety Act are presented and discussed. Guest lecture topics may include: buying and selling professional services, water supply management, contaminant abatement and/or remediation, management of engineering construction. Starting in Fall 2009, a one-day field exercise in engineering surveying methods will be held early in the term. COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 7
Engineering Studies 5
Engineering Design 30

PREREQUISITE(S): Completion of third-year common core for GEO ENG, or permission of the instructor

GEOE 446 Engineering Design Project I F | K3

Lecture: No
Lab: No
Tutorial: Yes
Student teams research, prepare a design work plan and carry out a "PhaseI" engineering investigation for a major, open-ended geological engineering project, in consultation with a Management Board comprising geological engineering faculty. Work plans adhere to current national and/or provincial regulations as appropriate, and include scope definition, development of a range of technical solutions to the engineering problem, cost analyses and project scheduling tasks. Design meetings are recorded in the form of minutes submitted to the course Management Board and time sheets are submitted. Engineering project work plans are presented and defended to a committee comprising faculty and external engineers. Evaluation is based on the presentation and the team-written preliminary design report. These reports form the basis for more in depth design work in GEOE 447 in the winter. Students must register in both GEOE 446 and GEOE 447.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 36

PREREQUISITE(S): Completion of third-year common-core for GEO ENG, or permission of staff.

GEOE 447 Engineering Design Project II W | K5

Lecture: No
Lab: No
Tutorial: Yes
Student teams carry out design work, including detailed analysis, synthesis, and presentation for the open-ended engineering projects proposed and initiated in GEOE 446. Projects adhere to current national and/or provincial regulations as appropriate, and include further development of engineering solutions while controlling project schedule, budget and critical path design objectives. Data are obtained from industrial sources, government documents,

engineering reports, the appropriate literature, and field studies and testing. Design projects, including methodologies, budgeting and technical components will be defended in class to a committee. Evaluation is based on two presentations and the team-written design report. Students must register in both GEOE 446 and 447.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 60

PREREQUISITE(S): GEOE 345 (GEOL 445), GEOE 446 (GEOL 446)

GEOE 452 Instrumental Techniques Applied to the Study of Solids W | 3

Lecture: 2
Lab: 1
Tutorial: 0
The theory and practical aspects of the techniques of X-ray powder diffraction and scanning electron microscopy are studied. Other techniques including Mossbauer, infra-red spectroscopy, and nuclear magnetic resonance spectroscopy will also be covered. An extensive term project is required where the student employs these techniques to study a material of their choice. This course may not be offered every year.

Academic Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Studies 12
Engineering Design 0

PREREQUISITE(S): GEOE 232 or permission of the Instructor

GEOE 462 Advanced Petrogenesis and Metallogenesis W | 4

Lecture: 3
Tutorial: 1
Application of the fundamental principles of igneous petrology, geochemistry and fluid-rock interaction to metallogeny and ore genesis. Training in ore microscopy and mineral paragenesis with mineral chemistry and lithogeochemical data for selected case studies. Lectures, critical reading, discussion sections, laboratory work and seminars will provide an understanding of ore forming processes.

Academic Units:
Natural Sciences 16
Engineering Studies 16
Engineering Design 16

PREREQUISITE(S): GEOE 362, GEOE 365 or permission of instructor

GEOE 463 Spatial Information Management in the Geosciences F | 3.5

Lecture: 2
Lab: 1.5

Tutorial: 0
An introduction to spatial information management focusing on methods to support and extend geological mapping, mineral and petroleum exploration, and engineering site investigation. Computers and computation, GIS software and theory, spatial simulation and analysis, databases and data management, and design of effective decision support solutions.

Academic Units:
Mathematics 14
Natural Sciences 0
Complementary Studies 0
Engineering Studies 28
Engineering Design 0

PREREQUISITE(S): GEOE 333 or permission of instructor
EXCLUSION(S): GISC 201

GEOE 464 Visualization in Geosciences W | 1.5

Lecture: 1
Tutorial: 0.5
An introduction to 3d visualization of natural sciences data with a focus on methods relevant to geological engineering, mineral exploration, and geoscience research. Perception, representation, and analytical methods. Design tools and data integration methods. Temporal analysis of natural sciences data. LiDAR data analysis. Global and local models. Virtual worlds.

Academic Units:
Engineering Studies 18
PREREQUISITE(S): GEOE 462 or permission of instructor

GEOE 465 Deleted - Exploration Geochemistry W | 3.5

Lecture: 2
Lab: 1.5
Tutorial: 0
Principles of geochemistry in mineral exploration, and the use of geochemistry in tracing specific paleohydrologic flow in complex, multicomponent media in systems that deposit ores. Primary and secondary dispersion and their significance in geochemical exploration. Selected case histories. Field and analytical techniques, and interpretation of geochemical data. Design of exploration programs. COURSE DELETED 2012- 2013

Academic Units:
Mathematics 0
Natural Sciences 16
Complementary Studies 0
Engineering Studies 26
Engineering Design 0

PREREQUISITE(S): GEOL 362 or permission of instructor

GEOE 466 Isotopes and the Environment W | 4

Lecture: 3
Lab: 1

Tutorial: 0
This course is designed to expose advanced students in the fields of biology, chemistry, geography or geology to the principles of stable isotope and radiogenic isotope systematics in natural processes. Emphasis will be placed on the use of isotopes in tracing elemental cycles, biological cycles and hydrologic cycles and how some isotopes can be used to place constraints on the timing of specific events in these cycles.

Academic Units:
Mathematics 0
Natural Sciences 48
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): GEOE 365 (GEOL 365)

GEOE 475 Exploration and Environmental Geochemistry W | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
Principles of rock-water interaction and element migration in the near surface environment applied to environmental and exploration geochemistry. Students learn field and analytical techniques, evaluate and interpret geochemical data, and design solutions related to geochemical hazards to human health, environmental impacts of mining, and formulation of strategies for detecting mineral deposits..

Academic Units:
Mathematics 0
Natural Sciences 27
Complementary Studies 0
Engineering Studies 26
Engineering Design 0

PREREQUISITE(S): GEOE 365 or permission of the instructor

GEOE 478 NOT OFFERED THIS YEAR - Terrigeneous Clastic Sedimentology F | 3.5

Lecture: 2
Lab: 1.5
Tutorial: 0
Detailed examination of depositional processes and external controls on the facies organization and sequence stratigraphy of fluvial, coastal, shelf, and deep-marine environments. Introduction to sedimentary basin types.

Academic Units:
Mathematics 0
Natural Sciences 26
Complementary Studies 0
Engineering Studies 16
Engineering Design 0

PREREQUISITE(S): GEOE 238 (GEOL 238) or permission of the instructor

GEOE 481 Structural Analysis Applied to Resource Deposits F | 3.5

Lecture: 2
Lab: 1.5
Tutorial: 0
Applications of the principles of rock deformation to the fabric analysis of rocks in the optimization of strategies for open-ended resource exploration, resource engineering and geotechnical engineering problems. Emphasis is on fracture, fault, and vein analysis; structures in fold and thrust belts; and studies of superposed deformation and their impact on effective and economical mineral resource development. Offered next in 2011/12, and every second year thereafter.

Academic Units:
Mathematics 0
Natural Sciences 20
Complementary Studies 0
Engineering Studies 22
Engineering Design 0

PREREQUISITE(S): GEOE 321 (GEOL 321) or permission of the instructor

GEOE 485 Deleted - Environmental Aqueous Geochemistry W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Examination of rock-water interaction, and the geological controls on the chemical evolution and anthropogenic modification of surface- and ground-water, as applied to environmental problems. Application of thermodynamics, activity diagrams, and computer models in the design of assessment systems and mitigation schemes for problems of water contamination. Students evaluate, and design solutions related to, case studies in the areas of geochemical hazards to human health and the environmental impacts of mining, including acid mine drainage. Offered next in 2011/12, and every second year thereafter. COURSE DELETED IN 2012/2013 ~

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 24
Engineering Design 0

PREREQUISITE(S): GEOE 232 (GEOL 232) or permission of the instructor

GEOE 488 Geology of North America F | 3

Lecture: 3
Lab: 0
Tutorial: 0
An advanced course discussing the principles of earth evolution as exemplified by North America. The holistic approach illustrates the way in which integrated geodynamics, geochemistry, sedimentation, paleobiology and oceanography are used to unravel the history of the continent.

Academic Units:
Mathematics 0
Natural Sciences 20
Complementary Studies 0
Engineering Studies 16

Engineering Design 0

COREQUISITE(S): Fourth Year Geological Engineering or permission of the instructors

Geology

GEOL 382 Deleted - Resource Engineering F |

Lecture: 33
Lab: 15
Tutorial: 0
Characterization of major ore deposit types using petrological, geochemical and geophysical engineering sciences, including tectonic setting, age, rock composition, geometry, mineralogy and textures, geochemical and geophysical signatures of mineral deposits. Design involves evaluation of ore deposit models and exploration programs, including ore processing and environmental issues. Laboratory work integrates investigation of mineral deposit's samples to determine paragenetic sequences, estimation of ore grade and evaluation of issues related to ore processing and site contamination. COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 21
Engineering Design 15

PREREQUISITE(S): GEOL 235, GEOL 281 or permission of the instructor.
EXCLUSION(S): GEOL 362

Geographic Information Science

GISC 201 Geographic Information Science W | 3

Lecture: 2
Lab: 1
Tutorial: 0
An introduction to the basic principles, techniques, and practical issues in assessing, accessing, and maintaining data sources and database systems and related tools for the manipulation and analysis of data. Students will learn concepts of database management and computer programming and will apply these concepts to the preparation, manipulation, analysis, and presentation of spatial and tabular data.

Academic Units:
Mathematics 4
Natural Sciences 16
Complementary Studies 6
Engineering Studies 4
Engineering Design 6

PREREQUISITE(S): Completion of the First Year Applied Science Program or permission of the Department of Geography

GISC 202 Data Collection, Management and Analysis W | 4

Lecture: 4
An introduction to the theory, methods, and practical issues in assessing, accessing, and maintaining data sources and database systems and related tools for the manipulation and analysis of data. Students will learn concepts of database management and computer programming and will apply these concepts to the preparation, manipulation, analysis, and presentation of spatial and tabular data.

Academic Units:
Mathematics 5
Natural Sciences 20
Complementary Studies 10
Engineering Studies 5
Engineering Design 8

PREREQUISITE(S): Completion of the First Year Applied Science Program or permission of the Department of Geography

GISC 301 Spatial Analysis F | 3

Lecture: 2
Lab: 1
Tutorial: 0
An in-depth exploration of the spatial analysis techniques used in vector GIS. The analysis of geographic primitives of points, lines, areas and surfaces in the context of applications drawn from geography, biology, planning and related disciplines. Emphasis is placed on the use of current GIS software in a hands-on environment.

Academic Units:
Mathematics 4
Natural Sciences 16
Complementary Studies 6
Engineering Studies 4
Engineering Design 6

PREREQUISITE(S): GISC 201 or GISC 202 or GEOE 463 (GEOL 463) or permission of the Department of Geography

GISC 302 Environmental Modelling W | 3

Lecture: 2
Lab: 1
Tutorial: 0
Study of the techniques of Geographic Information Systems and their applications in solving physical and environmental problems. Topics include data representation and models, spatial interpolation, raster-based analysis and modelling, surface models and terrain analysis, data visualization, temporal analysis, error and accuracy, and other algorithms and analytical procedures.

Academic Units:
Mathematics 4
Natural Sciences 16
Complementary Studies 6
Engineering Studies 4
Engineering Design 6

PREREQUISITE(S): GISC 201 or GISC 202 or GEOE 463 (GEOL 463) or the permission of the Department of Geography

GISC 303 Application Design and Customization in GIS F | 3

Lecture: 2
Lab: 1
Tutorial: 0
An introduction to customization of GIS and database software with an emphasis on spatial analysis tool development for desktop and Web-based GIS. Students will learn concepts of user requirements analysis, software requirements preparation, interface and software design, and computer programming while they develop customized GIS applications.

Academic Units:
Mathematics 4
Natural Sciences 16
Complementary Studies 6
Engineering Studies 4
Engineering Design 6

PREREQUISITE(S): GISC 201 or GISC 202 or GEOE 463 (GEOL 463) or permission of the Department of Geography

Geography

GPHY 304 Arctic and Periglacial Environments W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Advanced study of the physical geography of northern regions, emphasizing the Canadian Arctic.

Academic Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Studies 12
Engineering Design 0

Microbiology

MBIO 218 Gene Structure and Function (Molecular Biology) W | 3.25

Lecture: 3
Lab: 0
Tutorial: 0.25
Molecular mechanisms of gene expression, biochemistry of nucleic acids, chromatin structure, DNA replication, RNA transcription, processing and translation in prokaryotic, eukaryotic and viral systems. Offered jointly by the Departments of Biochemistry, Biology and Microbiology and Immunology.

Academic Units:

Mathematics 0
Natural Sciences 39
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): BIOL 205

MICR 360 Immunology F | 3

Lecture: 3
Lab: 0
Tutorial: 0
The general principles and mechanism of immune reaction. Immunochemical and immunobiological aspects of antibody formation and cell-mediated immunity in health and disease will be considered.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

COREQUISITE(S): BCHM 310 or BCHM 315 or BIOL 334 or equivalents or permission of the department.

Multi-department Courses

MDEP 221 Deleted - Engineering and Social Justice: Critical Theories of Technological Practices W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course is intended to help students understand critical theories and to develop critical perspectives towards technology in general and engineering practices in particular and draws from sociology, history, political economics, science and technology studies and philosophy. The course is cross-disciplinary in its approach and will explore the relationship between technology, labour, industry, society, and the natural world. Students will reflect on notions of rights, justice, freedom and sustainability in human and non human arenas.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Studies 0
Engineering Design 0

EXCLUSION(S): SOCY 234

MDEP 437 Fuel Cell Technology F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Introduction to and history of various fuel cell systems. Fuel cell fundamentals including thermodynamics, electrode kinetics, fuel cell performance and transport issues. Systems covered include Polymer Electrolyte Membrane (PEMFC), Direct Methanol (DMFC), Alkaline (AFC), Solid Oxide (SOFC), and Molten Carbonate (MCFC). Fueling processing issues and combined heat and power systems. Overview of the current fuel cell industry. This course is offered by the Department of Chemical Engineering and the Department of Mechanical and Materials Engineering.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 21
Engineering Design 21

Mechanical Engineering

MECH 212 Deleted - Design Techniques |

Physical, mental, and organizational techniques of competitive engineering design of components, machines, and products are introduced in a series of "hands-on" mini-projects. Examples include: development of alternatives; free-hand sketching in concept development and comparison; use of existing components and technologies; software applications; utilising information from handbooks, catalogs, design databases, patents, and competitive products; judgement and estimation; general design methodologies; design thinking and philosophies of design; physical modelling methods; problem-solving approaches; creative thinking; how things work; reverse engineering. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 42

COREQUISITE(S): APSC 161

MECH 213 Manufacturing Methods F | 4.5

Lecture: 3
Lab: 1
Tutorial: 0.5
The objective of this course is to achieve a knowledge and understanding of a wide variety of manufacturing processes involving plastics and metals. This course forms the basis for improved product and machine design, and will assist the mechanical engineer to function in the areas of design, manufacturing and general engineering. Training in the use of machine and welding tools found in a modern job shop is a required activity practiced in the machine tool laboratory. NOTE: It is highly advised that MME students take MECH 270 concurrently with this course.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0

Engineering Studies 36
Engineering Design 18

MECH 215 Instrumentation and Measurement F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course presents techniques and devices for measurements in mechanical systems of solids and fluids. On completion of the course, students will be able to: Identify and Quantify measurement objectives in practical engineering applications; Apply statistical analysis, including uncertainty for interpreting test results; Specify and Select transducers, acquisition systems, and procedures to measure temperature, pressure, stress, strain and force; position, velocity and acceleration; Apply physical principles to predict static and dynamic system performance for pressure, strain, temperature and position measurements. Students will use experimental and numerical skills typically acquired in MTHE 272 and MECH 216.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

PREREQUISITE(S): APSC 112
COREQUISITE(S): Remove - None

MECH 216 Instrumentation and Measurement Labs W | K2

Lecture: Yes
Lab: Yes
Tutorial: No
This course is composed of active lab modules that provide hands-on practical experience to complement the theory presented in MECH 215. On completion of the course, students will be able to: Install and test a micro controller system for data acquisition and control; Acquire and process digital and analog data; Apply transducers for temperature, pressure, stress, strain and force; position, velocity and acceleration; Formulate conclusions supported by data and comparison of results to appropriate models; Discuss the limitations of data employed, key findings, trends evident, uncertainty and error; Create graphs, tables and charts to clearly present data and support conclusions; Compose technical writing to concisely report measurement results and draw valid conclusions. Students will use experimental and numerical skills typically acquired in MTHE 272 and MECH 215.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 16
Engineering Design 8

PREREQUISITE(S): APSC 112
COREQUISITE(S): Remove - None

MECH 221 Statics and Solid Mechanics F, O/L | 4

Lecture: 3
Lab: 0
Tutorial: 1
Review of statics, forces and equilibrium, internal forces in simple structures; axial, torsion, shear and moment diagrams; concepts of stress and strain; mechanical properties of materials; centroids and moments of areas; axial stress; flexural stress; shear stress in shafts and beams; calculation of displacement by integration; introduction to combined loading; introduction to column buckling. This course is designed primarily for mechanical engineering students.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 48
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 171. Permission of the department for students not registered in Mechanical Engineering
EXCLUSION(S): CIVL 220, CIVL 230

MECH 228 Kinematics and Dynamics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course will cover the following topics in the field of dynamics. Kinematics of particles: planar motion (rectilinear, curvilinear), choosing a coordinate system, conversions between systems, space curvilinear motion, free and constrained paths, relative motion between particles. Plane kinematics of rigid bodies: absolute motion, relative motion (velocity and acceleration), instantaneous centre of zero velocity, motion relative to rotating axes. Kinetics of systems of particles: generalized Newton's Second Law, work and energy, impulse and momentum, conservation of energy and momentum, impact.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Studies 31
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 171
COREQUISITE(S): (None - remove)

MECH 230 Thermodynamics I F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introductory course in thermodynamics. Topics include: properties and behaviour of pure substances, concepts of heat, work and energy, the First and Second Laws of Thermodynamics, and the analysis of a variety of power and refrigeration cycles.

Academic Units:
Mathematics 0

Natural Sciences 30
Complementary Studies 0
Engineering Studies 12
Engineering Design 0

MECH 241 Fluid Mechanics I W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introductory course in fluid mechanics. Topics include properties of fluids, fluids at rest, manometers and other pressure measuring devices, dimensional analysis, the laws of conservation of mass and momentum, Bernoulli's equation for incompressible flow and the energy equation, flow measurements, elementary pipe flow problems including losses, pumps, etc. On completion of the course students will be able to: Explain Bernoulli based energy equations with reference to energy and hydraulic grade lines, static and dynamic pressure; Explain control volume and control mass analysis with reference to Eulerian and Lagrangian frames, applied forces and flows; Solve simple flow systems for velocity distributions using continuity and Navier Stokes equations with appropriate boundary conditions; Solve flow and force problems in an integral framework using Bernoulli, conservation of mass and momentum; Solve piping system performance problems using Bernoulli with friction, minor losses, pump and turbine performance curves; Calculate pressures and forces on submerged surfaces in a static fluid; Solve scaling problems using dimensionless groups.

Academic Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Studies 18
Engineering Design 0

PREREQUISITE(S): APSC 111

MECH 270 Materials Science and Engineering F | 3.75

Lecture: 3
Lab: 0.25
Tutorial: 0.5
This course provides the student with a background in the basic structural concepts of materials and the relationships between processing, structure, properties and performance. The topics will range from atomic bonding and arrangements, through micro-and macro-structures and their influence on properties, to the processing techniques required to produce the desired structures. All current types of engineering materials, including metals, ceramics, polymers, composites and semiconductors are covered. There is an experimental laboratory to illustrate the principles presented in the course along with some ASTM testing techniques.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 33
Engineering Design 0

MECH 271 Deleted - Materials Science and Engineering |

The lecture material is similar to that in MECH 270 but there is no laboratory component. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 30
Engineering Design 0

MECH 321 Solid Mechanics II F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Combined states of stress, transformation of stress and strain at a point. Beam deflections and statically indeterminate problems address the elastic deformation of bodies. Design of beams to resist bending and shear loads, as well as the design of shafts to resist bending and torsional moments. Elastic buckling of centrally-loaded slender columns and eccentrically, axially-loaded members are treated during the last portion of the course.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 12

PREREQUISITE(S): CIVL 220 or MECH 221

MECH 323 Machine Design W | 4.5

Lecture: 3
Lab: 1
Tutorial: 0.5
This course emphasises the application of theoretical and engineering background taught in other courses, but also relies heavily on empirical approaches and simplifications of theory. Core material includes static and fatigue failure theories and the design/specification of selected machine elements. The course is centered around a major design project which is undertaken in groups.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 27
Engineering Design 27

PREREQUISITE(S): APSC 200 OR MECH 212, MECH 321, APSC 221 or MTHE 334

MECH 328 Dynamics and Vibration F | 3.5

Lecture: 3
Lab: 0

Tutorial: 0.5
This course covers the kinematics and dynamics of rigid bodies in two and three dimensions, as well as an introduction to vibrations. Topics in dynamics include: mathematically rigorous kinematic analysis, Newton's laws, energy methods, impulse and momentum methods, mass moments of inertia, and gyroscopic motion. Topics in vibrations include: free and forced vibration of single-degree-of-freedom systems, undamped and damped systems, equivalent single degree of freedom system of continuous elements/systems using energy equivalence and equation of motion.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Studies 17
Engineering Design 14

PREREQUISITE(S): MECH 228

MECH 330 Applied Thermodynamics II F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A continuation of MECH 230 with selected topics such as gas and vapour power cycles, refrigeration, mixtures of gases and vapours, combustion and available energy.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

PREREQUISITE(S): MECH 230 or ENPH 274 (PHYS 274)

MECH 333 Gender, Engineering and Technology W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course examines relations between gender and technology. The main topics covered are: the role of technology on the shaping of society particularly in terms of gendering of jobs and exclusion of women, gender issues in the workplace, and the impact of technology on women's lives. Historical perspectives are presented and contemporary examples from western and developing countries are discussed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Studies 0
Engineering Design 0

MECH 341 Fluid Mechanics II W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A second course in fluid mechanics covering the differential form of conservation laws, boundary layer and external flows, compressible flows and the operation of rotational fluid machinery. On completion of the course students will be able to: Apply control volume analysis to mass, momentum and energy conservation; Apply differential form of mass and momentum conservation to the concept of flow field and its properties, including Navier Stokes equations; Apply stream function and velocity potential to the analysis of two-dimensional inviscid flows, and use the superposition principle to build complex flow fields from building block ingredients; Calculate drag and lift on solid bodies such as airfoils; Explain boundary layer flows, including the concept of various boundary layer thicknesses, shape factor, flow separation and the difference between laminar and turbulent boundary layers; Explain compressible flow features based on one-dimensional compressible subsonic and supersonic flows, with and without normal shock waves; Calculate design parameters of rotational fluid machinery, including centrifugal pumps and wind turbines.

Academic Units:
Mathematics 11
Natural Sciences 0
Complementary Studies 0
Engineering Studies 31
Engineering Design 0

PREREQUISITE(S): MECH 241

MECH 346 Heat Transfer W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introductory course which covers conduction, convection and radiation modes of heat transfer. Both analytical and numerical analysis will be discussed, and concepts will be reinforced through tutorial and laboratory sessions. Latter topics will include combined modes of heat transfer and the design of heat exchangers.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

PREREQUISITE(S): MECH 230 or ENPH 274 (PHYS 274) and MECH 241 or MECH 341

MECH 350 Automatic Control W | 3.5

Lecture: 2.75
Lab: 0.25
Tutorial: 0.5
An introduction to the basic principles of modelling, analysis and control of dynamic systems. Topics include: modes of control, principles of feedback, Laplace and transfer functions, transient response of first and second order systems, stability criteria, root locus, Bode and frequency response. After completion of this course a student will be able to design a control system by classical techniques and will have an awareness of modern techniques.

Academic Units:
Mathematics 0

Natural Sciences 0
Complementary Studies 0
Engineering Studies 23
Engineering Design 19

PREREQUISITE(S): MTHE 224 (MATH 224) or MTHE 225 (MATH 225) or MATH 226 and MECH 328, or ENPH 211 (PHYS 211) and ENPH 225 (PHYS 225)

MECH 361 Project Based Engineering: Conceive, Design, Implement and Operate W | K3.5

Lecture: Yes
Lab: Yes
Tutorial: Yes
This course provides academic credit for 3rd year students who take a lead role in design and implementation of an engineering device of substantial complexity that is part of a student project. The student has to demonstrate significant involvement with the project during the Fall term and be recommended by an academic advisor in order to qualify and be approved by the course coordinator. Students who are permitted to take this course will be required to "conceive, design, implement and operate" a sub-system or complete competition entry using the knowledge and skills acquired in earlier courses. Successful course completion will consist of specification of function, analysis, selection of materials and/or components, preparation of working drawings, manufactured prototype, completed with a major report and poster presentation. The evaluation will be based on joint assessment by the project academic advisor and the course coordinator.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 42

PREREQUISITE(S): Completion of 2nd Year and permission of the course coordinator upon the recommendation by the academic advisor.

MECH 370 Principles of Materials Processing F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The basic mechanisms of mass transport and phase transformations in materials are developed from thermodynamic and kinetic principles. Topics include phase equilibria, diffusion, solidification and solid-state transformations. The application of these phenomena to materials processing methods, such as casting, forming, heat treatment and sintering is described.

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0
Engineering Studies 24
Engineering Design 0

PREREQUISITE(S): MECH 270 or MECH 271

MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Fracture Mechanics are developed to explain crack propagation in materials and structures. This includes development of the strain energy release rate (GIC) and the critical stress intensity factor (KIC). Emphasis will be placed on developing the correlation between microstructure control and the resistance to crack propagation which this variable produces. Dislocation theory will be evoked to analyse the stress fields of point, line and plane defects. Plasticity and fracture will be detailed, which includes the time dependent aspects of such processes as static fatigue and creep fracture.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Studies 20
Engineering Design 11

PREREQUISITE(S): MECH 270 or MECH 271

MECH 391 Deleted - Technical Communication - Advanced |

This course provides advanced instruction and practice in effective technical writing (individual and team writing) and editing. Some exercises will be linked to required technical communication tasks in other courses. Open to Mechanical and Materials Engineering students only. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 292 or MECH 290

MECH 393 Biomechanical Product Development F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course focuses on design, manufacturing and product management of various implantable biomechanical devices, such as artificial joints, ligaments and various other external devices for persons with disabilities. Some aspects, such as the determination of the geometry and different sizes for artificial joints are product specific, while safety criteria, standards, rational choice of alternatives, design procedures and product management are applicable when designing a much larger variety of products. Much of the theory will be based on examples of artificial joints, and on external devices and instruments.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0

Engineering Studies 18
Engineering Design 24

MECH 396 Mechanical and Materials Engineering Laboratory I F | K2

Lecture: Yes
Lab: Yes
Tutorial: No
This is the first of two laboratory courses in the third year of the Materials Option of the Mechanical Engineering program. Lecture topics and course assignments are selected to provide the background required to undertake the laboratory work. Approximately half of the material is common with MECH 398.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 0

PREREQUISITE(S): Completion of 2nd year or permission of the instructor.
COREQUISITE(S): MECH 370
EXCLUSION(S): MECH 398

MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

Lecture: Yes
Lab: Yes
Tutorial: No
This is the second of two laboratory courses in the third year of the Materials Option of the Mechanical Engineering program. Lecture topics and course assignments are selected to provide the background required to undertake the laboratory work. Approximately half of the material is common with MECH 399.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 0

PREREQUISITE(S): Completion of 2nd year or permission of the instructor
COREQUISITE(S): MECH 371
EXCLUSION(S): MECH 399

MECH 398 Mechanical Engineering Laboratory I F | K2

Lecture: Yes
Lab: Yes
Tutorial: No
This is the first of two laboratory courses in the third year of the General Option of the Mechanical Engineering program. Lecture topics and course assignments are selected to provide the background required to undertake the laboratory work. Lab modules from MECH 396/MECH 397/MECH 399 completed but not counted for credit may be included for credit in this course.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 0

PREREQUISITE(S): Completion of 2nd year or permission of the instructor.
EXCLUSION(S): MECH 396

MECH 399 Mechanical Engineering Laboratory II W | K2

Lecture: Yes
Lab: Yes
Tutorial: No
This is the second of two laboratory courses in the third year of the General Option of the Mechanical Engineering program. Lecture topics and course assignments are selected to provide the background required to undertake the laboratory work. Lab modules from MECH 396/MECH 397/MECH 398 completed but not counted for credit may be included for credit in this course.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 0

PREREQUISITE(S): Completion of 2nd year or permission of the instructor.
EXCLUSION(S): MECH 397

MECH 420 Vibrations W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Considers mechanical vibration, the problems it presents and the means of dealing with it. Completes the treatment of systems with two degrees-of-freedom (introduced in MECH 328) and proceeds to systems with higher number of degrees-of-freedom. Co-ordinate systems, types of coupling, matrix formulation, vibration absorbers and dampers, specific and hysteretic damping, Rayleigh's method, torsional vibration, Holzer method, introduction to the finite element method, beam vibration.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 29
Engineering Design 13

PREREQUISITE(S): MECH 328 or ENPH 211 (PHYS 211) and ENPH 225 (PHYS 225)

MECH 423 Introduction to Microsystems F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course will deal with the practical engineering aspects of micro-machining technologies and microsystems. The contents will include: scaling issues, microfabrication technologies and production methods, classification and analysis of Microsystems (including microsensors, microactuators, RF switches, micromirrors, and other micromechanisms), the integration of devices into Microsystems (both assembly and interfacing). Micro-machining will be compared and contrasted to both micro-electronics and traditional macro-machining. The development and use of Microsystems simulation and design tools will be covered as well.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 25
Engineering Design 17

MECH 424 Sustainable Product Design W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course deals with sustainable product design and manufacture. Topics include: product Life Cycle Analysis issues; Streamlined Life Cycle Analysis and international Life Cycle Analysis standards; Energy, Global Warming Potential, Green House Gas and carbon emission issues (including energy needs in product design and manufacturing); Carbon footprint, basic chemistry of carbon emissions, international standards for carbon emissions signatures. Design topics include: product design for manunfacture and assembly, design for disassembly and design for environment. Product end-of-life considerations include: recycling, remanufacture and reuse. Students will complete several open ended projects. Guest speakers will be included where possible.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 42

PREREQUISITE(S): MECH 323 or permission of the instructor

MECH 430 Thermal Systems Design F | 4

Lecture: 3
Lab: 0
Tutorial: 1
This course is concerned with the technical, economic and environmental aspects of conventional and novel methods of energy supply and use. Emphasis will be placed on the analysis and design of thermal systems. Topics include: electric utility demand and supply; the analysis of thermal power generation systems including combined cycle and cogeneration plants; emission control; alternative energy systems. A group project related to the design of a thermal system will form a significant portion of this course. NOTE: Limited enrollment.

Academic Units:
Mathematics 0
Natural Sciences 0

Complementary Studies 0
Engineering Studies 24
Engineering Design 24

PREREQUISITE(S): MECH 330, or permission of the instructor

MECH 435 Internal Combustion Engines W | 3.5

Lecture: 3
Lab: 0.08
Tutorial: 0.42
This course covers all aspects of the design and operation of internal combustion engines. Principles of thermodynamics and fluid mechanics are used in the analysis of internal combustion engines. Course content includes discussions on both spark ignition and compression ignition (diesel) engines with special emphasis placed on new engine technologies. Intake, in-cylinder and exhaust flows are considered along with various aspects of combustion phenomenon relevant to engines. This course includes a laboratory involving engine performance measurements made using a dynamometer.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 12

PREREQUISITE(S): MECH 230 or CHEE 210

MECH 439 Turbomachinery F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Fluid mechanics and thermodynamics applied to turbomachines; dimensionless performance characteristics; momentum and energy equations; thermodynamics and efficiencies; cascade aerodynamics; compressors and turbines, reaction and stage loading; radial equilibrium; radial flow machines; application of generalized performance to choice of compressors; mechanical details and auxiliary systems.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

PREREQUISITE(S): MECH 330, MECH 341, or permission of the instructor

MECH 441 Fluid Mechanics III W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Topics will include: Derivation of equations of motion for incompressible fluids; exact solutions for laminar flows;

stability and transition; introduction to turbulence, including turbulent boundary layers, jets, wakes and mixing layers; drag reduction; introduction to the modelling of turbulence.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

PREREQUISITE(S): MECH 341

MECH 444 Computational Fluid Dynamics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course provides an overview of, and hands-on experience in, the numerical modelling of fluid flows. Finite volume, finite difference and finite elements methods are introduced. Students are expected to gain critical insight into the capabilities and limitations of fluid flow models by numerically simulating various engineering flows and by doing a term project. Topics include: comparison of numerical, experimental and analytical methods in fluid mechanics, numerical grids and their generation, flow equations and their discretization, solution techniques, turbulence modelling and data presentation. Features of commercial codes are critically reviewed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 12

PREREQUISITE(S): MTHE 272 (MATH 272) or ENPH 213 (PHYS 213), MECH 341

MECH 448 Compressible Fluid Flow F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Introduction and review of work done in earlier courses; basic equations for one-dimensional compressible flow; isentropic one-dimensional flow; steady and unsteady normal shock waves; oblique shock waves; steady and unsteady expansion waves; two-dimensional isentropic flow; nozzle flows; effects of friction and heat transfer; boundary layer flow; design of aircraft engine intake systems; design of supersonic wind-tunnels and shock tubes.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 31
Engineering Design 11

PREREQUISITE(S): MECH 341

MECH 452 Mechatronics Engineering F | 4

Lecture: 2
Lab: 2.5
Tutorial: 0.5
This is a course in mechatronic systems design. Mechatronics Engineering, an integration of computer, electrical and mechanical engineering, is studied in a seris of workshops that focus on electronics, microcontrollers, programmable logic controllers and mobile robots. The lectures provide the theoretical background to the workshops, and include discussion of related industrial and commercial applications. The knowledge and experience gained in the lectures and workshops is applied to a team design project.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 30

PREREQUISITE(S): ELEC 252 or ELEC 310 or ENPH 333 or ENPH 334, and MECH 350 or MTHE 332, and permission of the instructor

MECH 455 Computer Integrated Manufacturing W | 3.5

Lecture: 2
Lab: 1.5
Tutorial: 0
The course will focus on the integration of facilities (machine tools, robotics) and the automation protocols required in the implementation of computer integrated manufacturing. Specific concepts addressed include flexible manufacturing systems (FMS); interfaces between computer aided design and computer aided manufacturing systems; islands of automation.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 21
Engineering Design 21

MECH 456 Introduction to Robotics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course will cover the following topics in the field of robotics: historical development; robot components (sensors, actuators, and end effectors, and their selection criteria); basic categories of robots (serial and parallel manipulators, mobile robots); mobility/constraint analysis; workspace analysis; rigid body kinematics (homogeneous transformation, angle and axis of rotation, Euler angles, roll-pitch-yaw angles, cylindrical and spherical coordinates); manipulator kinematics and motion trajectories (displacement and velocity analyses, differential relations, Jacobian matrix); non-redundant and redundant sensing/actuation of manipulators; manipulator statics (force and stiffness); singularities; and manipulator dynamics.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0

Engineering Studies 21
Engineering Design 21

PREREQUISITE(S): MECH 350 or MTHE 332 (MATH 332) or ELEC 443 or permission of the instructor
EXCLUSION(S): ELEC 448

MECH 458 NOT OFFERED THIS YEAR - Machine Condition Monitoring and Fault Diagnostics F | 3.5

Lecture: 3
Lab: 0.17
Tutorial: 0.33
The primary objective of this course is to introduce students to the dynamic behaviour of rotating machinery (but other machinery classes will also be included) and to discuss appropriate fault and mechanical deterioration detection and diagnostic criteria and schemes for various applications. Emphasis will be placed on the application of vibration based methods of data acquisition and analysis techniques. There will be a laboratory component that will provide the students with demonstrations and the opportunity to collect and analyze vibration data from a set of mechanical fault simulators. Topics will include, but not be limited to; basic maintenance philosophies and strategies, vibration signal measurement and recording instrumentation, dynamic signal analysis and display, vibration level standards, rotating machinery balancing, shaft alignment, rolling element and journal bearing faults, gear wear detection and case studies. Correlation of infra-red thermography, oil analysis and other methods of fault detection and diagnostic techniques with vibration based methods will also be discussed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 28
Engineering Design 14

PREREQUISITE(S): MECH 328 or ENPH 321 (PHYS 321)

MECH 460 Team Project - Conceive and Design F | K4

Lecture: Yes
Lab: Yes
Tutorial: Yes
Students working in teams will be required to "conceive and design" a product, system or process using the knowledge and skills acquired in earlier courses. Elements of the design will include: specification of function, analysis, selection of materials and/or components, preparation of working drawings, cost analysis and tenders, and preparation of preliminary design report. A research project may be accepted as an engineering design project provided it can be clearly shown that the elements of "conceive and design" are fulfilled in the completion of the project. Lectures and Guest Speakers will focus on related professional skills and topics including engineering ethics, professional organizations and legislation, intellectual property and information systems in support of the project.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 48

PREREQUISITE(S): MECH 321, MECH 323, MECH 328, MECH 346 and MECH 350, or permission of the instructor
COREQUISITE(S): MECH 464

MECH 461 Research Project W | K4

Lecture: Yes
Lab: Yes
Tutorial: Yes
This course provides an opportunity for students to work individually on an engineering research project with staff members of the Department. The topic is selected by the student in consultation with a Department supervising faculty member by the end of the Fall term. The projects are laboratory-based to be completed by the end of the Winter term with a major report and presentation of the work.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 48
Engineering Design 0

PREREQUISITE(S): Completion of 3rd Year

MECH 462 Team Project - Implement and Operate W | K3.5

Lecture: Yes
Lab: Yes
Tutorial: Yes
This course is intended to enable team projects that started in MECH 460, to continue to the "implement and operate" phases of the design cycle. However, new projects can be the subject of MECH 462 as long as they meet the "implement and operate" objectives of the course. An engineering report is prepared and defended. The presentation is normally supported by a working prototype or physical mock-up of the design. Testing a process or system can replace the building of a prototype.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 42

PREREQUISITE(S): MECH 460 and permission of instructor

MECH 463 Engineering Project for International Students F/W | 2

Lecture: 0
Lab: 2
Tutorial: 0
This course is for students registered at a university outside Canada who wish to do a term at Queen's to satisfy the requirements of their home university. The student will work with a professor who has agreed to act as a supervisor. The time frame and requirements for course completion will be agreed upon by the supervising professor at Queen's, and a faculty member of the university for which the student is fulfilling the work term requirement.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 24

MECH 464 Communications and Project Management F | 1.5

Lecture: 0.75
Lab: 0
Tutorial: 0.75
This course provides advanced instruction and practice in technical communication and project management for multidisciplinary engineering projects. Content includes request for proposals, project planning and proposal writing, quality function deployment, oral presentation skills, client communications and concise report writing. Course deliverables are closely tied to deliverables in Capstone design courses. Open to Mechanical and Materials Engineering students only.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 18
Engineering Studies 0
Engineering Design 0

COREQUISITE(S): MECH 460 or permission of the instructor

MECH 465 Computer-Aided Design F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Concept of computational design including the choice of the objective function, equality and inequality constraints, and analysis methods; one-dimensional search methods, sensitivity analysis, and the steepest descent method. The principles of the finite element method and its application to stress analysis of mechanical components. NOTE: Enrolment is limited.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 11
Engineering Design 31

PREREQUISITE(S): Permission of the instructor

MECH 470 Deformation Processing W | 3.5

Lecture: 3
Lab: 0.17
Tutorial: 0.33
This course focuses on the elastic-plastic deformation of metals as it relates to the fabrication of stock materials, the

manufacture of components and in-service material performance. Methods for describing and analyzing elastic-plastic behaviour, at both macroscopic and microscopic length-scales, are presented. Additional topics include the measurement and prediction of forming limits, the effects of deformation rate and temperature on plastic flow, and mechanisms of ductile failure. In the final portion of the course, the concept of microstructural design is introduced and then reinforced through a series of case studies.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 12

PREREQUISITE(S): MECH 371

MECH 474 Deleted - Functional Ceramics |

This course is designed to provide an understanding of the relationship between composition, defect structure and electrical and thermal properties of functional ceramics. Emphasis is placed on the mechanisms of conduction in insulators, semiconductor ceramics and fast ionic conductors. The origin of ferroelectricity and piezoelectricity is presented for isotropic and anisotropic materials using tensors and matrix notations. Several ceramic systems and related devices are presented, including electronic and ionic conductors, ferroelectrics and dielectric materials. The design and operation of modern electrical/electronic devices, such as solid oxide fuel cells, varistors and smart structures, are discussed in detail. The breadth and importance of this class of ceramics in modern electronic industries are reviewed. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 12

PREREQUISITE(S): MECH 370

MECH 475 Deleted - Structural Ceramics |

The course deals with processing, structure and properties of advanced ceramics possessing a combination of properties not found in other classes of materials. Emphasis is placed on understanding the brittle nature of ceramics through the concept of linear-elastic fracture mechanics. The relationship between microstructure (eg. grain size, porosity and phase content) and mechanical properties (eg. strength, toughness and hardness) is developed using crack opening displacement analysis. The role of anisotropy and residual stresses in the development of high strength ceramics and structures is also discussed. Different mechanisms for the sintering of advanced structural ceramics are also covered along with forming and densification of high performance carbides, nitrides and oxides. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 28
Engineering Design 14

PREREQUISITE(S): MECH 371

MECH 476 Engineering of Polymers and Composite Materials W | 3.5

Lecture: 3
Lab: 0.25
Tutorial: 0.25
This course introduces the microstructure-property-processing relationships needed to understand the applicability of polymers and composites to engineering design. The courses start with an introduction to the structure and properties of different polymers. The mechanics of polymers are covered including elasticity, rubber elasticity, pressure dependent yield and viscoelasticity. The mechanics of composites depend not only on the matrix, but also on the reinforcing phase. While focussing on polymer composites, metal and ceramic-based composites will also be introduced. Topics covered will include the influence of the interface, mechanical and transport properties and design of composites. The final goal is to correlate constitutive relations describing the time-temperature dependence of mechanical properties of polymers and composites to microstructure and linking these relations to practical design.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 18

PREREQUISITE(S): MECH 370, MECH 371

MECH 478 Biomaterials F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introduction to the structure, properties and performance of biomaterials used for the construction of medical devices. Examples of biomaterials are bioactive ceramics, biodegradable polymers and advanced titanium-based alloys used for the construction of orthopedic implants. Topics covered will include surface and bulk properties of biomaterials and their impact on the clinical performance of implants. Discussion will focus on tissue-biomaterials interactions, biocompatibility and biodegradation. The course will also cover the current in-vitro and in-vivo testing methods for evaluating the long-term performance of biomaterials.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 11
Engineering Design 31

MECH 479 NOT OFFERED THIS YEAR - Nano-Structured Materials F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The majority of conventional materials have grain or crystallite sizes ranging from micrometers to several millimeters. Capabilities now exist to synthesize materials with grains where one or more dimension is on the nanoscale (less than

100 nm). As the grain size decreases, there is a significant increase in the volume fraction of grain boundaries or interfaces. This characteristic strongly influences the chemical and physical properties of the materials. For example, nanostructured ceramics are tougher and stronger than coarser grained ceramics, while nanostructured metals exhibit increases in yield strength and elastic modulus. It has also been shown that other properties (e.g. electrical, optical and magnetic) are influenced by a fine grain structure. The goal of this course is to introduce the student to the impact of length scale, from millimeter to nanometer, on material properties, with a primary but not exclusive focus on mechanical properties. It will include discussions on synethesis approaches as well as examples of applications.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Studies 20
Engineering Design 11

PREREQUISITE(S): MECH 370, MECH 371

MECH 480 Airplane Aerodynamics and Performance W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A technical course on the principles of flight. Techniques for the quantitative prediction of the aerodynamic characteristics of the wing will be described. Extensions to account for real-world effects will be discussed. These results will be used to predict the airplane performance (range, climb rate, maximum speed, etc.) The concept aerodynamic stability will be introduced and discussed. Students are expected to know MATLAB proficiently and have fluids knowledge typically acquired in MECH 241 and MECH 341. Those who have not taken these or similar courses will need to prepare through self study.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

MECH 481 Wind Energy F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introductory course on wind-turbine operation and aerodynamics. Topics include: the Betz limit; the Blade Element Momentum method; characteristics of the atmospheric boundary layer; unsteady aerodynamic theory; gusts and blade aeroelasticity; blade noise and health effects; and wind-park siting and planning. Extension of some of these topics to small wind turbines, run-of-the-river water turbines and off-grid systems will also be presented. Students are expected to have sufficient experience with fluid dynamics equivalent to MECH 341. Those who have not taken such a course will need to prepare through self-study.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0

Engineering Studies 42
Engineering Design 0

MECH 482 Noise Control W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introduction to the principles of noise control. Topics include: basic properties of sound and noise, the measurement of noise, effects of noise on people, description of sound fields, acoustics of rooms and enclosures, acoustical materials and structures, and noise source identification. A coherent approach to the solution of noise control problems is stressed throughout the course.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 25
Engineering Design 17

MECH 483 Nuclear Materials W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A nuclear reactor presents a unique environment in which materials must perform. In addition to the high temperatures and stresses to which materials are subjected in conventional applications, nuclear materials are subjected to various kinds of radiation which affect their performance, and often this dictates a requirement for a unique property (for example, a low cross section for thermal neutron absorption) that is not relevant in conventional applications. The effects of the radiation may be direct (e.g., the displacement of atoms form their normal positions by fast neutrons or fission fragments), or indirect (e.g., a more aggressive chemical environment caused by radiolytic decomposition). This course describes materials and structures typically used in nuclear environments, their manufacture, the unique conditions to which they are subjected, the basic physical phenomena that affect their performance and the resulting design and operational requirements for reactor components. The course includes a field trips to components manufacturers and to Canada's national nuclear research laboratory.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Studies 20
Engineering Design 11

PREREQUISITE(S): MECH 370, MECH 371

MECH 484 Introduction to Ceramics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introduction to the processing, structure and properties of advanced ceramics used for the design of components in electronic, automotive, aerospace, energy, mining and chemical and petrochemical industries. The emphasis is placed

on understanding the relationship between microstructure and mechanical, electrical and thermal properties of ceramics. Ceramic systems and related devices which are discussed include electronic and ionic conductors, capacitors, transducers, varistors, and dielectric substartes. The effect of porosity, grain size and residual stresses on strength, elastic and fracture properties of isotropic and anisotropic ceramics is also discussed. Material transport mechanism and sintering of powder ceramics materials is covered with recent examples of forming and sintering of oxides, carbides and nitrides.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 30
Engineering Design 12

PREREQUISITE(S): MECH 370 and MECH 371

MECH 492 Biofluids W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course presents some of the applications of fluid mechanics in human biomechanical systems. The course centres on the human circulatory and respiratory systems. Topics covered will include: blood flow in the heart, arteries, veins and microcirculation; air flow in the lungs and airways; mass transfer across the walls of these systems. Experimental tools for use in biomedical applications will be emphasized. Students are expected to have experimental and fluids knowledge typically acquired in MECH 215/MECH 241/MECH 341. Those who have not taken these or similar courses will need to prepare through self study. First offering 2009/2010.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 42
Engineering Design 0

MECH 494 Kinematics of Human Motion F | 3.5

Lecture: 2
Lab: 1
Tutorial: 0.5
In this course students will explore the application of classical mechanics to the analysis of human motion related to athletics, orthopaedics, and rehabilitation. The course covers the structure of human joints, including experimental and analytical techniques in the study of human joint kinematics; applications to the design of artificial joints and to clinical diagnosis and treatments. Students are introduced to the motion capabilities of the human body and how to develop and study kinematic models of the individual joints of the human body. Experimental methods used to collect kinematic data will be studied through interactive labs. Topics include defining body position and displacement, three dimensional representation of human motion, basic functional anatomy of individual joints, rigid body kinematics (homogeneous transformations, Euler angles, helical axis), intrajoint kinematics, joint modelling, articular surface motion. Three-dimensional kinematics of individual joints is emphasized from the perspective of total joint replacement design.

Academic Units:
Mathematics 0

Natural Sciences 0
Complementary Studies 0
Engineering Studies 12
Engineering Design 30

PREREQUISITE(S): MECH 393 or permission of instructor

MECH 495 Ergonomics and Design W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course provides an overview of ergonomic problems that are addressed in engineering design; including biomechanical, physical and physiological issues. Case studies will range from the design of vehicle cockpits to process control rooms, from industrial manual materials handling tasks to human directed robots, and from domestic tools to biomechanical devices.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 42

PREREQUISITE(S): MECH 323 or permission of the instructor

MECH 496 NOT OFFERED THIS YEAR - Musculoskeletal Biomechanics F | 3.5

Lecture: 2
Lab: 1
Tutorial: 0.5
Introduction to musculoskeletal biomechanics, including experimental and analytical approaches to movement analysis, experimental instrumentation and devices, and biomechanical devices for musculoskeletal disorder rehabilitations. Analysis of the contribution of external loading, forces generated by muscles and constraints provided by other musculoskeletal structures to predict forces and stresses in musculoskeletal joints and tissues. Numerical and modelling approaches, including inverse dynamics, and optimization, and determination of segmental inertial properties. Biomechanical devices including upper limb and lower limb orthotics and prosthetics. Applications in orthopaedic engineering, movement assessment, ergonomics, joint injury and replacements, and biomechanical system design.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 20
Engineering Design 22

PREREQUISITE(S): CIVL 220 or MECH 221, MECH 328, MECH 393 or permission of the instructor

Mining Engineering

MINE 201 Introduction to Mining and Mineral Processing F | 4

Lecture: 3
Lab: 0
Tutorial: 1
This course presents and overview of all aspects of mining from exploration, financing, development and mining operations. Underground and open pit mining are contrasted. Mineral processing systems for the production of gold, diamonds, copper, nickel, zinc and iron will be studied. Topics include decision-making process related to world market commodity pricing, mine planning and design, mining equipment, blasting and environmental considerations. Concepts of sustainability from economic, social and environmental perspective will be explored. Case studies, a major field trip and related assessment will be used to illustrate principles taught and how they are applied in a practical situation.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 36
Engineering Design 0

PREREQUISITE(S): must be enrolled in Mining Engineering, or permission of instructor

MINE 202 Computer Applications and Instrumentation in Mining F | 1.5

Lecture: 0
Lab: 1.5
Tutorial: 0
This lab applies commonly used computer applications to mining engineering problems and conducts experiments with instrumentation used in surface and underground mining and mineral processing. A major field trip in conjunction with MINE 201 will be used to illustrate principles taught and how they are applied in mining operations.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 12
Engineering Design 6

COREQUISITE(S): MINE 201

MINE 244 Underground Mining W | 3

Lecture: 3
Lab: 0
Tutorial: 0
A study of underground mining technology with special reference to economic optimization in both design and production. Conventional and up to date mining methods are reviewed. Developments and trends in mining methods are closely analyzed. Mine design is studied in relation to ore reserves, tonnage and grade distribution, equipment with emphasis on the growing importance of maintenance on underground machinery and capacities of various production units. Development and production costs associated with mining are an inherent aspect of this course. The problems and possibilities of existing and evolving mining techniques are reviewed.

Academic Units:
Mathematics 0
Natural Sciences 0

Complementary Studies 0
Engineering Studies 16
Engineering Design 20

PREREQUISITE(S): MINE 201

MINE 262 Deleted - Engineering Surveying S | 3.5

Lecture: 1.5
Lab: 0
Tutorial: 2
This introductory course in plane surveying consists of about 16 hours of lectures, the rest of the time being spent in the field. Lecture material includes distance measurement, differential, profile and indirect leveling and use of transit, traversing and mapping. Errors, corrections and balancing are also discussed. The use of available software packages for the reduction and calculation of data is encouraged throughout the course. In the field, students practice the basic techniques of instrument use through various assignments. Careful and efficient handling of instruments and proper note-keeping are stressed. The use of state-of-the-art electronic surveying instruments is included in the field assignments wherever possible. The school is held on campus immediately following the final First Year examination in April. - COURSE DELETED 2013-2014

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 40
Engineering Design 0

PREREQUISITE(S): Must be enrolled in Mining Engineering
EXCLUSION(S): CIVL 211

MINE 267 Applied Chemistry for Mining W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course provides an overview of the chemistry of inorganic and organic compounds used in the practice of mining and mineral processing including hydro-and pyro-extractive methods. Chemistry and chemical interactions for selected reagent formulations used in blasting, flotation/flocculation, leaching/precipitation, solvent extraction/electrowinning and pollution control technologies are outlined with relevant stoichiometry. Mineral stability and its relevance to metal extraction is discussed. Unary, binary and ternary phase diagrams are explored. The properties of solutions of interest are reviewed.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 30
Engineering Design 0

PREREQUISITE(S): APSC 131
COREQUISITE(S): MINE 268 or permission of the instructor

MINE 268 Analytical Methods in Mining W | 1

Lecture: 0
Lab: 1
Tutorial: 0
This course exposes the students to the analytical techniques utilized in the mining and the mineral processing industries. The first part of each laboratory includes the principles of the analytical technique while the second part is concerned with the practical use of the technique. The analytical techniques are typical of those of analytical groups in most mining companies. The techniques studied include: sampling, digestion, Atomic Absorption Spectroscopy, Induction Coupled Plasma Spectroscopy, X-Ray Diffraction and fire assay. Safety in handling of hazardous chemicals is emphasized with a review of selected Material Safety Data Sheets and industry standards.

Academic Units:
Mathematics 0
Natural Sciences 3
Complementary Studies 0
Engineering Studies 9
Engineering Design 0

PREREQUISITE(S): APSC 131
COREQUISITE(S): MINE 267

MINE 307 Front Line Supervision W | 1.5

Lecture: 1.25
Lab: 0
Tutorial: 0.25
This short course provides some basic tools which will help engineering graduates when they are placed in supervisory positions in industry. The material is generic in nature and examples cover various aspects of mining (production, maintenance, mill, engineering and administration), for both surface and underground operations. Topics include: Discovering a commonality among supervisors and their key role in maintaining standards. The importance of sharing information and expectations about costs, production goals and business objectives are explored in the context of motivation. The necessity of successful communication skills and techniques are discussed and demonstrated to achieve behaviours on the job, producing consistent results. A reliable methodology for handling difficult situations is provided. The fundamental rationale for safety and loss control is presented as well as a relevant perspective on management structure. A workable code of conduct that is a guide to professional behaviour is developed. Students will be graded on a Pass/Fail system. Offered as an intensive 2 day short course in the winter term.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 18
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): Must be registered in Mining Engineering

MINE 321 Drilling and Blasting F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
This course deals with the principles of commercial explosives technology and the application of blasting in mining and construction. The planning, design, economic considerations and trends of drilling and blasting practices in the different segments of the mining and construction industries are considered. Topics covered are detonation theory,

performance and sensitivity of explosives, fragmentation prediction measurement and control, vibrations from blasting, air blast, damage and special blasting techniques used in perimeter blasting and blast design methods.

Academic Units:
Mathematics 0
Natural Sciences 14
Complementary Studies 0
Engineering Studies 40
Engineering Design 0

PREREQUISITE(S): MTHE 367 or CHEE 209

MINE 324 Hydraulics for Mining Applications W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The fluid mechanics basic to fluid hydraulic systems used in the mineral industry are introduced. Topics covered include properties of fluids, fluid statics and its application to mining. Hydrodynamic studies include the energy balance and Bernoulli's equation, energy losses in incompressible flow, the momentum equation and its application, and flow and pressure measuring devices. Flow in closed conduits, including series and parallel pipeline systems and pipe networks, is studied in detail and open channel flow is introduced. Applications include industrial pumps, sump design, hydraulic structures, underground mine dewatering systems, open pit mine drainage systems, and mine backfill and mine tailings transportation.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 30
Engineering Design 0

PREREQUISITE(S): MTHE 225 and MECH 230

MINE 325 Applied Rock Mechanics W | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
Elastic prototypes are developed to investigate stress conditions around mine openings. Failure theories are discussed and used to explain fracture patterns. Stereographic methods of three dimensional analysis are introduced. The presence of fault and joint development in large rock masses dictates the use of broader engineering methods than those based entirely on idealized conditions. Techniques based on empirical knowledge and supported by available theory are presented, including slope stability, open pit design, tunnels, underground structural design, rock foundations, ground water, rock bursts and bumps, and design hazards. Various instrumentation of interest is discussed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 54
Engineering Design 0

PREREQUISITE(S): CIVL 230 and MINE 202 or permission of the instructor

MINE 326 Operations Research W | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
The course deals with the application of operations research methods in engineering with emphasis on mining applications. Topics covered are linear programming, optimization methods, transportation and network models, discrete optimization, non linear optimization, decision tree methods, simulation and elements of geostatistics as applied to mining. Lab sessions also deal with forecasting techniques, regression analysis, dispatch problems, planning and scheduling.

Academic Units:
Mathematics 20
Natural Sciences 0
Complementary Studies 0
Engineering Studies 14
Engineering Design 20

PREREQUISITE(S): APSC 142 or permission of the instructor

MINE 330 Mineral Industry Economics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course for students in Mining Engineering and allied disciplines will apply basic principles of economic evaluation learned in APSC 221 to the minerals industry. Topics covered include: the project definition and economic evaluation process; economic analysis tools and techniques; taxation; inflation; cost estimation; the nature of mineral supply and demand; mineral commodity markets and pricing; uncertainty and risks associated with the mining industry, their analysis and incorporation into the evaluation process. Assignments, examples, and tutorials reflect a variety of situations and challenges faced in the evaluation of exploration and mine development opportunities, as well as important applications to mining and mineral processing design and decision-making.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 42
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 221, must be enrolled in Mining Engineering or they must have or the permission of the instructor (or department)

MINE 331 Methods of Mineral Separation F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
Mineral separation processes of a physical and physicochemical nature are studied with laboratory sessions. Topics

include size reduction, classification, flotation, flocculation, gravity concentration, magnetic, electrostatic separations and dewatering. Surface phenomena involving fine particle processing, reagent classifications, flotation machines and circuits, plant practice in ore flotation are discussed. The laboratory practice includes a design project on flotation circuit analysis and sizing. Assignments will be completed based on field trip observations.

Academic Units:
Mathematics 0
Natural Sciences 14
Complementary Studies 0
Engineering Studies 25
Engineering Design 15

PREREQUISITE(S): MINE 201 and MINE 267 or permission of the instructor

MINE 338 Deleted - Mine Ventilation |

Hydraulics of air flow through mine openings and ducts is first studied, leading to mine ventilation design calculations and ventilation network analysis. The engineering design, testing, selection and application of mine ventilation fans are studied in detail. Topics related to the design of mine ventilation systems include: statutory regulations and engineering design criteria, ventilation circuit design, natural ventilation, auxiliary ventilation design, psychometry, mine air heating and cooling, dust and fume control, and ventilation economics. Health hazards of mine gases, dust and radiation are reviewed, together with statutory requirements for air quality. Procedures for conducting air quantity, pressure and air quality surveys are also taught. - COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Studies 24
Engineering Design 0

MINE 339 Mine Ventilation F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
Hydraulics of air flow through mine openings and ducts is first studied, leading to mine ventilation Hydraulics of air flow through mine openings and ducts is studied, leading to mine ventilation design calculations and ventilation network analysis. Topics related to the design of mine ventilation systems include: statutory regulations and engineering design criteria, ventilation circuit design, natural ventilation, testing, application and selection of mine ventilation fans, auxiliary ventilation design, psychrometry, mine air heating and cooling, dust and fume control, and ventilation economics. Health hazards of mine gases, dust and radiation are reviewed, together with statutory requirements for air quality. Procedures for conducting air quantity and quality surveys are also taught.

Academic Units:
Mathematics 0
Natural Sciences 14
Complementary Studies 0
Engineering Studies 40
Engineering Design 0

PREREQUISITE(S): MTHE 225 and MECH 230

MINE 341 Open Pit Mining F | 4.5

Lecture: 3
Lab: 0
Tutorial: 1.5
This course presents technologies and techniques employed in open pit mining with a focus on strategic and operations planning considerations. Topics of study include: pit design, application of algorithms for economic pit limit analysis, equipment selection, production scheduling, material control and reconciliation, remote sensing and geomatics applications, mine waste management, emerging trends in open pit mining, and mine safety. Regulatory controls and best practices in design are stressed for all stages of the mine life cycle. Environmental impacts of design decisions and mitigating strategies are explored. The use of software at various stages of the design and planning process is introduced and a strategic design project completed using commercial software applications.

Academic Units:
Mathematics 14
Natural Sciences 0
Complementary Studies 0
Engineering Studies 16
Engineering Design 24

PREREQUISITE(S): APSC 221 and MINE 201, or permission of instructor

MINE 422 Mining and Sustainability F | 4

Lecture: 4
Lab: 0
Tutorial: 0
This course describes the evolution of policies, operational procedures and management systems related to sustainability and the social, economic, environmental, ethical, and technical design challenges facing the mining industry. Themes examined will include: international and national performance expectations, standards and regulations; operational and management responses – social and environmental impact risk assessment; stakeholder engagement; impact mitigation planning and risk management systems; performance monitoring, evaluation and reporting; agreement making and benefit sharing. Students will be introduced to a range of complex situations with significant sustainability implications that need to be addressed responsibly during the life cycle of a mine, such as land acquisition, population and livelihood displacement, cultural heritage and habitat preservation, water use, waste disposal, mining-community relationships, mine closure and its community and environmental implications.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 24
Engineering Studies 12
Engineering Design 12

MINE 434 Project Report F/W | 4

Lecture: 1
Lab: 0
Tutorial: 3
In this course, the student is exposed to research in the mining, mineral processing and metal extraction industries. The work is performed under the supervision of a Faculty member. Standing is based on the work done and on the ability of individuals to meet project deliverables according to the schedule provided. The deliverables include; research proposal, research plan and literature review, poster presentation, and final report in the form of a technical paper. The

deliverables can be based on research performed during the fall and winter terms or an extension of a summer employment research project. Emphasis is placed on the critical treatment of the data obtained to produce useful conclusions. Participation in the departmental seminar series once per month is mandatory. Each student should submit a one page précis of the seminar.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 24
Engineering Studies 0
Engineering Design 24

MINE 445 Open Pit Mine Design W | 5.5

Lecture: 1
Lab: 3
Tutorial: 1.5
The material of MINE 341 is applied to the design of an open pit mine. Special attention is given to the selection of equipment and the use of computers in strategic and detailed mine planning and scheduling. The course uses commercial mine planning software to enable small groups of students (2-4) to complete mine designs starting with topography maps, drill information, and mineral inventory block models. Several real deposit databases are used including gold, copper, copper/molybdenum, copper/zinc. The deposits are evaluated, feasibility assessed, and production decisions discussed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 20
Engineering Studies 0
Engineering Design 46

PREREQUISITE(S): MINE 330 and MINE 341, and either MINE 326 or MINE 467, or permission of the instructor

MINE 448 Underground Design W | 5.5

Lecture: 1
Lab: 1.5
Tutorial: 3
This course provides an opportunity to apply a knowledge of basics to the design of an underground mine. Initial design information may range from diamond-drill assay data to a partially or completely designed mine. The problem of design or renovation entails ground stability, ventilation, systems analysis, equipment selection, maintenance, etc, with safety and economics as the basic criteria for design.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 18
Engineering Studies 0
Engineering Design 48

PREREQUISITE(S): APSC 221, MINE 244, MINE 339, MINE 325, MINE 467 AND MINE 469 or permission of the instructor

MINE 451 Chemical Extraction of Metals F | 3

Lecture: 3
Lab: 0
Tutorial: 0
The recovery and recycling of metals by both hydrometallurgical and pyrometallurgical techniques is discussed. The thermodynamic and kinetic aspects of the solutions utilized in these processes are reviewed. The major unit operations of the hydrometallurgical and pyrometallurgical processes are studied. For hydrometallurgy, the unit operations are; ion exchange, solvent extraction, cementation, purification, precipitation, electrowinning and electrorefining. Particular emphasis will be placed on the recovery of gold. For pyrometallurgy the unit operations are; roasting, agglomeration, calcination, smelting, converting, refining and electrolysis. In the course, the importance of environmental stewardship in metal extraction is stressed.

Academic Units:
Mathematics 0
Natural Sciences 10
Complementary Studies 0
Engineering Studies 16
Engineering Design 10

MINE 455 Design, Analysis and Operation of Mineral Processes F | 4.5

Lecture: 3
Lab: 0
Tutorial: 1.5
The material of MINE 341 is applied to the design of an open pit mine. Special attention is given to the selection of equipment and the use of computers in strategic and detailed mine planning and scheduling. The course uses commercial mine design software to enable small groups of students to complete mine designs starting with topographical maps, exploration drilling information, and mineral inventory block models. Several real deposit databases are used including gold, copper, copper/molybdenum, copper/zinc. The deposits are evaluated, feasibility assessed, and production decisions discussed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 54

PREREQUISITE(S): MINE 330 and MINE 341, and either MINE 326 or MINE 467, or permission of the instructor

MINE 458 Process Investigations W | 4

Lecture: 1
Lab: 3
Tutorial: 0
Projects may involve design of new processes, re-design of existing processes, process simulation and process innovation. Oral presentations and a formal report are required at the end of the term.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0

Engineering Studies 0
Engineering Design 48

PREREQUISITE(S): MINE 455 or permission of the instructor

MINE 459 Reliability, Maintenance, and Risk Assessment F | 4

Lecture: 3
Lab: 0
Tutorial: 1
This course aims to impart the analytical foundations and engineering insights necessary for the reliability analysis, maintenance, and risk assessment of industrial plants and equipment. Case studies are used throughout the course. Topics addressed include: reliability and failure analysis (FMECA, HAZOP); maintenance planning policies and life cycle behaviour; organization of maintenance operations; maintenance management and information systems; condition-based maintenance (CBM); reliability centred maintenance (RCM) and RCMII; reliability growth management in design and test.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 36
Engineering Design 12

MINE 460 Special Topics in Mining Engineering F/W | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
This course will change from year to year as subjects of special interest to mining engineers arise, or as special staff are available.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 27
Engineering Design 27

MINE 462 Occupational Health and Safety in Mining Practice F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Affirms a societal rationale and framework for due diligence in health, safety and environment (HS&E). Considers the five principal categories of workplace environmental factors that may lead to ill health / death, and introduces the principles (strategies and techniques) of exposure assessment (relative to both regulatory and professional standards) and control, as part of the Anticipation-Recognition-Evaluation-Communication-Control sequence. Enables the student to resolve, by means of memorandum, a specific topical occupational health issue. In addition to providing the basic tools for undertaking occupational health risk assessment / management, reviews fundamental chemical (non-toxicological) hazards and risk parameters.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 42
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): Completion of 3rd year Mining Engineering or permission of the instructor.

MINE 467 Geostatistics and Orebody Modelling F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
This course introduces those principals of geostatistics used in evaluating grade distribution in orebodies from drillhole data. Basic concepts of spatial distributions, sampling, distance weighted averages, and variograms are covered. Cases from practice will be employed to illustrate concepts. Use of commercially available software to carry out geostatistical calculations and graphical representation will be made. Utilizing these techniques, students will develop a block model of ore grade distribution for an orebody and then apply this model to a mine pre-feasibility study in a subsequent course.

Academic Units:
Mathematics 16
Natural Sciences 0
Complementary Studies 0
Engineering Studies 14
Engineering Design 24

PREREQUISITE(S): MINE 326, or permission of the instructor

MINE 469 Stability Analysis in Mine Design F | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
Application of rock mechanics principles to mine design. Includes planning and execution of geotechnical investigation programs, empirical and analytical methods of stability analysis and support design. Numerical methods are introduced, with emphasis on how to choose among them for particular applications and how to evaluate results. Instrumentation programs are described. Methods are illustrated using case histories.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Studies 12
Engineering Design 24

PREREQUISITE(S): MINE 325 or equivalent

MINE 471 Mine-Mechanical Design Project W | 5.5

Lecture: 1
Lab: 1.5
Tutorial: 3
This course involves a design project with emphasis on the mechanical aspects of mine or plant design and operation. Typical topics include mobile equipment, materials handling, automation, equipment redesign and systems integration.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 18
Engineering Studies 0
Engineering Design 48

PREREQUISITE(S): Completion of all 2nd and 3rd year courses or permission of instructor.

MINE 472 Mining Systems, Automation, and Robotics OL | K3.5

In order to address issues related to safety, productivity, and remote operations, the world's mineral resources industry has been gradually shifting towards the increased use of automated systems and roboticallyenhanced machines. It is important, therefore, that graduate engineers understand how these new technologies work so as to improve and make best use of them. This online course introduces senior students to the fundamental tools and techniques of automation and robotics as applied to modern mining practice. Enrolment is open to students from a range of engineering disciplines. This course provides an introduction to the basics of systems control, examples of how methods of automatic control can be applied to mining equipment and associated industrial vehicles, as well as to the fundamentals of sensing and navigation as applied to the design of robotic mobile equipment.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 24
Engineering Design 18

PREREQUISITE(S): MECH 350 or MTHE 332 or ELEC 443 or permission of the instructor

Mining Technology

MNTC P01 Engineering Mathematics W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course provides a detailed introduction to the fundamentals of calculus and linear algebra as applied to engineering applications. The purpose of the course is to provide a mathematical foundation for students pursuing upper-year engineering-related courses. The course covers topics such as derivatives, implicit differentiation, partial derivatives, integrals, first-order and higher-order linear ordinary differential equations, fundamentals of Laplace transforms, matrices and matrix inverses, solving systems of linear equations, vector spaces, orthogonality, and determinants. Topics are introduced by way of engineering examples.

Academic Units:

MNTC P02 Mining Geology W | 3

Lecture: 3
Lab: 0
Tutorial: 0
The geology of the Precambrian, Paleozoic, and Cenozoic eras is introduced in this course. Students are introduced to mapping technologies and the 'art' of visualization. Topics include basic geological structures, historical geology, and physical processes such as glaciation. Mineralogy is introduced through the physical properties of minerals.

Academic Units:

MNTC P03 Foundational Mathematics F | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course investigates the properties of polynomial, rational, logarithmic, and trigonometric functions. It develops techniques for combining functions and broadens understanding of rates of change while exploring how functions model real-world contexts.

Academic Units:

MNTC P04 Calculus W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Functions, limits, derivatives; optimization, rate problems, exponentials, logarithms, inverse trigonometric functions; exponential growth as an example of a differential equation. Fundamental Theorem of Calculus, Riemann integral; applications to problems involving areas, volumes, mass, charge, work, etc. Some integration techniques.

Academic Units:

MNTC P05 Foundational Physics W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course introduces new engineering students to Newtonian mechanics, including the concepts of work, energy, and momentum. A focus is given to problems that provide foundations for future technical courses in engineering. Finally, an introduction to simple electric circuits is given, and concepts such as voltage, current, and resistance are studied.

Academic Units:

MNTC P06 Foundational Chemistry F | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course enables students to deepen their understanding of chemistry through the study of the structure and properties of matter, energy changes and rates of reaction, basic organic chemistry, equilibrium in chemical systems, and electrochemistry. Students will further develop their problem-solving and investigation skills as they investigate chemical processes, and this course will refine their ability to communicate scientific information.

Academic Units:

MNTC 301 Technical Writing and Communications F/W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course focuses on the principles and practical applications of academic writing. Students apply effective writing strategies to address a variety of academic audiences. Students plan, outline, write, and revise reader-centered documents and print and electronic texts that relate to forms and contexts they will encounter in academia

Academic Units:

MNTC 302 Engineering Physics F/W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course continues the development of engineering physics topics in mechanics, electricity, and magnetism. In the first module, concepts of stress and strain are introduced, and followed up by normal and shear stresses in beams. Calculations involving displacements focus learnings on deformations and the concept of torque. In the second module, DC circuits are introduced, and after a brief study of magnetic fields, concepts such as inductance, capacitance, and power are studied, leading to the introduction of electric motors. A focus is given to problems that provide foundations for future technical courses in engineering.

Academic Units:

MNTC 303 Engineering Chemistry F/W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course will cover the basic of engineering chemistry, including topics such as stoichiometry and reaction balancing, chemical equilibrium, acid/base reactions, and titration. Then, it will get into details of thermodynamics, including the Three Laws of Thermodynamics, aqueous solution behavior, and gaseous/aqueous face behavior. Finally, the course will get into details of rates of reactions, thermodynamics and kinetics of electrochemical reactions, and organic chemistry. The application of these topics to the mining industry will be explored

Academic Units:

MNTC 304 Applied Metrology and Data Analysis W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
The objective of this course is to offer students an introduction to some of the primary tools and techniques of contemporary instrumentation and analysis. Presented is an introduction to signal analysis, data acquisition, sampling and quantization, as well as the fundamental statistical techniques necessary to process and analyze measured data with uncertainty. The course focuses on applied methods and draws on several examples that demonstrate the use of sensors and data acquisition in mining

Academic Units:

MNTC 305 Introduction to Mining and Mineral Processing F/W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course presents an overview of the stages of mining, from exploration and prospecting, through development, exploitation, and finally closure and reclamation. Students are introduced to mine financing, methods and design (both surface and underground), mining operations and planning, services (e.g., rock mechanics, ventilation, drilling and blasting), mining equipment and technologies, as well as social and environmental challenges. Case studies and examples are used to illustrate the fundamentals. Topics related to the processing of mined materials are not covered by this course, but rather in MNTC 306.

Academic Units:

MNTC 306 Mineral Processing Unit Operations W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course focuses on unit operations of mineral processing. Mineral separation processes of a physical and physicochemical nature are studied. Topics include size reduction, classification, flotation, flocculation, gravity concentration, magnetic, electrostatic separations and dewatering. Surface phenomena involving fine particle processing, reagent classifications, flotation machines and circuits, plant practice in ore flotation are discussed. The field school component of MNTC 399 will cover selected topics such as crushing, grinding, particle size analysis, gravity separation, magnetic separation, differential flotation. Quantitative understanding of various topics is facilitated through problem solving in class and assignments on mass balancing, kinetic analysis and circuit sizing.

Academic Units:

MNTC 307 Geomechanics and Ground Control W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
The study of rock mechanics is essentially the study of the action of forces on rock masses. The important conditions which are associated with stressed rock involve the formation of fracture phenomena (and related stability assessment) caused by stress, strain and energy transformations resulting from the application of changing or variable networks of forces within rock masses. Elastic prototypes are developed to investigate stress conditions around mine openings. Failure theories are discussed and used to explain fracture patterns. Stereographic methods of three - dimensional analysis are introduced. The presence of fault and joint development in large rock masses dictates the use of broader engineering methods than those based entirely on idealized conditions. Techniques based on empirical knowledge and supported by available theory are presented, including slope stability, open pit design, tunnels, underground structural design, rock foundations, ground water, rock bursts and bumps, and design hazards. Various types of instrumentation of interest for rock characterization and monitoring are also discussed

Academic Units:
PREREQUISITE(S): MNTC 302, MNTC 304, MNTC 305

MNTC 308 Safety and Occupational Health W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course is designed to help develop skills and knowledge about industrial occupational health and safety practices, in general, and to relate their applications to the mining industry in particular. The course will affirm a societal rationale and framework for the implementation of due diligence in health, safety and environmental control. The course will consider the five principal categories of workplace environmental factors that may lead to ill health/death, and introduces the strategies and techniques of exposure assessment, relative to both regulatory and professional standards, and control as part of the Anticipation -Recognition -Evaluation -Communication -Control sequence. In addition to providing the basic tools for undertaking occupational health risk assessment/management, the course will review fundamental industrial, chemical, (non - toxicological) hazards and risks and provide the basic tools for undertaking occupational health risk assessment and management.

Academic Units:

MNTC 309 Engineering Economics F/W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
Business practices play a major role in shaping the context for engineering projects. The aim of the course, through readings, lectures, individual assignments and quizzes is to provide insight into the business and economic aspects of engineering by examining the issues relating to the management of people, time & money and provide the tools required to solve basic economic questions faced by an engineer. Factors underlying the success and failure of projects will be highlighted. Business Planning, Project Management and Engineering Economics are closely related, but vast subjects. The scope of this course will be limited to the topics covered in the textbook "Engineering Economics, Second Custom Edition for Queen's University", along with supplemental material provided on the class website.

Academic Units:

MNTC 310 Mining and Society W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course takes a look at the social, economic, environmental, ethical, and technical issues facing the mining industry. An introduction to the mining industry's relation to society will explore the changing context of the mining industry and its evolving practice, identify various socio -environmental issues, and describe how governments attempt to regulate the industry. A brief assessment of the concept of corporate social responsibility will assess society need for proper industrial stewardship, and identify key roles mining corporations play within their communities. Finally, the course will go into the details of land acquisition, including a review of various cultural issues, and identification of major stakeholders involved in the process. Students will discuss the practical challenges related to a company's social license to operate

Academic Units:
COREQUISITE(S): MNTC 301

MNTC 311 Ore Body Modelling and Resource Estimation F/W/S | 3

Lecture: 3
Lab: 0
Tutorial: 0

This course presents a basic introduction to the use of classical and geostatistical estimation techniques for mineral resource estimation. Students will learn to recognize the geological influences to ore body modelling, apply various estimation methods, produce mineralization reports, and classify the mineral resources and reserves according to accepted internationally recognized methods. The course will also include basic ore exploration and sampling concepts.

Academic Units:
PREREQUISITE(S): MNTC 302, MNTC 304, MNTC 305

MNTC 312 Business Law and Ethics W/S | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course is intended to provide the student with a solid general knowledge of Business Law and Ethics. The course will cover core areas of the law, including the nature and structure of the Canadian justice system, contract, intellectual property, and tort law, as well as introduce concepts such as professional liability and ethics and the professions.

Academic Units:
PREREQUISITE(S): MNTC 301

MNTC 399 Field School I (Kingston) S/OL | 3.5

Lecture: 3.5
Lab: 0
Tutorial: 0
Field School I provides a hands -on laboratory experience for fields related to the third year curriculum. Field school modules include an introduction to laboratory techniques and data analysis, rock mechanics, blasting technology, and mineral processing. Students will develop practical skills both in laboratory and realistic field scenarios. A focus on occupational health and safety is emphasized throughout.

Academic Units:
PREREQUISITE(S): MNTC 301, MNTC 302, MNTC 303, MNTC 304, MNTC 306, MNTC 307,MNTC 308

MNTC 413 Surface Mine Design W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course presents a comprehensive overview of the principal components of surface mine design. Topics include pit limit analysis and economic optimization, haul road design, blast design, and basic stability calculations. Equipment selection and application and mine scheduling techniques will be introduced, including dragline applications. The focus will be on the practical application of design techniques to mine planning, and on the available equipment and methods for field monitoring to provide effective design feedback and support safe operations

Academic Units:
PREREQUISITE(S): MNTC 305, MNTC 308, MNTC 309, MNTC 310, MNTC 311

MNTC 414 Underground Mine Design S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0

A study of underground mining technology will be presented. Up -to -date mining methods are reviewed, and trends in mining method development are closely analyzed. Mine design is studied in relation to ore reserves, tonnage and grade distribution. The problems and possibilities of existing and evolving mining techniques are reviewed.

Academic Units:
PREREQUISITE(S): MNTC 305, MNTC 307, MNTC 308, MNTC 311

MNTC 415 Metallurgical Techniques S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course covers the fundamentals and practical applications of major hydrometallurgical and pyrometallurgical unit operations. An introduction to physical, hydrometallurgical and thermochemical processing in the production of metals and materials will be provided. Basic processing concepts and unit operations will be discussed. Fundamentals of mass and heat balances in metallurgical processes will be covered.

Academic Units:
PREREQUISITE(S): MNTC 303, MNTC 306

MNTC 416 Mine Services I: Ventilation and Hydraulics F/W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
Hydraulics of air flow through mine airways and ducts is studied, leading to mine ventilation design calculations and ventilation network analysis. Topics related to the design of mine ventilation systems include regulations and design criteria. Procedures for conducting air quantity and quality surveys are taught. The basics of hydraulic systems and fluid mechanics are introduced. Topics covered include fluid statics, the energy balance, the momentum balance, pumps, and mine drainage and dewatering systems. Practical applications to the mining industry will be explored.

Academic Units:
PREREQUISITE(S): MNTC 302, MNTC 303, MNTC 304, MNTC 305

MNTC 417 Mine Services II: Power, Communications and Compressed Air F/W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course presents a practical introduction to auxiliary mine services, including mine electrical power, communications systems, and compressed air services. Students are expected to evaluate the mine service requirements, make appropriate equipment selections, and estimate the costs associated with installation and operation of mine services.

Academic Units:
PREREQUISITE(S): MNTC 302, MNTC 304, MNTC 305

MNTC 418 Mining Sustainability and the Environment S/OL | 3

Lecture: 3
Lab: 0

Tutorial: 0
This course describes the evolution of policies, operational procedures, and management systems related to sustainability and the social, economic, environmental, ethical, and technical design challenges facing the mining industry. Students will be introduced to a range of complex situations with significant sustainability implications that need to be addressed responsibly during the life cycle of a mine, such as resource, water, and waste management, mining -community relationships, mine closure and rehabilitation, as well as a mine closure's community and environmental implications.

Academic Units:
PREREQUISITE(S): MNTC 305, MNTC 310

MNTC 419 Mine Supervision and Project Management S | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course presents an introduction to mine supervision; covering the roles and responsibilities of the industrial supervisor, as well as effective techniques for performance management. Students are introduced to the Occupational Health and Safety Regulations, and will learn about the importance of communication and training. The second half of the course introduces the students to the fundamentals of project management; covering the role of the project manager, project planning, the concept of risk and quality management, and budgeting. Case studies and examples are used to illustrate the fundamentals of both concepts, and are reinforced through a series of assignments, quizzes, and a team project

Academic Units:
PREREQUISITE(S): MNTC 301, MNTC 305, MNTC 308, MNTC 309

MNTC 420 Mine Mechanization and Maintenance S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course presents an introduction to the topic of mechanization in the minerals industry. It includes a comprehensive review of the evolution of mechanized equipment in mining, as well as existing and emerging mechanical excavation technologies (e.g., automation and robotics). Major topics include the theory and principles of mechanical fragmentation and cutting, and appropriate equipment selection to meet production requirements. This course also provides and introduction to reliability modelling and analysis (e.g., failure mode analysis and life distribution models), and discusses the selection of appropriate equipment maintenance strategies (e.g., run -to -failure, scheduled, and condition -based maintenance).

Academic Units:
PREREQUISITE(S): MNTC 302, MNTC 304, MNTC 305

MNTC 421 Organizational Behaviour and Human Resources F/W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
The foundation for the effective management of companies in the mining sector lies in understanding the management of its most fundamental resource: its people. Sound knowledge of human behaviour informs many elements including employee recruitment, evaluation, compensation and organizational culture. These play critical roles in a company's success. Knowing the role of the Human Resources department, and the different tools and methods used to approach

issues will give learners insight into the soft skills required to be effective managers

Academic Units:

MNTC 422 Soft Rock Mining and Processing F/W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course describes the industrial mining practices associated with a number of industrial minerals. A major emphasis of the course on quarry mining operations related to the major mineral and aggregate industries will be explored. Topics will cover resource definition, quarry planning and design, extraction, and processing of materials. Details for each topic include marketing, transportation, source geology, typical operations, mining, processing, customers, and specifications.

Academic Units:
PREREQUISITE(S): MNTC 305, MNTC 306, MNTC 307

MNTC 423 Geomatics F/W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course introduces students to the fundamentals of mine surveying. Basic measurement and calculation techniques are used to measure distances, elevation changes, and coordinates. The principles of measurement theory, as well as error propagation and analysis are taught, to give students the knowledge required to complete the field school laboratories. Finally, a study of modern survey technology such as total stations, LiDar, and GPS mapping will give students an understanding of the latest technologies being used in industry today.

Academic Units:
PREREQUISITE(S): MNTC 302, MNTC 304, MNTC 305

MNTC 424 Capstone Project F/W/S/OL | 3

Lecture: 3
Lab: 0
Tutorial: 0
The objective of this course is to further develop the student's design, innovation, and professional skills. Working in teams, students will engage in a mining-related real-world design project. Design processes will be applied from problem definition, scheduling, though to exception and validation. Professional engineering skills such as communication, teamwork, project management techniques, engineering economics, ethics, and safety will be integral to the project. The course will culminate in the production of an engineering design report and video presentation of the design.

Academic Units:
PREREQUISITE(S): MNTC 413, MNTC 414, MNTC 415

MNTC 499 Field School II (Timmins) S/OL | 3.5

Lecture: 3.5
Lab: 0
Tutorial: 0

Field School II covers the laboratory component for all fourth year curriculum. Modules will include a study of geology and rocks, mine ventilation, an introduction to metallurgical techniques, as well as surveying technologies. Students will develop basic laboratory analytical skills both in lab and field sessions. A focus on safety and occupational health will be maintained throughout.

Academic Units:
PREREQUISITE(S): MNTC 301, MNTC 302, MNTC 303, MNTC 304, MNTC 415, MNTC 416, MNTC 423

Mathematics and Engineering

MTHE 212 Linear Algebra W | 3.5

Lecture: 3
Tutorial: 0.5
Vector spaces, direct sums, linear transformations, eigenvalues, eigenvectors, inner product spaces, self-adjoint operators, positive operators, singular-value decomposition, minimal polynomials, Jordan canonical form, the projection theorem, applications to approximation and optimization problems.

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 174
EXCLUSION(S): MTHE 312 (MATH 312)

MTHE 217 Algebraic Structures with Applications F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The purpose of the course is to provide an introduction to abstract algebraic systems and to illustrate the concepts with engineering applications. Topics include symbolic logic; switching and logic circuits; set theory, equivalence relations and mappings; the integers and modular arithmetic; groups, cyclic groups, Lagrange's theorem, group quotients, group homomorphisms and isomorphisms; applications to error-control codes for noisy communication channels.

Academic Units:
Mathematics 30
Natural Sciences 0
Complementary Studies 0
Engineering Studies 12
Engineering Design 0

PREREQUISITE(S): APSC 174

MTHE 224 Applied Mathematics for Civil Engineers F | 4.2

Lecture: 3
Lab: 0.4
Tutorial: 0.8

The course will discuss the application of linear differential equations with constant coefficients, and systems of linear equations within the realm of civil engineering. Additionally, the course will explore relevant data analysis techniques including: graphical and statistical analysis and presentation of experimental data, random sampling, estimation using confidence intervals, linear regression, residuals and correlation.

Academic Units:
Mathematics 50
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 142, APSC 172, APSC 174
EXCLUSION(S): MTHE 225 (MATH 225), MATH 226, MTHE 235 (MATH 235), MTHE 237 (MATH 237), STAT 267, MTHE 367 (STAT 367)

MTHE 225 Ordinary Differential Equations F/W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
First order differential equations, linear differential equations with constant coefficients, and applications, Laplace transforms, systems of linear equations.

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172, APSC 174

MTHE 227 Vector Analysis F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Review of multiple integrals. Differentiation and integration of vectors; line, surface and volume integrals; gradient, divergence and curl; conservative fields and potential. Spherical and cylindrical coordinates, solid angle. Green's and Stokes' theorems, the divergence theorem.

Academic Units:
Mathematics 36
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172, APSC 174

MTHE 228 Complex Analysis W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Complex arithmetic, complex plane. Differentiation, analytic functions. Elementary functions. Elementary functions. Contour integration, Cauchy's Theorem and Integral Formula. Taylor and Laurent series, residues with applications to evaluation of integrals.

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172, APSC 174

MTHE 232 Deleted - Differential Equations |

Introduction to ordinary differential equations and their applications to the physical and social sciences. Topics may include: numerical solutions, power series and series solutions, Laplace transforms. - COURSE DELETED 2015-2016

Academic Units:
Mathematics 36
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172, APSC 174
EXCLUSION(S): MTHE 225 (MATH 225), MATH 226, MATH 231, MTHE 235 (MATH 235), MTHE 237 (MATH 237)

MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3

Lecture: 3
Lab: 0
Tutorial: 0
First order differential equations, linear differential equations with constant coefficients. Laplace transforms. Systems of linear differential equations. Introduction to numerical methods for ODEs. Examples involving the use of differential equations in solving circuits will be presented.

Academic Units:
Mathematics 27
Natural Sciences 0
Complementary Studies 0
Engineering Studies 9
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172, APSC 174

MTHE 237 Differential Equations for Engineering Science F | 3.25

Lecture: 3
Lab: 0
Tutorial: 0.25
Topics include models for dynamical systems, classification of differential equations, methods for solving differential equations, systems of equations and connections with Linear Algebra, stability of dynamical systems and Lyapunov's method, the Laplace Transform method, and numerical and computer methods.

Academic Units:
Mathematics 18
Natural Sciences 11
Complementary Studies 0
Engineering Studies 10
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172, APSC 174
EXCLUSION(S): MATH 231, MTHE 232 (MATH 232)

MTHE 272 Application of Numerical Methods W | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
An introductory course on the effective use of computers in science and engineering. Topics include: solving linear and nonlinear equations, interpolation, integration, and numerical solution of ordinary differential equations. Extensive use is made of MATLAB, a high level interactive numerical package.

Academic Units:
Mathematics 20
Natural Sciences 0
Complementary Studies 0
Engineering Studies 11
Engineering Design 11

PREREQUISITE(S): APSC 174 or equivalent (Note: some programming experience is important for the course)
COREQUISITE(S): MTHE 225 or MTHE 235 or MTHE 232 or equivalent

MTHE 280 Advanced Calculus F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Limits, Continuity, C', and linear approximations of functions of several variables. Multiple integrals and Jacobians, Line and surface integrals. The theorems of Green, Stokes, and Gauss.

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 172, APSC 174
EXCLUSION(S): MATH 221, MTHE 227 (MATH 227)

MTHE 281 Introduction to Real Analysis W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Taylor's theorem, optimization, implicit and inverse function theorems. Elementary topology of Euclidean spaces. Sequences and series of numbers and functions. Pointwise and uniform convergence. Power series.

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 172

MTHE 312 Deleted - Linear Algebra |

Vector spaces, linear transformations and matrices. Linear equations. Determinants. Eigenvalues and eigenvectors. Normal forms. Linear functions and dual spaces. Bilinear functions, quadratic and hermitian forms. Inner product spaces, the projection theorem and applications to approximation and optimization problems. - COURSE DELETED 2015-2016

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): MTHE 217 (MATH 217) or permission of the instructor

MTHE 326 Functions of a Complex Variable F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Complex numbers, analytic functions, harmonic functions. Cauchy's theorem. Taylor and Laurent series. Calculus of residues. Rouche's theorem.

Academic Units:
Mathematics 36
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): MTHE 280 (MATH 280), MTHE 281 (MATH 281)

MTHE 332 Introduction to Control W | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
Modeling control systems, linearization around an equilibrium point. Block diagrams, impulse response, transfer function, frequency response. Controllability and observability, LTI realizations. Feedback and stability, Lyapunov stability criterion, pole placement, Routh criterion. Input/output stability, design of PID controllers, Bode plots, Nyquist plots, Nyquist stability criterion, robust controllers.Laboratory experiments illustrate the control concepts learned in class.

Academic Units:
Mathematics 6
Natural Sciences 0
Complementary Studies 0
Engineering Studies 31
Engineering Design 11

PREREQUISITE(S): MTHE 326 MTHE 335 (MATH 326)
COREQUISITE(S): MTHE 335

MTHE 333 Deleted - Control-Robotics Lab I |

This laboratory introduces the use of motion control devices such as optical encoders, pulse width amplifiers and armature controlled DC servo motors. The experiments complement the analytical and theoretical work on control taken in other third year courses. Students design and implement proportional, proportional-derivative, and proportional-integral-derivative controllers. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 4
Engineering Design 8

COREQUISITE(S): MTHE 332

MTHE 334 Mathematical Methods for Engineering and Physics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Banach and Hilbert spaces of continuous- and discrete-time signals; spaces of continuous and not necessarily continuous signals; continuous-discrete Fourier transform; continuous-continuous Fourier transform; discrete-continuous Fourier transform; discrete-discrete Fourier transform; transform inversion using Fourier series and Fourier integrals.

Academic Units:
Mathematics 28
Natural Sciences 0
Complementary Studies 0
Engineering Studies 14
Engineering Design 0

PREREQUISITE(S): MTHE 237 (MATH 237), MTHE 281 (MATH 281)

MTHE 335 Mathematics of Engineering Systems W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Linear input/output systems and their stability. Frequency-domain and time-domain analysis. Continuous and discrete-time modeling. Fourier, Laplace, and Z-transforms. Sampling and the discrete-time Fourier transform. Applications to modulation of communications signals, filter design, and digital sampling.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Studies 20
Engineering Design 11

PREREQUISITE(S): MTHE 334 (MATH 334), MTHE 326 (MATH 326) or MTHE 228 (MATH 228)

MTHE 337 NOT OFFERED THIS YEAR - Introduction to Operations Research Models W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Formulation and solution of some industrial and business problems using mathematical models. Review of probability. Markov chains and applications to inventory problems. Introduction to queuing theory and applications. Machine maintenance planning; optimal number of servers. Simulation and Monte Carlo methods. Reliability and replacement problems. Inventory and production planning problems. One, or possibly two, topics chosen from constrained optimization, network flow analysis and dynamic programming.

Academic Units:
Mathematics 18
Natural Sciences 0
Complementary Studies 0
Engineering Studies 9
Engineering Design 9

PREREQUISITE(S): STAT 256 or MTHE 267 (STAT 267) or equivalent or permission of the instructor

MTHE 338 Fourier Methods for Boundary Value Problems F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Methods and theory for ordinary and partial differential equations; separation of variables in rectangular and cylindrical coordinate systems; sinusoidal and Bessel orthogonal functions; the wave, diffusion, and Laplace's equation; Sturm-Liouville theory; Fourier transform and Laplace transform techniques.

Academic Units:
Mathematics 28
Natural Sciences 0
Complementary Studies 0

Engineering Studies 14
Engineering Design 0

PREREQUISITE(S): MTHE 227 (MATH 227) or MTHE 280 (MATH 280), MATH 226 or MTHE 237 (MATH 237) or MTHE 232 (MATH 232) or permission of the instructor

MTHE 339 Evolutionary Game Theory W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course highlights the usefulness of game theoretical approaches in solving problems in the natural sciences and economics. Basic ideas of game theory, including Nash equilibrium and mixed strategies; stability using approaches developed for the study of dynamical systems, including evolutionary stability and replicator dynamics; the emergence of co-operative behaviour; limitations of applying the theory to human behaviour.

Academic Units:
Mathematics 18
Natural Sciences 9
Complementary Studies 9
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): APSC 172 or MATH 120 (or MATH 121); APSC 174 or MATH 110 (or MATH 111) recommended
EXCLUSION(S): MATH 239

MTHE 351 Probability I F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course is a PREREQUISITE for theoretical statistics courses and further courses in probability and stochastic processes. Basic probability theory: probability models; discrete and continuous random variables; moments; jointly distributed random variables; transformations and generating functions. Inequalities and limit laws. Distributions include: binomial, Poisson, exponential, gamma, normal. Applications include: elementary stochastic processes, time-to-failure models, binary communication channels with Gaussian noise.

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

COREQUISITE(S): MTHE 280
EXCLUSION(S): STAT 251

MTHE 353 Probability II W | 3

Lecture: 3
Lab: 0

Tutorial: 0
Intermediate probability theory as a basis for further study in mathematical statistics and stochastic processes; probability measures, expectations; modes of convergence of sequences of random variables; conditional expectations; independent systems of random variables; Gaussian systems; characteristic functions; Law of large numbers, Central limit theory; some notions of dependence.

Academic Units:
Mathematics 36
Natural Sciences 0
Complementary Studies 0
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): STAT 251 or MTHE 351 (STAT 351), APSC 174, MTHE 281 (MATH 281)

MTHE 367 Engineering Data Analysis W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Exploratory data analysis -- graphical and statistical analysis and presentation of experimental data. Random sampling. Probability and probability models for discrete and continuous random variables. Process capability. Normal probability graphs. Sampling distribution of means and proportions. Statistical Quality Control and Statistical Process Control. Estimation using confidence intervals. Testing of hypothesis procedures for means, variances and proportions -- one and two samples cases. Liner regression, residuals and correlation. ANOVA. Use of statistical software.

Academic Units:
Mathematics 31
Natural Sciences 0
Complementary Studies 0
Engineering Studies 11
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172
EXCLUSION(S): STAT 261, STAT 263, STAT 266, STAT 267

MTHE 393 Engineering Design and Practice for Mathematics and Engineering W | K4

Lecture: Yes
Lab: Yes
Tutorial: Yes
This is a project-based design course where methods of applied mathematics are used to solve a complex open-ended engineering problem. The projects involve using system theoretic methods for modeling, analysis, and design applied to engineering problems arising in a variety of engineering disciplines. Students will work in teams and employ design processes to arrive at a solution. The course will include elements of communications, economic analysis, impacts of engineering, professionalism, and engineering ethics.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Studies 0

Engineering Design 36

PREREQUISITE(S): APSC 200
COREQUISITE(S): MTHE 332, MTHE 335

MTHE 406 NOT OFFERED THIS YEAR - Introduction to Coding Theory F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Construction and properties of finite fields. Polynomials, vector spaces, block codes over finite fields. Hamming distance and other code parameters. Bounds relating code parameters. Cyclic codes and their structure as ideals. Weight distribution. Special codes and their relation to designs and projective planes. Decoding algorithms.

Academic Units:
Mathematics 14
Natural Sciences 0
Complementary Studies 0
Engineering Studies 12
Engineering Design 10

PREREQUISITE(S): MTHE 217 (MATH 217)

MTHE 418 Number Theory and Cryptography F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Time estimates for arithmetic and elementary number theory algorithms (division algorithm, Euclidean algorithm, congruences), modular arithmetic, finite fields, quadratic residues. Simple cryptographic systems; public key, RSA. Primality and factoring: pseudoprimes, Pollard's rho-method, index calculus. Elliptic curve cryptography.

Academic Units:
Mathematics 18
Natural Sciences 0
Complementary Studies 0
Engineering Studies 9
Engineering Design 9

PREREQUISITE(S): MTHE 217 (MATH 217) or MATH 210 or MATH 211 with permission of the instructor

MTHE 430 Modern Control Theory F | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
This course covers core topics in modern control theory: Linearization, existence and uniqueness of trajectories for nonlinear and linear systems, the transition matrix, controllability, observabiity, minimal realizations, feedback stabilization, linear state observers, optimal control theory, the linear quadratic regulator, dynamic programming.

Academic Units:
Mathematics 28

Natural Sciences 0
Complementary Studies 0
Engineering Studies 20
Engineering Design 0

PREREQUISITE(S): MTHE 237 (MATH 237), MTHE 212 (MATH 212) or MTHE 312 (MATH 312), MTHE 326 (MATH 326),MTHE 332 (MATH 332), or permission of the instructor

MTHE 434 Optimization Theory and Applications F | 3.5

Lecture: 3
Tutorial: 0.5
Theory of convex sets and functions; separation theorems; primal-dual properties; geometric treatment of optimization problems; algorithmic procedures for solving constrained optimization programs; engineering and economic applications.

Academic Units:
Mathematics 15
Natural Sciences 0
Complementary Studies 0
Engineering Studies 15
Engineering Design 12

PREREQUISITE(S): MTHE 280 (MATH 280), MTHE 281 (MATH 281), MTHE 212 (MATH 212) or MTHE 312 (MATH 312), or permission of the instructor

MTHE 437 Deleted - Topics in Applied Mathematics | 3

Lecture: 3
Lab: 0
Tutorial: 0
Subject matter to vary from year to year. - COURSE DELETED 2013-2014

Academic Units:
Mathematics 9
Natural Sciences 0
Complementary Studies 0
Engineering Studies 9
Engineering Design 18

PREREQUISITE(S): Permission of the instructor

MTHE 439 Lagrangian Mechanics, Dynamics, and Control W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Geometric modelling, including configuration space, tangent bundle, kinetic energy, inertia, and force. Euler-Lagrange equations using affine connections. The last part of the course develops one of the following three applications: mechanical systems with nonholonomic constraints; control theory for mechanical systems; equilibria and stability.

Academic Units:

Mathematics 20
Natural Sciences 0
Complementary Studies 0
Engineering Studies 11
Engineering Design 11

PREREQUISITE(S): MTHE 280 (MATH 280), MTHE 281 (MATH 281), MTHE 237 (MATH 237) or MATH 231, or permission of the instructor

MTHE 454 NOT OFFERED THIS YEAR - Statistical Spectrum Estimation W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Many systems evolve with an inherent amount of randomness in time and/or space. The focus of this course is on developing and analyzing methods for analyzing time series. Because most of the common time--domain methods are unreliable, the emphasis is on frequency--domain methods, i.e. methods that work and expose the bias that plagues most time--domain techniques. Slepian sequences (discrete prolate spheroidal sequences) and multi--taper methods of spectrum estimation are covered in detail.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Studies 12
Engineering Design 12

PREREQUISITE(S): MTHE 353 (STAT 353), MTHE 312 (MATH 312); or MTHE 338 (MATH 338), STAT 251; or STAT 261, MATH 321; or permission or the instructor

MTHE 455 Stochastic Processes and Applications F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Markov chains, birth and death processes, random walk problems, elementary renewal theory, Markov processes, Brownian motion and Poisson processes, queuing theory, branching processes.

Academic Units:
Mathematics 28
Natural Sciences 0
Complementary Studies 0
Engineering Studies 14
Engineering Design 0

PREREQUISITE(S): MTHE 353 (STAT 353) or one of STAT 251, MTHE 351 (STAT 351), ELEC 326 with permission of the instructor

MTHE 472 Control of Stochastic Systems W | 3

Lecture: 3
Lab: 0

Tutorial: 0
Optimal control of stochastic systems with applications to engineering systems and applied mathematics. Topics include Markov chains and stochastic stability, Martingales, dynamic programming, fully observed and partially observed models, non-linear filtering, Kalman Filtering, linear programming approach, team decision and information structures.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 18
Engineering Design 18

PREREQUISITE(S): MTHE 351 (STAT 351), MTHE 332 (MATH 332), or permission of the instructor

MTHE 474 Information Theory F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Topics include: information measures, entropy, mutual information, modeling of information sources, lossless data compression, block encoding, variable-length encoding, Kraft inequality, fundamentals of channel coding, channel capacity, rate-distortion theory, lossy data compression, rate-distortion theorem.

Academic Units:
Mathematics 9
Natural Sciences 0
Complementary Studies 0
Engineering Studies 17
Engineering Design 10

PREREQUISITE(S): STAT 251 or MTHE 351 (STAT 351) or ELEC 326

MTHE 477 Data Compression and Source Coding W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Topics include: arithmetic coding, universal lossless coding, Lempel-Ziv and related dictionary based methods, rate-distortion theory, scalar and vector quantization, predictive and transform coding, applications to speech and image coding.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 21
Engineering Design 15

PREREQUISITE(S): MTHE 474 (MATH 474)

MTHE 478 NOT OFFERED THIS YEAR - Topics in Communication Theory F/W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Subject matter will vary from year to year. Possible subjects include: constrained coding and applications to magnetic and optical recording; data compression; theory and practice of error-control coding; design and performance analysis of communication networks; and other related topics.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Studies 18
Engineering Design 18

PREREQUISITE(S): Permission of the instructor

MTHE 484 NOT OFFERED THIS YEAR - Data Networks W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course covers performance models for data networking, delay models and loss models; analysis of multiple access systems, routing, and flow control; multiplexing; priority systems; satellite multiple access, wireless networking, wireless sensor networks. Knowledge of networking protocols is not required.

Academic Units:
Mathematics 10
Natural Sciences 0
Complementary Studies 0
Engineering Studies 26
Engineering Design 0

PREREQUISITE(S): MTHE 455 (STAT 455) or permission of the instructor

MTHE 493 Engineering Mathematics Project FW* | K7.5

Lecture: No
Lab: Yes
Tutorial: Yes
This is the capstone design course for Mathematics and Engineering. Students must work in groups, with a typical group size being between two and four members. Projects are selected early in the year from a list put forward by Mathematics and Engineering faculty members who will also supervise the projects. There is a heavy emphasis on engineering design and professional practice. All projects must be open-ended and design oriented, and students are expected to undertake and demonstrate, in presentations and written work, a process by which the design facets of the project are approached. Projects must involve social, environmental, and economic factors, and students are expected to address these factors comprehensively in presentations and written work. Students are assessed individually and as a group on their professional conduct during the course of the project.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 23

Engineering Studies 27
Engineering Design 40

MTHE 494 Mathematics and Engineering Seminar F | 3

Lecture: 3
Lab: 0
Tutorial: 0
This is a seminar and course, with an emphasis on communication skills and professional practice. A writing module develops technical writing skills. Students give an engineering presentation to develop their presentation skills. Seminars are given by faculty from the Mathematics and Engineering program, by Mathematics and Engineering alumni on the career paths since completing the program, and by visiting speakers on a variety of professional practice matters, on topics such as workplace safety, workplace equity and human rights, and professional organizations. Open to Mathematics and Engineering students only.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 26
Engineering Studies 10
Engineering Design 0

School of Urban and Regional Planning

SURP 844 Real Estate Planning and Development W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course examines real estate market research, project planning finance and development techniques. Residential, retail and office market analysis and development are studies through lectures and case study discussions. Learning materials approx. $24.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): Permission of the instructor

SURP 851 Environmental Policy W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course will examine environmental policies in urban and regional contexts. Tools used by policy makers (e.g. risk assessment and management, quality indices, evaluation, impact assessment, mitigation and compensation) and the constraints they encounter (e.g. uncertainty, legal and administrative constraints and financial costs) will be reviewed. Substantive areas to be examined will be focused on the relationship between the built environment and the quality of air and water as well as the use of land resources. Specific cases will vary from year to year. The scope of policies and

readings will range from local to global; integration will be stressed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): Permission of the instructor

SURP 853 Environmental Services W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course will focus on the relationships between environmental services and quality of life in cities and regions. It includes a critical examination of the development, delivery and evaluation of environmental technologies and services. There is an emphasis on water, open space, and solid waste. Case studies and field trips will supplement a lecture/seminar format.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): Permission of the instructor

SURP 855 Environmental Planning and Management W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course examines planning and management issues and tools in environmental services, such as inventory management, needs assessment, demand management, and investment decisions. The emphasis is on planning, management and financing options and their relationship to land use and urban form.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Studies 0
Engineering Design 0

PREREQUISITE(S): Permission of the instructor

SURP 874 Housing Policy F | 3

Lecture: 3
Lab: 0

Tutorial: 0
This course assesses housing policy options and the contributions planners can make to the supply of affordable, adequate and appropriate housing. It presents the many factors influencing the housing market and analyzes public and private initiatives affecting the provision of housing. It shows the interdependence between housing and social service planning and analyzes issues regarding the choices among housing and other social policies. Current policies targeted at specific groups in need of assistance will be reviewed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Studies 0
Engineering Design 0

Admission and Fees

Admissions

Information on Admissions

Students who are considering applying to Queen's are directed to Queen's Admission Services at: http://www.queensu.ca/admission. The Admissions website provides information regarding the admission requirements for all undergraduate programs, facilities and services, residences, scholarships and financial assistance.

Campus Visits

Applicants and potential applicants are encouraged to visit the Queen's campus, as well as the Faculty of Engineering and Applied Science. Formal arrangements can be made by contacting engineering.reception@queensu.ca.

Criteria

Admission is offered to the best qualified students applying. Academic success is the primary criterion for admission to Engineering and Applied Science. Students whose academic performance exceeds a required minimum will receive an offer of admission. In all other cases, students will be evaluated on a combination of their academic and non-academic achievements. Submission of a completed Personal Statement of Experience (PSE) form is required for all first year applicants.

Fees

The Board of Trustees reserves the right to make changes in the scale of fees if, in its opinion, circumstances so warrant.

Tuition Fees

Tuition fees are reviewed each year and are dependent on government funding and regulation. Specific information on tuition levels is available on the Web at http://queensu.ca/registrar/financials/tuition-fees as well as the Faculty web site at http://www.appsci.queensu.ca. The information is also available in the Guide to Registration and Fees, which is mailed to all new incoming students during the Summer. This publication also contains information on Registration, Payment Methods, Fee Adjustments and much more. Students are encouraged to become familiar with this information.

Ancillary Fees

Students may be required to pay ancillary fees for course related learning materials, safety equipment and field trips. The maximum estimated compulsory fees for specific academic plans are shown below. Those plans not listed do not have ancillary fees. In most cases the actual cost to individual students will be less than the amount indicated.

First Year	$	25
Chemical Engineering[1]		150
Civil Engineering		50
Engineering Chemistry		150
Geological Engineering[2]		1,055
Mechanical Engineering		50
Mining Engineering[3]		650

[1]See the Chemical Engineering and Engineering Chemistry Academic Plan section of this calendar for a breakdown and explanation of costs.

[2]See the Geological Engineering Academic Plan section of this calendar for a breakdown and explanation of costs.

[3]To be confirmed prior to start of the 2015-16 Fall term.

Non-compulsory Fees

Academic Appeal Fee will be refunded if appeal is granted.	$40.00	payable through Student Services
Challenge (Qualifying) Examinations Fee will be refunded upon successful completion of the examination.	250.00	payable through SOLUS
Request for Course Substitution (Letter of Permission) To take a course from another university and substitute the course for credit towards Queen's Engineering Degree.	60.00	payable through Student Services

Document Fee For completion of all documents related to registration at Queen's. Includes documents such as proof of enrolment, degree eligibility, course descriptions.	30.00	payable through Student Services
Exam Rereads Fee will be refunded if the mark increases.	50.00	payable through Student Services
Internship Program - application fee	35.00	payable through Student Services
Late Application Fee includes late course add/drop, late registration/withdrawal of Supplemental Examinations of J Section Re-write Exams, late Application to Graduate	60.00	payable through Student Services
Registered Education Savings Plan - form completion Fee includes direct submission of RESP form by registered mail or fax.	30.00	
Required to Withdraw Waiver Request	40.00	payable through Student Services
Supplemental Examinations	250.00	payable through SOLUS
Extended Program (Section 900/J-Section) & Rewrite Exams:		
Extended Program - Section 900 per course tuition fee [1]	516.40	payable through SOLUS
Rewrite Exam - per exam fee (Spring term) [2]	466.00 +SAL	payable through SOLUS
Section 900 or Rewrite Exam - remote exam fee per exam[3]	344.00	payable through Student Services
Section 900 or Rewrite Exam - remote exam admin fee [3]	75.00	payable through Student Services

[1]2015/16 Extended Program course fee is $516.40. The course tuition fee is for the 6-week portion of the course that extends past the end of Winter term, and includes Spring term exams in June.

[2]The Spring 2016 exam fees are assessed under the 2015/16 fee schedule and will be $466.00, plus $10.00. (SAL = Student Assistance Levy) per exam.

[3]Students may choose to write exams in a location other than Kingston. There is a $344 fee per exam plus an administrative fee of $75.00 for one or more exams.

Fees quoted are for domestic students. Fees for International students are higher. Please contact the Registrar's Office or refer to the Guide to Registration and Fees at http://www.queensu.ca/registrar/ for details. In case of differences between the above and the Guide, the fees shown in the Guide shall prevail.

Account Information

Students can use SOLUS to determine their account balances.

Student Services Fee Payments

Fee payments that are made through our Student Services office may be by cheque or credit card/debit. We do not accept cash payments at any time.

No form that requires a Student Services payable fee will be processed without payment.

Cheques are to be made out to "Queen's University".

Credit card payments may be made either in person or over the phone. If a student chooses to make a credit payment over the phone, they must first contact Student Services Reception (613-533-2055 or engineering.reception@queensu.ca) , to discuss the process of appropriate authorization to complete the transaction. DO NOT PROVIDE CREDIT CARD NUMBERS AT ANYTIME, VIA EMAIL.

Debts

Any student with an overdue debt with the University will not be permitted to register or to receive examination results, official transcripts, or marks reports until the outstanding account is settled in full. A Senate Regulation forbids the release of a diploma to a student in debt to the University.

Questions

Questions about fees or charges should be directed to:

Office of the University Registrar
Gordon Hall
Queen's University
Kingston, Ontario
K7L 3N6
Telephone: 613 533-6894

Please refer to the *Guide to Registration and Fees* (http://www.queensu.ca/registrar) for a comprehensive outline of the items referred to above.

Faculty Policies and Regulations

The Faculty of Engineering and Applied Science may be obliged to make changes to the curricula, academic plan descriptions, and course descriptions in this Calendar.

In that case, the corrections will appear in the Minutes of the Faculty Board. In the event of discrepancies between statements that appear on the Faculty Web Sites and the corresponding statements in this Calendar and the Faculty Board Minutes, the latter versions will apply. The following policies and regulations apply to all students registered in the Faculty of Engineering and Applied Science.

The Faculty intends its students to have as much opportunity as possible to develop their individual interests and abilities. Its regulations, academic plans and fields of study have been developed with this goal in mind. The plans, curricula and courses of study are, however, constrained by many factors including accreditation requirements, timetabling, physical facilities, number of staff and the interests of faculty members. The current offerings have been designed in the light of experience and of these restrictions to provide a sufficiently diverse selection to satisfy the interests of most students. However, some students may have valid reasons for seeking variations from the prescribed programs and the regulations include provision for doing so (see Regulations 2d and 2e).

Faculty Policies

Academic Integrity

Honesty in a University is an essential component in maintaining high ethical standards. In preparing students for the profession of engineering, the Faculty of Engineering and Applied Science must send a clear message that high standards are expected. Consistent with this message, students are entitled to an environment where individual performance can be presented and evaluated as fairly as possible. Courses and assignments vary in the amount of collaborative versus individual work that is expected, and the intention of the instructor must be clear to the student. Similarly, the physical setting for examinations should allow individual work where invigilation need not be intrusive. The type and amount of any information that a student may take into an examination must be clearly known ahead of time and of a nature that can be easily verified.

The detailed Academic Integrity Policies and Procedures are on-line at:
http://engineering.queensu.ca/policy/Honesty.html

Student Responsibility with respect to Academic Plan and Registration

Students are responsible for ensuring that their course registrations are accurate and complete, and that the courses in which they register meet the requirements for graduation. Course prerequisites and any restrictions on enrolment should be noted carefully prior to registration. The Chair of Undergraduate Studies for the academic plan, or the year advisors in the department, should be consulted whenever requirements are not fully understood.

Calculators in Examinations

From September 2012 onwards, there will be no sticker system for approved calculators. The Casio 991 will be the only calculator approved for engineering exams.

Calculators are divided into three classes.

1. *Communicating Calculators:* These are never permitted in examinations.
2. *Non-Communicating Calculators with text storage and/or graphing capability and/or longterm memory:* Instructors may permit the use of these calculators in examinations but only if students are also permitted to

bring "significant amounts" of written material to offset the advantage that otherwise accrues to those with fancy calculators. To be used in an examination, such a calculator must carry a "red sticker".

3. *non-communicating calculators without the features mentioned above:* Instructors may permit the use of such calculators in any examination. To be used in an examination, such a calculator must carry a "gold or blue sticker", with the exception of the very common Casio 991 model, which may be used without a sticker.

NOTE: From September 2012 onwards there will be no sticker system for approved calculators. The Casio 991 will be the only calculator approved for engineering exams. Students who received a sticker prior to September 2012 will still be able to use the calculator with the sticker.

The examination Proctors will also be told which class of calculator is to be permitted. Students bringing unauthorized or unmarked calculators into an examination may be charged with Academic Integrity (refer to Senate and University-wide Policies).

Release of Examination Papers

Final examination question papers will be made available to students by the end of September (for the previous academic year) through publication in the Exambank (see http://www.queensu.ca/registrar/exams/).

In exceptional circumstance the Associate Dean (Academic) may grant an exemption from this policy. Exemptions, granted only on an annual basis, require written justification from the instructor and a supporting letter from the Head of the Department. There should be no expectation of renewal of an exemption decision.

Faculty Regulations

1. **Registration**

    a. A student must register within the first two weeks of the commencement of term.
    b. A student may change registration from one program to another only within the first two weeks of the commencement of a term and with the approval of the Associate Dean (Academic) and the Department Heads concerned.
    c. The addition of a course after the prescribed "add course" deadline requires approval of the course instructor, the department in which the student is registered, and the Operations Committee.
    d. A student may withdraw voluntarily from a Fall Term course or a Winter term course prior to the deadline to drop without academic penalty. If so dropped, the course is removed from student record.
    e. Withdrawal from a course after the prescribed deadline to drop without academic penalty requires the approval of the department and the Operations Committee, and will only be permitted in exceptional circumstances. Withdrawals such as these will be indicated on the student's transcript by the designation DR (see Regulation 3c).
    f. A student may add an Extended Program offering of a Fall Term course, or apply to rewrite a Fall Term examination, only within the first three weeks after the commencement of Winter Term and may drop such a course only within the first four weeks after the commencement of Winter Term. A student may add an Extended Program offering of a Winter Term course only within the first nine weeks after the commencement of Winter Term and may drop such a course only before the end of regular Winter Term classes.
    g. A student who wishes to rewrite second term examinations of the first year when they are offered at the end of the Extended Program may register to do so only within the first two weeks of the Summer Term, and may cancel this registration without academic penalty only within the first three weeks of the Summer Term.

2. **Programs of Study**

a. Students must obtain written approval from Student Services, FEAS, to add or drop first year courses.
b. A student who is registered in the Regular First Year Program for Winter Term courses may register to rewrite the final examination in any failed course at the next examination period only if the student's Engineering Sessional GPA (ESGPA) is at least 0.7.
c. An upper year student may request an exemption in a course by application to the Operations Committee or delegate on the basis of knowledge acquired through practical experience. Approval for a request for a course exemption must be recommended by the course instructor and by the Department, on the basis of a satisfactory assessment of the student's proficiency in the exempted course material. A replacement course of similar level, total weight, and CEAB units must be proposed in the exemption application. If the exemption is granted the student must take and pass the specified replacement course.
d. An upper year student may request an exemption in a course by application to the Operations Committee or delegate on the basis of knowledge acquired through studies prior to first admission to the FEAS. Approval for a request for a course exemption must be recommended by the course instructor and by the Department, on the basis of a satisfactory assessment of the student's proficiency in the course material. A replacement course of similar level, total weight, and CEAB units must be proposed in the exemption application. If the exemption is granted the student must take and pass the specified replacement course.
e. An upper year student may request permission for substitution of a course in his/her program by a similar course, either at Queen's or elsewhere, by application to the Operations Committee prior to enrolling in the substitute course. Approval for a request for a course substitution must be recommended by the instructor of the prescribed course and the Department. For courses other than Complementary Studies, the request will normally only be considered if the institution offering the course has an accredited engineering program and if the student has an Engineering Cumulative Grade Point Average (ECGPA) of at least 1.6. If a request to take a substitute course at another institution is approved, the FEAS will issue a Letter of Permission to allow the student to enroll in the course.
f. A student seeking a degree in Engineering and Applied Science may not receive more than two years of credits for work done in another Faculty or university, and such credits may not encompass more than one half of the courses of the third and fourth years of the program. Additionally, at least one half of the fourth year of the program must be taken at Queen's.
g. A student who has not passed all of the courses of the first year which are specified as prerequisite to any course in the chosen upper year program must, during the next session, follow a special Fall and Winter term program arranged by the Chair of Undergraduate Studies of the chosen department. During this session, the student must pass all prerequisite courses during the session or he or she will be required to withdraw.
h. Regulation 2h has been removed since it is now covered under Regulation 10. (Removed May 1, 2011)

3. **Course Weighting**

a. Each course in the Calendar of the Faculty of Engineering and Applied Science is assigned a weight as specified in the Calendar. A weight of 1 unit is given for each 12 lecture hours in a course, with 0.5 units given for every 12 tutorial hours, and 0.5 units for every 12 lab hours. The multiplying factor to convert from "units'Äù to CEAB accreditation units (AUs) is 12, i.e. 1 unit = 12 AUs. When engineering students take courses outside the FEAS they must use the unit weighting assigned by the Faculty hosting the course.
b. The following table indicates the grading system used in the FEAS, including permitted letter grades, associated grade points, and equivalent percentage marks. If percentage marks are submitted by instructors, these will be converted to letter grades and grade points and will not be used in the evaluation of student progress or academic standing.

Letter Grade	Grade Points	Numeric Equivalent
A+	4.3	90-100%
A	4.0	85-89%
A-	3.7	80-84%
B+	3.3	77-79%
B	3.0	73-76%
B-	2.7	70-72%
C+	2.3	67-69%
C	2.0	63-66%
C-	1.7	60-62%
D+	1.3	57-59%
D	1.0	53-56%
D-	0.7	50-52%
FR	0.0	40-49%
F	0.0	0-39%

c. Non-evaluative grades: The following is a list of the possible nonevaluative grades and their uses.

Incomplete (IN):
Incomplete standing (IN) is a temporary designation reserved for a course in which a student who, because of extenuating circumstances beyond his or her control, has not completed all term work for a course or requests permission to defer the writing of a final examination. All Incomplete designations require submission of documentation to verify the extenuating circumstances, and must be approved by the Operations Committee of the FEAS. Approval of the instructor must be obtained, and a date set for the completion of the work (normally within 9 months of approval). An IN designation will revert to the "default grade" submitted by the instructor after the date set for completion of the work.

Pass in a Pass/Fail Course (P)
A Pass standing (P) is reserved for a course in which the student successfully completes all of the requirements in a course designated as Pass/Fail. A course that has been designated as Pass/Fail will not be included in the student's grade point average but can be counted as credit towards a degree program.

Dropped (DR)

The Dropped (DR) designation indicates a course that has been dropped after the deadline to drop without academic penalty. This designation can only be applied with approval from the Operations committee.

Failure with Review (FR)
For information, please see Regulation 14 - Supplemental Examinations

4. **Standing in a Course**

    a. The passing grade for a course is D- or above, or P. The basis upon which the final grade is assigned, including the weight given to term work, should be made available to students by the instructor at the beginning of a course.
    b. If a student is unable to write the final examination or to submit required coursework because of incapacitating illness or other extenuating circumstances, a temporary designation of IN (incomplete) will be recorded for the course on the recommendation of the course instructor, the Department Head, and upon approval by the Operations Committee of the FEAS (see regulation 3c). The submission of a mark of IN must be accompanied by documents verifying the extenuating circumstances, and by a proposed date of completion which should be as early as possible, but no later than 9 months beyond the date of approval. The course for which a mark of IN has been entered will be excluded when calculating the Engineering Sessional and Cumulative Grade Point Averages of the student concerned. An IN on a transcript does not preclude the application of Regulations 2g or 10. An IN designation will revert to the "default grade" submitted by the instructor after the date set for completion of the work.
5. **Conduct and Attendance**
    a. A student may, for any form of departure from Academic Integrity, or misconduct in an academic setting, incur penalties up to and including the requirement to withdraw under Regulation 11d.
    b. A student who claims illness or compassionate grounds as a reason for missing any required component of the course other than the final exam is responsible for making alternative arrangements with the instructors concerned. Verifying documentation is normally not required for short-term extenuating circumstances. If there is a significant effect on attendance or academic performance such that the student may wish to request an incomplete (GD) grade, the student is responsible for providing appropriate documentation to the Operations Committee. Refer to Academic Regulation 4b for procedures and documentation required to request an incomplete grade. In the case of illness, a medical certificate should be requested at the time of the treatment.
6. **Examinations**
    a. Candidates are referred to the Exam Regulations located on the website of the University Registrar.
7. **Requirements for Graduation**
    To qualify for the degree of Bachelor of Science (B.Sc.) in engineering, in the FEAS, a student must, at the end of not more than six calendar years from date of first registration in the Faculty:
    a. have passed all the courses required in the First Year program;
    b. have passed all courses required by the department in which she or he is registered;
    c. while registered in their engineering program, have passed courses whose units total is not less than the minimum required by the department in which he or she is registered and each course may be counted only once;
    d. have achieved an Engineering Cumulative Grade Point Average (ECGPA) of 1.6 or higher;
    e. have successfully completed field and technical excursions required by the department in which he or she is registered;
    f. have passed the English Proficiency Test;
    g. have satisfied the minimum curriculum content specified by the CEAB in each content category;
    A student who has not completed the degree program in six years will normally be required to withdraw. An extension will normally be granted to students who have completed, or are working on an Internship, Exchange, or are enrolled in a Dual Degree program, or have received accommodation through the Queen's Disability Services office due to a disability. If a student is allowed to continue, on successful appeal of this regulation, his/her program of study will be

reviewed by the Department and the Faculty. Extra courses may be required to permit completion of the degree program within an agreed time limit. As a result of the review, possible changes to the student's required program will include but not be limited to the following:

- Courses which have changed significantly in content may have to be retaken.
- Additional courses which have been added to the degree program may be required for graduation.
- Courses which are no longer part of the degree program may not count toward the degree.

8. **Scholarship**
To be eligible for scholarship awards, a student must take in one session all the courses, including electives, prescribed for the year of the program in which he or she is registered. An exception will be made if any of these courses have been completed previously with a grade of C- or higher. In that event other courses of equivalent total weight and approved by Operations Committee for scholarship purposes must be added to the student's program. Substitutions granted under Regulation 2e are also acceptable.

9. **Graduation with Honours Standing**
A student will be granted the status of graduation "with Second Class Honours" if, upon graduation, she or he has attained either an ECGPA or an EGGPA of 2.2 or higher. A student will be granted the status of graduation "with First Class Honours" if, upon graduation, she or he has attained either an ECGPA or an EGGPA of 3.5 or more.

10. **Academic Probation and Requirement to Withdraw**

Academic Probation

a. A student shall be placed on Academic Probation, at the time of their academic standing assessment, if he or she**:**
    i. has an ECGPA of less than 1.6 for the previous Engineering Session (fall and winter terms) at the end of the winter term;
    ii. returns to studies after having previously been Required to Withdraw. The academic standing "Placed on Academic Probation" shall be placed on the student's transcript.
b. A student under Academic Probation must follow a special program for the next Engineering Session:
    i. Students having an ECGPA < 1.3 must repeat all courses in their previous Engineering Session for which they obtained a grade less than C-.
    ii. Students with 1.3 ≤ECGPA <1.6, or students returning to studies after being previously Required to Withdraw, must repeat courses specified by the Associate Dean, in consultation with the program chair for the department in which the student is registered.
    iii. The Associate Dean, in consultation with the program chair for the department in which the student is registered, may also specify additional probationary conditions to improve the chances of student success, in their program. The total course load for this session must not exceed the AUs prescribed for that year of the program.
c. Any student who is placed on Academic Probation and who fulfills all of their Academic Probation conditions at the time of their next academic standing assessment shall be released from Academic Probation.
d. If a student is Required to Withdraw at the time of their academic standing assessment but is currently taking a Spring/Summer course at Queen's University, he/she may complete the term-length course in which he/she is enrolled, but is then required to withdraw at the end of the term.

Requirement to Withdraw, with opportunity to be considered for readmission after one year:

e. A student whose ESGPA is less than 0.7 at the time of the academic standing assessment has failed the year and is required to withdraw for a period of at least one year, and may be considered for readmission only after one year.
f. A student who is on Academic Probation under Regulation 10a (i) or 10a (ii) at the time of assessment and does not fulfill all of their conditions of Academic Probation is required to withdraw for a period of at least one year and may be considered for readmission only after one year.

The academic standing "Required to Withdraw for a minimum of one year" shall be placed on the student's transcript.

Requirement to Withdraw, with opportunity to be considered for readmission after a minimum of three years:

g. A student who has failed a previous year, or who has been previously Required to Withdraw for academic reasons, and whose ESGPA at the time of their academic standing assessment is less than 0.7 has failed the year and is required to withdraw for a minimum period of three years, and may be considered for readmission only after a minimum of three years.
h. A student who is on Academic Probation at the time of assessment, does not fulfill all of their conditions of Academic Probation and has previously been required to withdraw, is required to withdraw for a minimum period of three years, and may be considered for readmission only after a minimum of three years.
   The academic standing "Required to Withdraw for a minimum of three years" shall be placed on the student's transcript.

11. **Withdrawal**
    a. A student having a fall term Grade Point Average less than 0.7 who withdraws voluntarily no later than 31 January is not considered to have failed the year. The student must reapply in order to be considered for readmission to the FEAS.
    b. A student who withdraws voluntarily after 31 January is considered to have failed the year. The student must reapply in order to be considered for readmission to the FEAS.
    c. The Faculty Board may, at any time, require a student whose attendance or work is deemed unsatisfactory, to withdraw. The student must reapply in order to be considered for readmission to the FEAS.
    d. The Faculty Board Committee on Non-Academic Discipline may require a student to withdraw from the Faculty or it may recommend to Senate the student's dismissal from the University because of misconduct in an academic setting. The student must reapply in order to be considered for readmission to the FEAS.
    e. A student who withdraws for any reason, or is not registered in the FEAS for twelve consecutive months, must reapply in order to be considered for readmission.
12. **Readmission**
    a. A student applying for readmission after a failed year must present evidence that he or she is likely to succeed in completing the degree in the program for which readmission is sought. The student shall not be readmitted unless the Operations Committee is satisfied that this evidence, together with the student's academic record at Queen's, indicates probable success in completing the degree, and that space is available in the required program. A failed year or a withdrawal from a program in engineering at another university will be treated as if it had occurred at Queen's University.
    b. A student readmitted after a failed year will be placed on Academic Probation and must follow a program constrained by the appropriate requirements outlined under Regulation 10b. In addition, during the first year of registration following a failed year the total unit weight of courses in the student's program shall not exceed that of the regular program of the failed year. As outlined in Regulation 10f and 10h, this student must fulfill all of their conditions of Academic Probation or be required to withdraw.
13. **Review and Rereading of Examination Papers**
    A student who wishes to have a paper reread must make written application to the FEAS within four weeks of the release of the results. The application is to be accompanied by the rereading fee.

    Students have the right of access to their final examination papers. As a first step, the student should request an informal review with the instructor concerned, and instructors are strongly encouraged to consent. If the request for an informal review is denied or if the student is not satisfied with the decision, the student may submit a formal appeal to the FEAS. The appeal must be submitted in writing to the FEAS within four weeks of the release of results.

(The attention of students is directed to the Senate Policy on Student Access to Final Examinations and to Regulation 14b regarding the deadline for applying to write a supplemental examination).

14. **Supplemental Examinations**
    a. A student receiving a grade of FR (Failure with Review) may be permitted to write a supplemental examination in a failed upper year course offered in the FEAS provided the student has an ECGPA of 1.6 or higher and an ESGPA of 0.7 or higher. Supplemental examinations will be held at Queen's University in September. The privilege of writing these supplemental examinations will be confined to the September following the session in which the failure occurred, and limited to a maximum of three examinations in the student's degree program, with no more than two in any calendar year.
    b. A student requesting permission to write a supplemental examination must apply in writing to the FEAS by June 12 following the session in which the failure occurred. A student may cancel a request for a supplemental examination and the examination fee will be refunded if written notice of the cancellation is received by the FEAS by 15 August following the session in which the failure occurred.
    c. The result obtained on a supplemental examination will be substituted for that of the previous final examination in producing the final grade for the course. A student failing to write a supplemental examination for which he or she is registered and who has not canceled his or her registration by 15 August will be awarded a final grade of F on the supplemental examination. The final grade for a course which is based on a supplemental examination will be included in the ECGPA for the next Engineering Session and in the EGGPA. It will not be included in any ESGPA.
    d. Any student who completes more than one rewrite examination in any individual first-year course will have the total number of supplemental examinations permitted reduced by one for each additional rewrite.
15. **Written English Proficiency**
    a. A student must, within the first academic term of first registration, take a written English Proficiency Test as specified for students registered in the FEAS.
    b. Upon successful completion of the English Proficiency Test, the designation "English Proficiency Test Passed" will be added to the student transcript.
    c. A student must pass the English Proficiency Test or an equivalent test, approved by the Associate Dean (Academic), to be eligible for graduation.
16. **Averages**
    a. The Grade Point Averages (GPAs) used in determining a student's standing are calculated by multiplying the grade points earned in a course by the unit value of that course, summing the products so obtained for all the courses in a given period, and dividing this sum by the total number of units attempted during that given period of time over which the GPA is calculated. Each course is only counted once in calculating either the ECGPA or ESGPA. When, during the period considered, a course or a course examination is repeated or replaced by a substitution approved by the Operations Committee, only the most recently obtained mark will be used in calculating the GPA.
    b. The "Academic Year" concludes at the end of winter term, and includes the previous three consecutive terms (summer, fall, winter). An "Engineering Session" is defined as the Fall and Winter terms of the academic year, provided the student is registered in the FEAS for these sessions. The Engineering Sessional Grade Point Average (ESGPA) is the Grade Point Average of all courses taken in the Engineering Session of an academic year, while the student is registered in the FEAS. Queen's courses taken during the summer term of the academic year will also be included in the ESGPA*. Decisions regarding yearly academic progress will be based on the ESGPA.
    c. The Engineering Cumulative Grade Point Average (ECGPA) is the Grade Point Average of all courses taken in the Fall and Winter terms of all academic years, while the student is registered in the FEAS. Queen's courses taken during the summer term of the academic year will also be included in the ECGPA*. The Engineering Graduation Grade Point Average (EGGPA) is

calculated after all degree requirements have been met and follows the same calculation method as the ECGPA, except that it excludes courses that are part of the First Year Curriculum.

d. The Engineering Graduation Grade Point Average (EGGPA) is calculated after all degree requirements have been met and follows the same calculation method as the ECGPA, except that it excludes courses that are part of the First Year Curriculum.

e. Academic status of each student is assessed once a year, at the end of the Winter term. Decisions regarding yearly academic progress will be based on the ESGPA. Students on Academic Probation will only be considered for release from probation if they have taken a minimum of 12 units since their previous assessment.

17. **Special Students**
Students may be allowed to take courses in the FEAS without being registered in a degree program. Such students are defined as "Special Students" and must apply to the Faculty before taking additional courses. A Special Student may apply for admission as a regular student proceeding to a degree but, once admitted as a regular student, a student may not re-register as a Special Student before completing a degree in the FEAS.

Senate Policies

From time to time, the Senate of the University adopts policies governing administrative and academic affairs of all members of the University Community, including Undergraduate Students in the Faculty of Engineering and Applied Science. These policies can be found on Senate Websites. The most convenient entry to these is the index can be found at Senate and University-wide policies.

Faculty Regulations must conform with Senate policies. All Faculty Regulations are approved by Senate. Digests of some of the Senate Policies of particular relevance to students in Engineering and Applied Science are given here. The date after the title is the year in which the policy was adopted or most recently amended.

Access and Privacy
Student Appeals, Rights and Discipline (2004)
Policy on Academic Integrity
Student Access to Final Examination Papers
Confidential Exams
Electronic Information Security Policy Framework

Awards and Financial Assistance

Prospective Students

Please visit the Awards website.

Current Students

To view the list of year 1, 2, 3, 4 and graduation award/scholarship offerings, please click on List of Awards/Scholarships Available to Students in Engineering and Applied Science.

Student Financial Assistance

Student Awards, as part of the Office of the University Registrar, plays a key role in supporting the University's mission. Our goal is to ensure that all students have the opportunity to attend Queen's, regardless of their personal financial circumstances. To achieve this, a variety of funding sources may be required.

The Student Awards Office is responsible for administering all merit-based undergraduate funding and all need-based funding for both undergraduate and graduate students. Merit-based (scholarship) funding recognizes and rewards students for their achievement, both academic and extra-curricular. Need-based funding (bursaries, awards, work study, loans and grants) is disbursed to students on the basis of demonstrated financial need. Listed directly below is general information as it pertains to the various student financial assistance programs administered by the Student Awards Office. For more detailed information please refer to either the Student Awards website or contact the office.

Awards Officers are available throughout the year to provide financial advising on budgeting and the various options available to assist students with financing their Queen's education.

For further Information:

Office of the University Registrar
Student Awards
Gordon Hall, 74 Union Street
Queen's University
Kingston, Ontario, Canada K7L 3N6
Tel: 613-533-2216
Fax: 613-533-6409
E-mail: awards@queensu.ca
Web: http://www.queensu.ca/studentawards/

Government Student Financial Assistance (Loans and Grants)

The federal and provincial governments provide student financial assistance for Canadian citizens, permanent residents, and protected persons studying at the post-secondary level. This assistance is intended to supplement student and family resources and recipients must demonstrate financial need. This assistance is offered in the form of repayable loans and in some cases may also include a limited amount of grant or bursary funding.

The appropriate provincial or territorial authorities will evaluate student applications and will provide funding. Funding options, eligibility criteria and regulations vary by jurisdiction. Students from Ontario will access government student financial assistance through the Ontario Student Assistance Program (OSAP): osap.gov.on.ca. Students from a province or territory outside Ontario must apply for government student financial assistance through their home province or territory.

Other government student financial assistance programs include:

Canada Study Grant for the Accommodation of Students with Permanent Disabilities

This program is designed to assist disabled students with disability-related costs of equipment and/or services associated with their participation in post-secondary studies. Students must first apply for funding from their applicable government student financial assistance program for the current academic year and must demonstrate financial need. Students must also be registered with the Health, Counselling and Disability Services Office at Queen's University.

OSAP Child-Care Bursary

The OSAP Child-Care Bursary is provided to eligible Ontario students who, in relation to their participation in post-secondary studies, incur child-care costs for three or more children.

Ontario Special Bursary

Ontario students with low income and enrolled in part-time studies (as defined by the government - maximum 59% of a full course load in each term of study) due to family responsibilities or other personal circumstances may be eligible. Students must be enrolled in a program leading to a degree or diploma and generally cannot have a previous post-secondary degree or diploma.

Part-time Canada Student Loan/Canada Study Grant (CSG) Program

Canadian citizens and permanent residents with low income and enrolled in part-time studies (as defined by the government - maximum 59% of a full course load in each term of study) may be eligible. Students must be residents of a province or territory that participates in the Canada Student Loans program. To qualify for the CSG students must be studying part-time due to family responsibilities or other personal circumstances.

Work Study Program

Queen's University and the Government of Ontario fund this program. The objective is to provide an opportunity for students in financial need to receive priority for certain part-time jobs, generally on-campus, during the academic terms. Applications for the Fall-Winter academic session are available in May and applications for the Spring-Summer academic session are available in February.

General Bursaries

Queen's University bursary assistance is granted after the student's own financial contribution to the cost of his/her education, parental assistance, government aid assistance, or a bank line of credit have been exhausted. Financial need is the primary consideration in the granting of a bursary.

In order to be considered for the majority of Queen's bursaries, including the ones specifically pertaining to Engineering and Applied Science students, students need to complete a single General Bursary application form (unless otherwise noted in the terms of the awards), which is available from the Student Awards website. The deadline for this application is 31 October. If a student is not granted an Engineering and Applied Science bursary or award he/she is still eligible to receive General Bursary funds. Funds will be distributed at the beginning of Winter Term. Bursaries and awards are paid to the student's tuition account if a balance is owing, and any remaining funds are paid by cheque or electronic funds transfer. The values of the bursaries and awards are variable, unless otherwise noted. For complete terms of these, and other named bursaries and awards see the Student Awards website.

Short-term Loans

Short-term loans (of 90 days or less) may be granted in emergency situations if a full-time student is experiencing temporary cash-flow difficulties and can provide satisfactory evidence that he/she will have sufficient resources to repay the loan on or before the due date. Short-term loans are approved on the basis of financial need to assist students in meeting those expenses normally incurred in support of attendance at the University during the current academic session.

Entrance Awards

Queen's Entrance scholarships, bursaries and awards are not listed in this Calendar. Details on these awards are available on the Student Awards web-site or in the Viewbook brochure. The Viewbook should be available in the Guidance Offices of secondary schools or may be obtained by writing to the Office of the University Registrar (Admission Services), Queen's University, Kingston, ON K7L 3N6

Scholarships

Queen's upper-year scholarships are generally available to full-time students in their respective faculty/school and who will be returning to full-time studies in the year following the award. For the most part, separate applications are not required. Candidates will be considered for those awards for which they are eligible in competition with all other qualified candidates. In instances where a scholarship application is required, specific instructions about the application process are given in the description of the award.

General Awards

Queen's University bursary assistance is granted after the student's own financial contribution to the cost of his/her education, parental assistance, government aid assistance, or a bank line of credit have been exhausted. Financial need is the primary consideration in the granting of a bursary.

In order to be considered for the majority of Queen's bursaries, including the ones specifically pertaining to Engineering and Applied Science students, students need to complete a single General Bursary application form (unless otherwise noted in the terms of the awards), which is available from the Student Awards website at http://www.queensu.ca/studentawards/. The deadline for this application is 31 October. If a student is not granted an Engineering and Applied Science bursary or award he/she is still eligible to receive General Bursary funds. Funds will be distributed at the beginning of Winter Term. Bursaries and awards are paid to the student's tuition account if a balance is owing, and any remaining funds are paid by cheque or electronic funds transfer. The values of the bursaries and awards are variable, unless otherwise noted. For complete terms of these, and other named bursaries and awards see the Student Awards website.

First Year Awards

William and Beatrice Alder Scholarships

Awarded annually to students entering the second year of the Mathematics and Engineering program or the Engineering Physics program who have obtained First Class standing. Two awards are available.

William Coombs Baker Memorial Prize (Book Prize)

Founded by graduates in memory of William Coombs Baker, formerly the Robert Waddell Professor of Experimental Physics at Queen's. Awarded annually to the student with the highest standing in APSC 111.

Robert Bruce Scholarships

Established under the terms of the will of R. Bruce of Quebec and awarded annually on the basis of first-class standing to students entering second year. The award is renewable in third and fourth year providing satisfactory standing is maintained in the Faculty of Engineering and Applied Science. Two awards are available.

Eric R. Davis Memorial Award in Applied Science

Established by friends and family in memory of Eric Davis, B.Sc.(Eng) 1950, former member of the Board of Trustees of Queen's University. Awarded on the basis of standing on year's work to a student entering second, third or fourth year in any program in the Faculty of Engineering and Applied Science.

R.L. Dorrance Memorial Scholarship in Chemistry

Given by the Engineering Society for highest standing in first year Chemistry.

N.F. Dupuis Prize

Founded by Science graduates, for standing in Mathematics.

G.B. Dyer/DuPont Canada Scholarships

Established by DuPont Canada Inc. to recognize the significant contribution of Gerry B. Dyer, B.Sc.'52, D.Sc.'94, to the improvement and advancement of science education. Two scholarships will be awarded, one to a male and one to a female, who are Canadian or permanent residents and entering the second year of study in Chemical Engineering, Engineering Chemistry or Chemistry. Selection is based on high academic standing with consideration given to participation in the community or extra-curricular activities. In the case of students being equally eligible, financial need will be considered. Letters of application must be submitted by 15 April to the Heads of the Departments of Chemical Engineering or Chemistry who will then forward nominations by 1 May to their respective Scholarship Committee. **2 awards**

Lorne C. Elder Scholarship in Mechanical and Materials Engineering

Established by Lorne C. Elder, B.Sc. 1942, and awarded on the basis of academic excellence to students entering second, third or fourth year in the Department of Mechanical and Materials Engineering.

J.E. Hawley Memorial Scholarship in Geological Sciences and Geological Engineering

Established by Alban H. Norton, P.Eng. B.A. (Hons.) '36, in memory of J.E. Hawley, former Head of the Department of Geological Sciences. Awarded on the basis of academic excellence to a student registered in the second year of either the Geological Engineering program in the Faculty of Engineering and Applied Science or an Honours B.Sc. program in the Faculty of Arts and Science with a concentration in Geological Sciences. The candidate will be nominated by the Head of the Department of Geological Sciences and Geological Engineering.

H. Janzen Memorial Scholarship

Established in memory of H. Janzen who taught in the Department of Physics at Queen's until his death in 1988. Awarded annually to the student entering the second year of the Engineering Physics program who attained the highest standing in the first year physics courses in Engineering and Applied Science.

The Nellie and Ralph Jeffery Awards in Mathematics

Three or more scholarships are awarded, on the recommendation of the Department of Mathematics and Statistics, to undergraduate students majoring in Mathematics or Statistics. One of these shall be awarded to the student entering the fourth year of the Mathematics and Engineering program, or of an honours program with a Mathematics major, having the highest standing in the mathematics courses of the first three years and an overall first class average.

Annie Bentley Lillie Prizes in First Year Calculus

Founded in memory of the late Annie Bentley Lillie. A number of book prizes to be awarded each year on the recommendation of the Department of Mathematics and Statistics to students with high standing in any first year calculus courses.

Jacob Malomet Memorial Scholarship

Established by the family, friends and fellow-students of Jacob Daniel Malomet, who died in 1978 during his first year at Queen's. The award is presented annually to a first year Engineering and Applied Science student for general proficiency in term-length courses of the fall term.

Andrew McMahon Standards of Excellence Award

Established in memory of Andrew M. McMahon Sc. '59, a former president of the Engineering Society and member of the Board of Trustees. Awarded annually in Applied Science on the basis of excellent academic achievement to a first year student in the top ten percent of the class who is entering second year. The recipient should demonstrate strong interpersonal skills, with a commitment to excel in all aspects of university life, and high personal standards. The recipient will be chosen by a Selection Committee, to be chaired by a member of the family, consisting of the Director (Program Development), one member of the business community and a family member. Candidates should submit a letter of application with supporting documents to the Faculty of Engineering and Applied Science by 31 March.

A.J. McNab Scholarship

Given by Mr. A.J. McNab, this scholarship is awarded for standing in APSC 151, no failed courses. Open to students proceeding in Geological or Mining Engineering.

James L. Mason Cup

Established March 2010 in recognition of James L. Mason, an Associate Dean in the Faculty of Applied Science from 1996 to 2008, who has been instrumental in establishing the program in team-based, project-based learning in the First Year which is now an integral part of the Engineering and Applied Science curriculum. The cup recognizes Dr. Mason's outstanding leadership, education insight and administrative skill in developing and implementing the Program.

Criteria:

To be eligible the winning team in all of its project work, must function as an effective team with broad participation;

- Exhibit a high degree of technical competence;
- Demonstrate awareness of the economic, social, and environmental factors relevant to whatever they do;
- Communicate their work both in writing and oral presentation in such a way that the principles guiding their choices are clear to both technical and non-technical audiences.

Dr. William Moffat Prize

Founded by Dr. W. Moffat of Utica, N.Y., for second highest standing in APSC 131 and APSC 132.

William Wallace Near Scholarship

Established under terms of the will of W.W. Near of Toronto, for standing on year's work.

George and Mary Louise Patton Scholarship

Founded by G. Patton in memory of his wife and himself, for standing on year's work.

Ontario Professional Engineers Foundation for Education Scholarships

Awarded by the Ontario Professional Engineers Foundation for Education, on the recommendation of the University's Faculty of Engineering and Applied Science; undergraduate (in course) scholarships to be awarded based on a combination of high academic achievement and demonstrated leadership in professional affairs and extracurricular activities. Applications are submitted to the Faculty of Engineering and Applied Science for selection by the Engineering and Operations Committee (Scholarships). **2 awards in each of years 1, 2, 3**

Polycorp Ltd./Kumar Scholarship in Mining Engineering

Established in April 2007 by Polycorp Ltd. in recognition of Polycorp Ltd.'s Manager, Mining Products, Pramod Kumar, P.Eng. and in memory of his late father, Dr. Jiwan Lal Gupta. Awarded on the basis of academic excellence to a student entering second, third or fourth year of the Mining Engineering program in the Faculty of Engineering and Applied Science.

James H. Rattray Memorial Scholarships in Applied Science

Established by Major James H. Rattray, M.C. Several scholarships are awarded annually on the basis of academic merit to students entering the second, third and fourth years of programs in the Faculty of Engineering and Applied Science.

Carl Reinhardt Scholarship

To be awarded annually to a deserving student who enrolls in a second-year program leading to an honours B.Sc. degree with a concentration in Geological Sciences in the Faculty of Arts and Science, or who registers in the second year of the B.Sc. Geological Engineering program in the Faculty of Engineering and Applied Science.

Science 1941 Memorial Scholarship

Maintained by the class of Science '41 in memory of Mr. J.O. Watts, for standing on year's work.

Science 1945 Memorial Scholarship

Maintained by the Class of Science '45 as a memorial to members who gave their lives in World War II and awarded for standing on year's work. Two awards are available - one for standing on the first year's work and the other for standing on the second year's work.

Science 1946 Memorial Upper Year Scholarship

Maintained by theClass of Science '46 as a memorial to members who gave their lives in World War II and awarded on the basis of academic excellence to a student entering second or third year in the Faculty of Engineering and Applied Science.

Robert F. Segsworth Scholarship in Mining Engineering

Awarded at the beginning of the second year of the Mining Engineering program for general proficiency and renewable in the third and fourth years, provided satisfactory standing is maintained.

Raymond H. and Phyllis J. Smart Scholarships

Estalbished in January 2010 by a bequest from the Estate of Phyllis J. Smart and awarded on the basis of academic excellence to students entering second, third or fourth year in the Faculty of Engineering and applied Science. Selection will be made by the Engineering and Applied Science Operations Committee (Scholarships).

Stantec Award in Civil Engineering

Established in May 2006 by Stantec Consulting Ltd., and awarded to a full-time student entering the second or third year of the Civil Engineering program in the Faculty of Engineering and Applied Science on the basis of academic excellence and involvement in extracurricular activities specifically related to the Department, Faculty, or the University. Application must be submitted by letter to the Head of the Department of Civil Engineering by 31 March.

Ho Ming Tai Memorial Scholarship

Established by the family in memory of Ho Min Tai, Sci '83, who died tragically when Korean Air Lines Flight 007 was shot down on 1 September 1983. Awarded on the basis of standing in first year to an international student who is studying Electrical Engineering or Computer Engineering on a student authorization or a student visa and is subject to the payment of higher tuition fees. The scholarship will be renewed in the third and fourth years provided honours standing is maintained.

Adam Wallgren Memorial Award

Founded by Science '90 in memory of Adam Wallgren and awarded to a first year engineering student who through his/her kind actions and friendly disposition eased the rigors of day-to-day life in first year. Written nominations should be submitted to the Engineering Society no later than 15 February. The recipient shall be selected by the Engineering Society Awards Committee, in consultation with the Dean, and awarded at the Engineering Society's Annual Retreat.

George Thomas Warren Scholarship in Computer Engineering

Established in October 2000 by Mrs. Evelyn Warren, in memory of her husband, George Thomas Warren, B.Sc. (Eng.) 1938. Awarded on the basis of academic excellence to full-time students entering second year of the Computer Engineering program in the Faculty of Engineering and Applied Science.

Morley E. Wilson Scholarship in Geological Sciences and Geological Engineering

Established by a bequest from the estate of Morley E. Wilson, and awarded on the basis of standing at the end of the first year to a student entering the second year of a B.Sc. program in Geological Engineering or an Honours B.Sc. program with a concentration in Geological Sciences. The award is in two parts, one-half on entrance to the second year program and one-half on entrance to the third year program, provided that the student maintains an average of at least 75 percent.

Second Year Awards

American Society for Metals Scholarship in Mechanical Engineering (Kingston Chapter)

Established by The Kingston Chapter of the American Society for Metals to provide an annual scholarship to a full-time student entering the third year of the Materials Option in the Mechanical Engineering program in the Faculty of Engineering and Applied Science. Awarded to the student with the highest cumulative average.

Manley B. Baker Scholarships in Geology

Founded by Agnes Moreland Baker. Two scholarships awarded annually to the students in the Faculty of Arts and Science or Engineering and Applied Science, obtaining the highest and second highest standing in the geology courses of the first and second years of their respective programs. These scholarships are open only to students taking a program leading to an honours B.Sc. degree with a concentration in Geological Sciences in Arts and Science or to a B.Sc. in Geological Engineering in Engineering and Applied Science.

Donovan Brown Scholarship in Applied Science

Established in May 2006 by Alice J. Brown in memory of her husband, Donovan Brown, B.Sc. (Engineering Chemistry) 1949, and awarded on the basis of academic excellence to student(s) entering the third or fourth year of any Engineering program in the Faculty of Engineering and Applied Science. Selection will be made by the Engineering and Applied Science Operations Committee (Scholarships).

Orville and Carmel Brown Scholarship

Established by Orville and Carmel Brown and awarded to a student in any year of the Engineering Physics program on the basis of academic excellence. The recipient must be a Canadian citizen or landed immigrant, and if possible, a resident of Lennox and Addington, Frontenac or Leeds and Grenville counties. Selection will be made by the Engineering Physics Department.

Dr. Erwin Buncel Scholarship in Chemistry

Established in September 2008 by the family of Dr. Erwin Buncel, a distinguished professor of organic chemistry in the Department of Chemistry since 1962, in memory of Ignacz, Irena and Marta Buncel. Awarded to a student in an Honours Chemistry or Environmental Chemistry program (Faculty of Arts and Science), or Engineering Chemistry program (Faculty of Enginering and Applied Science), entering third year with the highest combined average standing in either CHEM 222 and CHEM 223 (Arts and Science), or ENCH 222 and ENCH 245.

Cameron Applied Science Scholarship

Established in February 2006 by Hugh Cameron, B.Sc. 1973, and Heather Hume, B.A. 1972, M.D. 1978, to provide an award on the basis of academic excellence to students entering third or fourth year of any program in the Faculty of Engineering and Applied Science who has applied their engineering knowledge and/or techniques in an innovative manner related to non-traditional engineering fields. Nominations may be made by faculty members or students should apply by letter, with attached resume, to the Faculty of Engineering and Applied Science by 1 October.

Harold M. Cave Undergraduate Travel Scholarship

Established in June 2014 by the estate of Harold M. Cave, B.A. 1925, M.A. 1926 and awarded on the basis of academic excellence to students in ay undergraduate year of an honours degree in Physics or Astronomy in the Faculty of Arts and Science or an honours degree in Engineering Physics in the Faculty of Engineering and Applied Science. Awarded to students for the purpose of attending the Canadian Undergraduate Physics Conference or other equivalent conference. Funds are to be used to cover conference fees and travel related expenses. Selection will be made by the Scholarship Committee of the Department of Physics, Engineering Physics & Astronomy. Applicants are to submit a letter of application to the Department of Physics, Engineering Physics & Astronomy by 30 September.

ConeTec Geotechnical Award

Established in October 2012 by ConeTec Investigations Ltd. and awarded to students registered in second or third year in any undergraduate academic plan in Civil Engineering, Mining Engineering and/or Geological Engineering in the Faculty of Engineering and applied Science. The student recipient must have demonstrated leadership, curiosity and independent thinking, and have indicated a desire and suitability to pursue fieldwork and field-based research. A letter of application, along with a one to two page submission outlining their interests and engagement in geotechnical engineering, for example, through courses taken, co-curricular activities, and/or summer employment, is to be submitted to the Faculty of Engineering and Applied Science by 1 February for selection by the Operations Committee (Scholarships). Recipients will also be invited to apply for a paid summer internship experience for a period of 12-16 weeks at one of ConeTec's North American field operations; acceptance of employment is not a condition of this award.

ConeTec Geotechnical Award in Mining Engineering

Established in October 2014 by ConeTec Investigations Ltd. and awarded on the basis of academic achievement to undergraduate students in second or third year of the undergraduate program in Mining Engineering in the Faculty of

Engineering and Applied Science. The student recipient must have demonstrated leadership, curiosity and independent thinking, and have indicated a desire and suitability to pursue fieldwork and feild based research. A letter of application, along with a one to two page submission outlining their interests and engagement in geotechnical engineering through courses taken, co-curricular activities and/or summer employment, is to be submitted to the Faculty of Engineering and applied Science by 1 February for selection by the Operations Committee (Scholarships). Recipients will also be invited to apply for a paid summer internship experience for a period of 12-16 weeks at one of ConeTec's North American field operations; acceptance of employment is not a condition of this award.

Engineering Chemistry Industrial Scholarship

Established in February 2010 to recognize the industrial practice of engineering chemistry, as embodied by the DuPont Industrial Research Chair held by Dr. Warren Baker from 1985-1995 in the Department of Chemistry at Queen's. Awarded to a student entering third year of the Engineering Chemistry program in the Faculty of Engineering and Applied Science on the basis of academic excellence in the second year of the Engineering Chemistry program, who does not hold a scholarship of greater value from Queen's University. Selection will be made by the Operations Committe (Scholarships) of Engineering and Applied Science on the recommendation of the Head and Chair of Undergraduate Studies in the Department of Chemical Engineering.

Isaac Cohen Scholarship

Given by Mr. Isaac Cohen for standing on year's work. Open to candidates in Civil Engineering.

H. Arnold Cowan Scholarship

Established in December 2005 from the estate of Ellen Harcourt Boyd in memory of her husband H. Arnold Cowan. Awarded on the basis of academic excellence to students entering the third or fourth year of any Engineering program in the Faculty of Engineering and Applied Science. Selection will be made by the Engineering and Applied Science Operations Committee (Scholarships).

Eric R. Davis Memorial Award in Applied Science

Details of this award are given in the section on *First Year Awards*.

Parsons Inc. Scholarship (formally named the Delcan Corporation Scholarship in Applied Science)

Established in October 2006 by Parker & Associates Inc. and awarded on the basis of academic excellence, demonstrated initiative and leadership, to students entering the third or fourth year of studies in the Faculty of Engineering and Applied Science. Students in second or third year of studies submit their applications to the respective Head of their Department by 31 March. Selection will be made by Faculty of Engineering and Applied Science Operations Committee (Scholarships).

J.J. Denny Memorial Scholarship

Founded by Mrs. J.J. Denny and by the Classes of '03-'06 and other friends of James Denny, M.Sc.'21, for standing on year's work. On the recommendation of the Department of Mining Engineering, two awards are made, one in the 'mining option' and the other in the 'mineral processing option', with preference given to students in their second year.

J.J. Denny Memorial Scholarship in Geological Engineering

Established from the sale of gold nuggets donated by Mrs. J.J. Denny in memory of James Denny, M.Sc. '21, and awarded on the basis of academic performance in the second year to two students entering the third year of a program in Geological Engineering. The scholarships are awarded on the recommendation of the department and students entering fourth year may be chosen if there are no suitable candidates entering third year.

Charles W. Drury Scholarship

The will of C.W. Drury, B.Sc. 1909, provides for this scholarship. Open to students entering third or fourth year of the Materials Option in Mechanical Engineering. Awarded on the recommendation of the Department of Mechanical and Materials Engineering mainly for academic excellence but consideration will be given for evidence of additional traits desirable in a professional engineer.

Lorne C. Elder Scholarship in Mechanical and Materials Engineering

Details of these awards are given in the section on *First Year Awards*.

Endeavour Silver Corp. Scholarship

Established in January 2012 by Endeavour Silver Corp. and awarded on the basis of academic excellence to students entering third or fourth year in the Geological Sciences program in the Faculty of Arts and Science, or the Geological Engineering program in the Faculty of Engineering and Applied Science. Selection will be made by the Undergraduate Scholarship Committee in the Department of Geological Sciences and Geological Engineering.

Engineering Society Prize

Given by the Engineering Society to the student in second year Engineering who has exhibited the most ability in non-athletic extracurricular leadership and activity. Recipient is chosen in consultation with the Engineering Society Awards Committee.

Fluor Canada Ltd. Scholarship

Established in September 2009 by Fluor Canada Ltd. Awarded on the basis of academic excellence to full-time students who are Canadian citizens or permanent residents entering the third or fourth year of the Chemical Engineering, Electrical and Computer Engineering, Mechanical or Civil Engineering program in the Faculty of Engineering and Applied Science.

Les Gulko Award

Awarded on the recommendation of the Department of Mathematics and Statistics to a student entering the third year of the Mathematics and Engineering program, based on academic performance in the second year. At the discretion of the Department, the award may be divided equally between two qualified candidates.

J.C. Gwillim Prize

Awarded for standing on year's work to candidates in Mining Engineering.

Robert Hall Memorial Award

Founded by the class of Science '86 and the Queen's Mining Club in memory of Robert Hall, a member of Science '86. Awarded on the basis of interest in the Engineering Society, participation in intramural or intercollegiate sports and the demonstration of those qualities exemplified by Robert Hall: spirit, fellowship and enthusiasm. The recipient will have passed all the courses of the First Year and maintained a full academic program in the second year. Selection is by the Engineering Society from nominations made by the engineering student body. A replica of the commemorative plaque will be presented annually in March with the award.

Mike Hamze Memorial Scholarship

Established in March 2002 by friends, family and co-workers in memory of Mike Hamze, B.Sc. 1997 (Eng.). Awarded to a student entering the third or fourth year in the Civil Engineering program in the Faculty of Applied Science based on academic merit and community involvement. Applicants should submit a letter of application, along with a resume, to the Head of the Department of Civil Engineering by 31 March.

James Hickey Memorial Prize

Established by Mr. and Mrs. J.W. Hickey, Marmora, Ontario, in memory of their son, James Hickey, for standing in MECH 213.

Lawrence M. Hunter Memorial Award

Established by John L. Hunter, B.Sc. 1969, in memory of his father, Lawrence M. Hunter, B.Sc. 1936 and awarded to a student entering the third or fourth year of studies in the Faculty of Applied Science, who has made outstanding humanitarian contributions as evidenced through volunteer activities both within and outside of the university environment while maintaining satisfactory academic achievement. Preference will be given to candidates who have not received other University awards of higher value. This award may be received only once by an individual. Students in second year or third year of studies submit their application by letter, accompanied by a resume and two letters of reference, one of which must be from an individual who can attest to the student's humanitarian efforts and submitted to the Faculty of Engineering and Applied Science by 31 March.

Ingenium Group/Joe Dominik Scholarship

Established in May 2005 by the Ingenium Group in memory of Joe Dominik, a Queen's alumnus and local Kingston Architect. Awarded on the basis of academic excellence to a full-time student entering the third year of study in the Department of Electrical and Computer Engineering in the Faculty of Engineering and Applied Science.

Nellie and Ralph Jeffery Awards in Mathematics

Details of these awards are given in the section on *Third Year Awards*.

Shirley C. Kennedy Scholarship in Civil Engineering

Established in November 2006 memory of Shirley C. Kennedy, Arts 1940, and awarded on the basis of academic excellence to a full-time undergraduate or graduate student in the Department of Civil Engineering. Selection will be made by the Departmental Awards Committee.

KGHM International Ltd. Scholarship

Established in March 2012 by KGHM International Ltd. and awarded on the basis of academic excellence and proven leadership skills, to undergraduate students registered in the Geological Engineering program or the Mining Engineering program in the Faculty of Engineering and Applied Science. A letter of application outlining interest and engagement in the mining industry, as well as a resume is to be submitted to the Office of the University Registrar, Student Awards, by 1 March. Selection will be made by a Committee comprised of faculty members from the Department of Geological Sciences and Geological Engineering and the Robert M. Buchan Department of Mining.

Cyril W. Knight Scholarship

A bequest by Douglas G.H. Wright, awarded to student who attains the highest Grade Point Average in all science and engineering courses in both first and second years of the program.

Kostuik Scholarship in Mining Engineering

Established by Anne and John Kostuik, B.Sc. Eng. '34, and awarded on the basis of academic standing to one student entering the third year and one student entering the final year of the Mining Engineering program.

Frank B. Lee Memorial Scholarship in Engineering

Established by friends and family in memory of Frank B. Lee, B.Sc. 1945. Awarded on the basis of high academic standing to a student entering the third year of any engineering program in the Faculty of Engineering and Applied Science.

Ian Joseph MacDonald Scholarship in Mechanical Engineering

Founded in memory of Dr. Ian J. MacDonald, Sc. '54, awarded to the Mechanical Engineering student completing second year with the highest aggregate mark in the courses in Statics, Kinematics, Dynamics, and Solid Mechanics.

Clifton Campbell MacKinnon and Barbara Claire Adsit MacKinnon Prize in Mechanical Engineering

Established by the family of the late C.C. MacKinnon, Science '36. Awarded to the second year Mechanical Engineering student with the highest standing on the year's work.

Alexander Macphail Scholarship

Maintained by the Class of Science '14, for standing on year's work.

Michele Mainland Memorial Scholarship in Chemical Engineering

Established in memory of Michele Mainland, B.Sc. '97, by family, friends and fellow students to honour Michele's love of learning and education. Two awards are given annually to students in second and third year Chemical Engineering with the highest overall standing on year's work.

Roberta McCulloch Prize in English

Founded by the late Andrew McCulloch of Thorold. Awarded to the student in second, third or fourth year Engineering and Applied Science who achieves the highest standing in an English course.

McLean Family Award in Student Design

Established in March 2007 by the McLean family in honour of Kenneth Mclean, B.S.c (Eng. Phys.) 2005, in appreciation for the valuable team experiences and life lessons learned from his active participation with the Queen's Solar Vehicle Team from 2001 to 2005. Awarded to an upper year student in the Faculty of Engineering and Applied Science who has a cumulative average of at least 65% and who is actively involved on a student design team, with preference to students who are members of the Solar Vehicle Team. Preference will be given to students whose address on admission to Queen's was from outside the province of Ontario. Application is by letter, along with a written endorsement by a design team faculty member, to the Faculty of Engineering and Applied Science by 31 March. The recipient shall be selected by the Engineering and Applied Science Operations Committee (Scholarships).

Mining 1988 Scholarship

Awarded, on the recommendation of the Head of the Robert M. Buchan Department of Mining, to a student entering third or fourth year of the Mining Engineering academic plan in the Faculty of Engineering and Applied Science who demonstrates good character and strong industry leadership potential, a keen interest and aptitude for his or her studies in mining engineering and the desire and ambition to truly make a difference in the global metals and minerals industry. Consideration will also be given for the candidate's involvement in extracurricular activities at Queen's, school spirit and impace on class camaraderie.

Modular Mining Systems Scholarships

Established in April 2012 by Modular Mining Systems and awarded on the basis of academic excellence to an undergrdauate student entering second or third year in the Mining Engineering Option of the Mining Program in the Faculty of Engineering and Applied Science, and to an undergraduate student entering second or third year in the Mining-Mechanical Option of the Mining Program in the Faculty of Engineering and Applied Science. Selection will be made by the Faculty of Engineering and Applied Science Operations Committee (Scholarships). Two awards available.

R.T. Mohan Undergraduate Scholarship in Chemistry

Awarded to a promising student entering the third or fourth year of the Engineering Chemistry program in the Faculty of Engineering and Applied Science or the Honours Chemistry program in the Faculty of Arts and Science, provided that the recipient has first class standing. At the discretion of the Department, the scholarship may be divided equally between two qualified candidates. A Mohan Scholar may be eligible for renewal of the award once only in competition with other qualified candidates.

Mowat Prize

Founded by John McDonald Mowat for standing on year's work.

Frank S. Pichler Memorial Scholarship

Established in April 2012 by Sherly Pichler in memory of her husband Frank S. Pichler, B.Sc. (Eng) 1983. Awarded on the basis of academic excellence to students entering third or fourth year in the Robert M. Buchan Department of Mining. Selection will be made by the Engineering and Applied Science Operations Committee (Scholarships).

William Wallace Near Scholarship

Established under the terms of the will of W.W. Near of Toronto, for standing on year's work.

Emil Nenniger International Exchange Scholarship in Chemical Engineering

Established in 2004 by Dr. Emil Nenniger, B.Sc. '50 and awarded on the basis of academic excellence to a student entering third year in the Department of Chemical Engineering or Engineering Chemistry in the Faculty of Engineering and Applied Science, who has been selected to participate in an official exchange program at a location outside Canada. Letters of application must be submitted to the Head of Chemical Engineering by 1 March. Selection will be made by the Departmental Scholarships Committee.

Dr. William H. Nichols Prize in Chemistry

Founded by Mr. C.W. Nichols in memory of his father, Dr. William H. Nicols. Awarded annually to a student in the Faculty of Engineering and Applied Science or in the Faculty of Arts and Science who has attained the highest standing in CHEM 213.

Northeastern Chemical Association Scholarship

Established by Northeastern Chemical Association, Inc. and awarded to a full-time undergraduate student enrolled in Chemical Engineering, Engineering Chemistry or Chemistry on the basis of academic performance and interest in science issues. Students must submit a letter of application outlining goals, interests, career objectives and experience to the Head of their Department by 15 March, who will then forward nominations by 1 April to their respective Scholarship Committee.

Novelis Scholarship

Established in April 2006 by Novelis Inc. Two scholarships will be granted to students in the penultimate or final year on the basis of academic excellence. One scholarship will alternate between the School of Business and the Faculty of

Arts and Science (Chemistry, Economics, Geological Sciences or Physics). The scholarship will be awarded to a student in the Faculty of Arts and Science in even numbered years and to a student in the Bachelor of Commerce program in odd numbered years. **One scholarship will be awarded to a student in any program of Engineering in the Faculty of Engineering and Applied Science**. Preference will be given to children of Novelis employees who have applied by letter to the Associate University Registrar (Student Awards) by 1 March. If there are no eligible children of Novelis employees, the selection will be made by the Awards Committee of the faculties.

O'Connor Associates Scholarship in Geological Engineering

Established by O'Connor Associates Environmental Inc. and awarded to a student entering the third year of the Geological Engineering program, Geo-environmental Option. Selection will be based on a strong academic record, a keen interest in environmental issues, and participation in student activities. The scholarship recipient will be selected by the Geo-environmental Engineering Steering Committee, in consultation with second year instructors. If there is no suitable candidate entering third year, the scholarship may be awarded to a student entering fourth year.

Ontario Power Generation Award

Established by Ontario Power Generation and awarded to a student who at the time of application is registered in second year in any program in the Faculty of Engineering and Applied Science. The recipient must be a Canadian citizen or a landed immigrant to be eligible. Selection will be based on academic achievement, strong oral and written communication skills, leadership ability and involvement in extra-curricular activities. The recipient must be a member of the employment equity target groups (women, aboriginal, disabled, visible minority) and cannot hold more than one other award of equal or greater approximate value. Candidates should submit a letter of application to the Head of Departments by 31 January and selection will be made by the Engineering and Applied Science Operations Committee (Scholarships).

Ontario Professional Engineers Foundation for Education Scholarships

Details of this award are given in the section on *First Year Awards*.

David Parkes Scholarship in Applied Science

Established by David Parkes, B.Sc. 1968, and awarded on the basis of academic excellence to a full-time upper year student in the Faculty of Engineering and Applied Science.

Polycorp Ltd./Kumar Scholarship in Mining Engineering

Details of this award are given the in section on First Year Awards.

Queen's C.A.P. Prize Examination Award

Established in April 2008 by the Department of Physics, Engineering Physics and Astronomy, and awarded annually to students based on their academic performance in the nationwide Canadian Association of Physicists University Prize Examination. Awarded to first and second ranked students in each of second, third, and fourth year of undergraduate studies in the Department of Physics, Engineering Physics and Astronomy. Selection of award recipients will be based on the recommendation of the Department of Physics, Engineering Physics and Astronomy.

QUIP International Tuition Award

Established in November 2007 by the Faculty of Engineering and Applied Science and awarded on the basis of academic achievement to international students participating in the Queen's University Internship Program (QUIP).

James H. Rattray Memorial Scholarships in Applied Science

Details of this award are given in the section on *First Year Awards*.

Alvin Craig Ross Memorial Scholarships in Mineral Processing

Established in memory of Alvin Craig Ross by his father, Mr. A.H. Ross, B.Sc.(Eng.)'36. One scholarship is awarded annually on the completion of the second year and one on the completion of the third year, to candidates enrolled in Mining Engineering, who are Canadian citizens resident in Canada who have demonstrated an interest in the field of extractive metallurgy and have expressed an intention of making a career in the mining industry in Canada. Selection is based on academic standing, character, personal initiative and industry, and reliability. Financial need will only be considered if two applicants exist with comparable other qualifications. Candidates will be recommended to the Engineering and Applied Science Operations Committee by a committee composed of the Dean of Engineering and Applied Science and Head of the Mining Engineering, by 1 May.

Science 1911 Prize

Awarded for standing on year's work.

Science 1922 Scholarship

Maintained by the Class of Science '22, for standing on year's work.

Science 1945 Memorial Scholarship

Details of this award are given in the section on *First Year Awards*.

Science 1946 Memorial Upper Year Scholarship

The Science 1946 Memorial Upper Year Scholarship is maintained by the Class of Science '46 as a memorial to members who gave their lives in World War II. Awarded on the basis of academic excellence to a student entering second or third year in the Faculty of Engineering and Applied Science.

Science 1948 S.N. Graham Award

Founded by the class of Science '48 in honour of Professor S.N. Graham. Awarded on the completion of the second year to a student with a sound academic record who has demonstrated outstanding performance in extra-curricular activities on campus. Nominations are to be made by Heads of Departments by 31 March, who will then forward their nomination to the the Faculty of Engineering and Applied Science for selection by the Operations Committee (Scholarships).

A.E. Segsworth Prize

Founded by R.F. Segsworth of Toronto in memory of his brother. Open to a student in any year on the basis of the best essay describing his or her experiences in practical underground mining. Essays to be submitted by 31 March to the Robert Buchan Department of Mining.

Raymond H. and Phyllis J. Smart Scholarships

Details of this award are given in the section on *First Year Awards.*

Carolyn F. Small Memorial Award for Design Innovation

Awarded on the basis of demonstrated outstanding creativity in the practice of engineering design to an individual or a group of students at Queen's University who are directly involved with academic or sponsored extracurricular design efforts associated with or funded by the Faculty of Engineering and Applied Science.

Robert E. Smith Memorial Scholarship in Mining Engineering

Established by the family and friends of Robert Evan Smith, a Queen's Mining Engineer, who died in a tragic mining accident shortly after graduation in 1984. Awarded to a full-time Canadian student entering the third or fourth year. The recipient will be one who conscientiously contributes to all aspects of university life, while maintaining good academic standing and who exhibits cheerful enthusiasm and a positive attitude towards the Mining Engineering program and the mining industry in general. Financial need will also be taken into consideration, as will the recipient's personality and compassion towards fellow students. Selection will be made by the Head of the Department of Mining Engineering in consultation with appropriate instructors.

Stantec Award in Civil Engineering

Details of this award are given in the section on *First Year Awards*.

Alice Pierce Waddington Scholarship

Open to students in Civil Engineering specializing in building construction. Awarded on scholastic ability and attainment, integrity of character and purpose.

William E. White Scholarships in Geological Sciences and Geological Engineering

Established by a bequest from the estate of William E. White, B.A. (1929), B.A. (Hons) 1930, and Medalist in Geology. Awarded to students in the second year, or students entering third or fourth year of a program leading to B.Sc. degree with a concentration in Geological Sciences in the Faculty of Arts and Science or a B.Sc. degree in Geological Engineering in the Faculty of Engineering and Applied Science. Awards are based on academic achievement and contribution to the Department as judged by the Head of the Department in consultation with the Department's teaching staff.**Awards to second-year students are made in January** based on performance in GEOL 211 or 221 and GEOL 232. **Awards to third-and fourth-year students are made in the Spring.**

W.P. Wilgar Memorial Scholarship

Maintained by the classes of Science '03-'06 and other friends of W.P. Wilgar, B.Sc. '03, for standing on year's work.

Marion and Arthur Wonnacott Scholarship

Established in September 2008 from the estate of Marion Wonnacott and Arthur Wonnacott, B.A. 1934. **Two awards will be made each year**, one to a student in Arts and Science who achieves the highest combined average in MATH 280 and 281 taken in the same year and one to the student in Engineering and Applied Science who achieves the highest combined average in MTHE 280 and MTHE 281.

Third Year Awards

Joseph Abramsky Prize

Founded in memory of Joseph Abramsky by his sons, for standing on year's work. Open to candidates in Mechanical Engineering.

Accenture in Applied Science Scholarship

Established in May 2002 by Accenture Inc. and awarded to a student entering fourth year in the Faculty of Applied Science. Selection will be made on the basis of academic excellence and leadership in extracurricular activities, such as professional or social organizations, sports, or part-time employment. Preference will be given to students who have had exposure to a consulting business or initiative in the past. Application is by letter with attached resume to the Faculty of Engineering and Applied Science by 31 March for selection by the Operations Committee (Scholarships).

Frederick and Christopher Ansley Scholarship

Established by Peter Ansley's family in honour of his father Frederick C. Ansley, B.Sc. (Eng.) 1937 and brother Christopher Ansley, B.Sc (Eng.) 1969, and awarded to a student entering the fourth year of the Civil Engineering program. Selection will be based on academic excellence and contribution to the betterment of campus life through interest in the student chapters of the profession, Engineering Society, campus activities and community affairs. Applications and nominations should be submitted to the Head of the Department of Civil Engineering by 1 March. Selection will be made by the Departmental Awards Committee.

Leonard G. Berry Memorial Award

Established by the family, colleagues, friends and former students of the late Professor Leonard G. Berry, professor of mineralogy at Queen's University from 1944 to 1980, as a tribute to his outstanding contributions to mineralogical science and his devotion as a teacher. Awarded, on the recommendation of the Department of Geological Sciences and Geological Engineering, to a senior undergraduate student with a strong academic record and a demonstrated interest in mineralogy. To be eligible, the student must be enrolled in an honours B.Sc. program with a concentration in

Geological Sciences in the Faculty of Arts and Science, or in Geological Engineering in the Faculty of Engineering and Applied Science.

Donovan Brown Scholarship in Applied Science

Details of this award are given in the section on *Second Year Awards*.

Orville and Carmel Brown Scholarship

Details of this award are given in the section on *Second Year Awards*.

Erwin Buncel Scholarship in Chemistry

Details of this award are given in the section on *Second Year Awards*.

Cameron Applied Science Scholarship

Details of this award are given in the section on *Second Year Awards*.

Kenneth B. Carruthers Scholarship in Mechanical Engineering

Founded in memory of Major K.B. Carruthers, B.Sc., for standing on year's work. Open to candidates in Mechanical Engineering, Materials option.

Kenneth B. Carruthers Scholarship in Mining Engineering

Founded in memory of Major K.B. Carruthers, B.Sc., for standing on year's work. Open to candidates in Mining Engineering.

Harold M. Cave Scholarship in Experimental Physics

Established in memory of Harold M. Cave, M.A. (Queen's), Ph.D. (Cantab), who taught in the Physics Department from 1930 until years after his retirement in 1967. Two scholarships are awarded annually to students with first class standing, one entering the third year leading to a B.Sc. degree in Engineering Physics and one entering the third year of a B.Sc. (Honours) program in Arts and Science with a concentration in Physics. The awards will be based on achievement in experimental work as judged by the Department of Physics.

Harold M. Cave Undergraduate Travel Scholarship

Details of this award are given in the section on *Second Year Awards*.

CMC Electronics Scholarship

Established by the Canadian Marconi Company, this scholarship is awarded annually to a student with high academic standing in the third year of an Electrical or Computer Engineering program in the Faculty of Engineering and Applied Science.

Harold Arthur Cohen Book Prize in Engineering Physics

Established by the family in memory of Harold Arthur Cohen, B.A. 1928, B.Sc. 1930 (Engineering Physics). Awarded to a student entering the fourth year of Engineering Physics who shows the most promise for inventiveness and discovery in Engineering Physics, as determined by the Chair of the Engineering Physics program.

ConeTec Geotechnical Award

Details of this award are given in the section on *Second Year Awards.*

ConeTec Geotechnical Award in Mining Engineering

Details of this award are given in the section on *Second Year Awards.*

H. Arnold Cowan Scholarship

Details of this award are given in the section on *Second Year Awards.*

Eric R. Davis Memorial Award in Applied Science

Details of this award are given in the section on *First Year Awards.*

Delcan Corporation Scholarship in Applied Science

Details of this award are given in the section on *Second Year Awards.*

John Deere Foundation of Canada Scholarship in Mechanical Engineering and Commerce

Established by the John Deere Foundation of Canada and awarded on the basis of academic merit to a student entering the final year of the Mechanical Engineering program in the Faculty of Engineering and Applied Science or to a student entering the final year of the Commerce program in the School of Business. The award will be presented to a student in Mechanical Engineering in even-numbered years and to a student in Commerce in odd-numbered years.

J. Allan Donaldson Prize in Geology

Established by J. Allan Donaldson, B.Sc. 1956, and awarded to a student entering the fourth year in either an Honours B.Sc. program in the Faculty of Arts and Science with a concentration in Geological Sciences or in the Geological Engineering program in the Faculty of Applied Science. If there are no eligible recipients the award can be given to a student entering third year. The recipient of the award will have demonstrated an involvement and ongoing interest in the broad area of Precambrian geology, as demonstrated by coursework and/or summer field employment. The recipient will be chosen by the Head of the Department of Geological Sciences and Geological Engineering, in consultation with the Chairs of Arts and Science for Geology and Engineering and Applied Science for Geological Engineering.

Drilling and Blasting Scholarship

Established in October 2012 by Jamie Archibald and the Rock Mechanics Group of the Robert M. Buchan Department of Mining to honour those in the mining industry who strive to augment explosives technology training and enhance the safety of all who participate in explosives applications within this industry. Awarded on the basis of academic excellence in MINE 321 (Drilling and Blasting) to students entering year four in the Mining Engineering program in the Robert M. Buchan Department of Mining. Selection will be made by the Faculty of Engineering and Applied Science Operations Committee (Scholarships).

Charles W. Drury Scholarship

The will of C.W. Drury, B.Sc. (Queen's)'09, provides for this scholarship. Open to students entering third or fourth year of the Materials Option in Mechanical Engineering. Awarded on recommendation of the Department of Mechanical and Materials Engineering mainly for academic excellence but consideration will be given for evidence of additional traits desirable in a professional engineer.

Endeavour Silver Corp. Scholarship

Details of this award are given in the section on *Second Year Awards*

Engineering Physics Award

Awarded to a student, with at least second class standing, entering preferably the third or alternatively the fourth year of the Engineering Physics program whose total awards, administered by Queen's University, will not exceed twice the tuition fees for Canadian residents. The award is restricted to women until such time as 50 percent of the students registered in Engineering Physics are women. Applications should be made by 31 March to the advisor of Engineering Physics, who will make the nomination on behalf of the Department.

Expo 1986 Award

Established to commemorate the 1986 International Exposition held in Vancouver, and the Innovative Vehicle Design Competition held during the exposition, in which the team from Queen's University received fourth prize. Awarded on the recommendation of the Dean in consultation with the Engineering Society to a student entering the final year of a program in Mechanical Engineering, Electrical Engineering or Computer Engineering. Selection will be on the basis of academic standing, a demonstrated ability in innovative engineering design, and participation in extra-curricular activities. Applications must be submitted to the Faculty of Engineering and Applied Science for selection by the Operations Committee (Scholarships) by 31 March.

Fifth Field Company Prize

Provided from funds accumulated by members of the unit since World War I. Awarded to student in Civil Engineering standing highest in third year course in hydraulics.

Fluor Canada Ltd. Scholarship

Details of this award are given in the section on *Second Year Awards.*

J. Nelson Gibson, B.Sc., Memorial

Awarded by Department of Mechanical Engineering to student entering fourth year Mechanical Engineering; consideration given to academic status and need.

Mike Hamze Memorial Scholarship

Established in March 2002 by friends, family and co-workers in memory of Mike Hamze, B.Sc. 1997 (Eng.) Awarded to a student entering the third or fourth year in the Civil Engineering program in the Faculty of Engineering and Applied Science based on academic merit and community involvement. Applicants should submit a letter of application, along with a resume, to the Head of the Department of Civil Engineering by 31 March.

Wm. Roy Hardick Scholarship

Established through the estate of Mr. Wm. Roy Hardick, B.A. 1933, M.A. 1934. Two scholarships are awarded on the basis of academic excellence: one scholarship to an undergraduate student entering fourth year in the Faculty of Arts and Science with a concentration in Mathematics and Statistics and one scholarship to an undergraduate student entering fourth year in the Faculty of Engineering and Applied Science in the Mathematics and Engineering program.

Lawrence M. Hunter Memorial Award

Details of this award are given in the section on *Second Year Awards.*

Nellie and Ralph Jeffery Awards in Mathematics

Details of this award are given in the section on *Second Year Awards.*

Shirley C. Kennedy Scholarship in Civil Engineering

Details of this award are given in the section on *Second Year Awards.*

KGHM International Ltd. Scholarship

Details of this award are given in the section on *Second Year Awards.*

The Kostuik Scholarship in Mining Engineering

Details of this award are given in the section on *Second Year Awards.*

Mark Latham Memorial Award

Established by the family and friends in memory of Mark Latham (B.Sc. '83), a Queen's Engineering Chemist. The purpose of this award is to recognize a student with personal characteristics similar to those of Mark Latham. The purpose of this award is to recognize students with personal characteristics similar to those Mark Latham. It will be awarded to students in good academic standing entering the fourth year of the Faculty of Engineering and Applied Science. The recipients will be well rounded students combining enthusiasm and leadership with integrity and a sense of humour. Candidates for this award will have made significant contributions to Queen's and the community. Selection shall be made by the Operations Committee (Scholarships) of Engineering and Applied Science based on nominations provided by the Engineering Society.

Reuben Wells Leonard Penultimate Scholarships

Given by Reuben Wells Leonard for standing on year's work in any program in engineering. A minimum average of 80 percent is required.

Michele Mainland Memorial Scholarship in Chemical Engineering

Details of this scholarship are given in the section on *Second Year Awards.*

Kogi Lon Mayell Memorial Scholarship

Established in memory of Kogi Lon Mayell, B.Sc.'91, by his family and friends and awarded on the basis of academic performance to a student entering the final year of the Mechanical Engineering program. The recipient should also be involved in student affairs, sports, and other extracurricular activities and show a willingness to assist fellow students. The selection of the candidate will be made by the Head of Mechanical Engineering in consultation with members of the Department.

Roberta McCulloch Prize in English

Details of this scholarship are given in the section on *Second Year Awards.*

McLean Family Award in Student Design

Details of this award are given in the section on *Second Year Awards.*

Edward Hugh McLellan Memorial Scholarship in Soil Mechanics

Established in memory of Edward Hugh McLellan, Sc.'80. Awarded annually to the Civil Engineering student with the highest standing in CIVL 340.

Andrew McMahon Standards of Excellence Award

Established in memory of Andrew M. McMahon Sc. '59, a former president of the Engineering Society and member of the Board of Trustees. Awarded annually in Engineering and Applied Science on the basis of academic achievement to a third year student in the top 25% of the class who is entering fourth year. Preference will be given to students who have demonstrated an interest in business studies or economics. The recipient will show a strong record of participation in student organizations and government, extra curricular and community activities and interest in promoting the well-being of the University. The recipient will be chosen by a Selection Committee, to be chaired by a member of the family, consisting of the Associate Dean (Academic), one member of the business community and a family member. Candidates should submit a letter of application and supporting documents to the Faculty of Engineering and Applied Science by 31 March.

Mining Engineering Scholarship

Established in May 2007 by Bill James, LL.D 1990, and awarded on the basis of academic excellence and demonstrated leadership qualities to a student entering the fourth year of the Mining Engineering program in the Faculty of Engineering and Applied Science. Students should apply by letter, with a resume, to the Buchan Department of Mining by 31 March.

Mining 1988 Scholarship

Details of this award are given in the section on *Second Year Awards.*

R.T. Mohan Undergraduate Scholarship in Chemistry

Details of this award are given in the section on *Second Year Awards.*

Modular Mining Systems Scholarships

Details of this award are given in the section on *Second Year Awards.*

Susan Near Scholarships

Established under terms of the will of Susan Near of Toronto, for standing on year's work. (5 available)

Susan Near Prizes in Chemistry

Founded by the late Susan Near of Toronto. Two prizes to be awarded, one to the student in Arts and Science with the highest standing in CHEM 397, and one to the student in Applied Science with the highest standing in CHEM 398 or CHEM 399, provided the mark obtained in each case is at least 80 per cent.

William Wallace Near Scholarships

Established under the terms of the will of W.W. Near of Toronto, for standing on year's work; one awarded to a student in each of the following programs: Engineering Chemistry, Chemical Engineering and Civil Engineering.

P.E. Newbury Prize in Geological Sciences and Geological Engineering

Established by the late Mrs. Peggy Ethel Newbury. Awarded in the Fall on the recommendation of the Department of Geological Sciences and Geological Engineering for outstanding achievement in geological field work, with at least second class standing in the previous year's academic work.

Northeastern Chemical Association Scholarship

Details of this award are given in the section on *Second Year Awards.*

Novelis Scholarship

Details of this award are given in the section on *Second Year Awards.*

Ontario Professional Engineers Foundation for Education

Details of this award are given in the section on *First Year Awards.*

David Parkes Scholarship in Applied Science

Details of this award are given in the section *Second Year Awards.*

Christopher Petrie Memorial Prize in Physics

Awarded to a student in either Engineering and Applied Science or Arts and Science who has obtained a first class standing in a third year laboratory course in experimental physics and who, in the opinion of the department, shows the most promise of future achievement in experimental physics.

Mark Pettit Memorial Prize

Established in April 2002 by friends and family in memory of Mark Pettit, B.Sc. (Mechanical Eng.) 2000. Awarded annually to a student in the third year of the Mechanical Engineering program in the Faculty of Engineering and Applied Science who has applied and been accepted into the Queen's Undergraduate Internship Program (QUIP). The candidate should demonstrate an enthusiasm for engineering and a proven record of helping his/her classmates, as well as a solid academic record. Nomination forms are available from the Department of Mechanical Engineering and must be submitted to the Department by 15 April. Selection of the candidate is made by the Head of the Department of Mechanical Engineering in consultation with faculty and students.

Frank S. Pichler Memorial Scholarship

Details of this award are given in the section *Second Year Awards.*

Polycorp Ltd./Kumar Scholarship in Mining Engineering

Details of this award are given in the section on *First Year Awards.*

W.T. Pound Engineering Design Award

In memory of William Thomas Pound, who graduated from Queen's University in Mechanical Engineering in 1929. Awarded to a third year student upon completion of MECH 323 Machine Design. The award is directed to the individual who has demonstrated an exceptional understanding of machine design principles, and an outstanding aptitude for creative and innovative design. The selection of the candidate will be made by the Head of the Department in consultation with the course instructors.

Queen's C.A.P. Prize Examination Award

Details of this award are given in the section on *Second Year Awards.*

QUIP International Tuition Award

Established in November 2007 by the Faculty of Engineering and Applied Science and awarded on the basis of academic achievement to international students participating in the Queen's University Internship Program (QUIP). **Value: variable on the basis of available funding and duration of internship.**

James H. Rattray Memorial Scholarships in Applied Science

Details of this award are given in the section on *First Year Awards.*

Major James H. Rattray, M.C. Prize in Mining

Founded by Major J.H. Rattray, M.C., for general proficiency in Mining. Aptitude as well as academic standing to be taken into account in making the award.

Carl Reinhardt Scholarship in Physics

To be awarded annually on the basis of standing at the end of the third year to a student registered in the fourth year of a B.Sc. program in engineering physics or an honours B.Sc. program with concentration in physics who does not already hold an award of higher approximate value.

Rock Mechanics Achievement Scholarship

Esablished in January 2012 by James F. Archibald and the Rock Mechanics Group of the Robert M. Buchan Department of Mining. Awarded on the basis of academic excellence in the third year course in Applied Rock Mechanics to a student entering the fourth year in Mining Engineering in the Robert M. Buchan Department of Mining. Selection will be made by the Faculty of Engineering and Applied Science Operations Committee (Scholarships).

Alvin Craig Ross Memorial Scholarships in Mineral Processing

Details of these awards are given in the section on Second Year Awards.

Science 1944 Memorial Prize

Maintained by the class of Science '44 in memory of members who were killed in World War II. Awarded on basis of extra-curricular student activities. Candidates must have passed all work of year.

A.E. Segsworth Prize

Details of this award are given in the section on *Second Year Awards.*

Raymond H. and Phyllis J. Smart Scholarships

Details of this award are given in the section on *First Year Awards.*

Carolyn F. Small Memorial Award for Design Innovation

Details of this award are givenin the section on *Second Year Awards>*

Robert E. Smith Memorial Scholarship in Mining Engineering

Details of this award are given in the section on *Second Year Awards.*

Roberto Rocca/Tenaris Scholarships

Established in April 2010 by Tenaris and the Roberto Rocca Education Program. The scholarships reflect the long-standing commitment of the late Roberto Rocca and Tenaris to supporting education at all levels in countries where the sponsoring companies have a major presence. Throughout his lifetime Roberto Rocca demonstrated an abiding concern for education, founding and supporting a variety of initiatives dedicated to learning at all levels and research. Awarded on the basis of academic excellence to students entering their final year in the Faculty of Engineering and Applied Science. Preference will be given in the following order of priority: (a) female students from Norther Ontario or Alberta; (b) students from Northern Ontario or Alberta; (c) female students. Selection will be made by the Operations Committee (Scholarships) of the Faculty of Engineering and Applied Science. **3 awards**

Walter Thumm Memorial Scholarship in Physics

Established by his family and friends in memory of Walter Thumm, Professor at Queen's until his death in 1977. By his understanding and enjoyment of physics, by his writing and by his own example, he inspired countless students and teachers of physics. Awarded on the recommendation of the Physics Department to a student beyond the second year who has indicated his/her intention of pursuing a career in teaching physics, preferably at the high school level, and who has a strong aptitude in physics as well as a demonstrated commitment to teaching.

Howard Vance Memorial Book Prize

Established in memory of Howard Vance, B.Sc. '70. Awarded annually to the Civil Engineering student proceeding to the final year who, in the opinion of the Department of Civil Engineering, has made the greatest improvement in his/her academic work from second to third year.

WAMIC Scholarship

Established in October 2010 by the Women's Association of the Mining Industry of Canada Foundation and awarded on the basis of academic excellence to students entering year four in the Robert M. Buchan Department of Mining or the Geological Engineering program in the Department of Geological Sciences and Geological Engineering. Selection will be made by the Faculty of Engineering and Applied Science Operations Committee (Scholarships).

William E. White Scholarships in Geological Sciences and Geological Engineering

Details of these awards are given in section on *Second Year Awards.*

Martin Wolff Memorial Prize

Established by Dr. A.R. Bader in memory of Martin Wolff, for standing on year's work. Open to candidates in Civil Engineering.

Fourth Year Awards

L.M. Arkley Prize

Founded by the Scots Run Fuel Corporation of Morgantown, W.Va., in recognition of Professor Arkley's interest in the proper methods of purchasing, analyzing and burning coal. Awarded to a fourth year Mechanical Engineering student or group of students who submits the best paper, supported by an oral presentation, on a subject of the students' choice and with the approval of the Mechanical Engineering Department. Selection will be made by the Department of Mechanical Engineering by 31 March.

Alfred Bader Scholarship in Chemistry

Established by A.R. Bader, M.Sc. (Queen's), Ph.D. (Harvard). Awarded to a student in Arts and Science or in Engineering and Applied Science who has registered in the fourth year and obtained the highest Grade Point Average in Chemistry 311 or Chemistry 345.

Orville and Carmel Brown Scholarship

Details of this award are given in the section on Second Year Awards.

Harold M. Cave Undergraduate Travel Scholarship

Details of this award are given in the section on *Second Year Awards.*

George Christie Design Awards

Established by J.G. Parrett, B.Sc.'89 and W.R. Sherwin, B.Sc.'89 in memory of the late George Christie. The awards are presented to individual students or groups of students in Mechanical Engineering on the basis of their performance in the area of design and product modification in their fourth year Mechanical Engineering Design Project. The selection of award winners will be made by the Department.

Civil 1985 Award

Awarded annually to a 4th year student in Civil Engineering who has contributed to the betterment of campus life through interest in the Engineering Society, Civil Club, campus activities and community affairs. The successful candidate must have maintained a satisfactory academic record. Applications and nominations should be submitted to the Head of the Civil Engineering Department by 31 January.

Charles W. Drury Scholarship in Mechanical Engineering

Details of these awards are given in the section on *Third Year Awards.*

Dynatec Corporation Prize in Mining Engineering

Awarded for combined standing in courses MINE 325 and MINE 444. Details of these awards are given in section on *Fourth Year Awards.*

Willard G. Henry Memorial Scholarship

Established by the family, friends, colleagues and students of the late Dr. Willard Geldard Henry, Professor of Metallurgical Engineering 1962-1981, Head of Department 1977-1981, as a tribute to his outstanding contribution to metallurgical science, his excellence as a teacher and above all, his concern for his fellow man. The scholarship is awarded in the fall on the recommendation of the Head of the Department of Mechanical and Materials Engineering, following consultation with departmental colleagues and students, to a student registered in the fourth year of the Materials Option in the Mechanical Engineering program on the basis of the scholarship, character, industry and contribution to furthering the well-being of the student body. On occasion the scholarship may be given to an exceptional student registered in the third year of the above program.

Shirley C. Kennedy Scholarship in Civil Engineering

Details of this award are given in the section on *Second Year Awards.*

Joan M. Lund Memorial Award

Established by the family and friends of Joan M. Lund, a geophysics student in the Department of Geological Sciences at the time of her death. Awarded in the Fall term in the fourth year of either the Applied Geophysics option, Faculty of Engineering and Applied Science, or the B.Sc. (Honours, Geological Sciences) with Physics program, Faculty of Arts and Science to the student who has contributed most to the geophysics program in the previous years. The recipient will be decided by the Chairpersons of the Engineering and Applied Science and Arts and Science Curriculum and Liaison committees in consultation with the student members of those committees.

Dr. W.B.F. Mackay Memorial Scholarship in Mechanical and Materials Engineering

Established in May 2007 by family, friends, colleagues and students of the late Dr. William Brydon Fraser Mackay, HD.Sc (1993). Awarded to a student in the fourth year of the Materials Option in the Department of Mechanical and Materials Engineering on the basis of academic excellence and contributions to furthering the well-being of the student body by way of active participation in volunteer activities, project teams, and professional and social activities within the Department. Application is by letter, with resume, to be submitted to the Department of Mechanical and Materials Engineering by 1 October.

Roberta McCulloch Prize in English

Details of this scholarship are given in the section on *Second Year Awards.*

McLean Family Award in Student Design

Details of this award are given in the section on *Second Year Awards.*

Novelis Scholarship

Details of this award are given in the section on *Second Year Awards.*

David Parkes Scholarship in Applied Science

Details of this award are given in the section on *Second Year Awards.*

Polycorp Ltd./Kumar Scholarship in Mining Engineering

Details of this award are given in the section on *First Year Awards.*

Queen's C.A.P. Prize Examination Award

Details of this award are given in the section *Second Year Awards.*

Science 1971 Norman Fritz Memorial Award

Awarded annually to a fourth year student of the Faculty of Engineering and Applied Science who displays conspicuous leadership and management skill in a student-organized faculty activity which has educational value. An example of such an activity might be that of Convenor of the Science Formal. The recipient of the award is to be selected by the Dean of Engineering and Applied Science and the presentation will be made during the first quarter of each calendar year.

A.E. Segsworth Prize

Details of this award are given in the section on *Second Year Awards.*

Carolyn F. Small Memorial Award for Design Innovation

Details of this award are given in the section on *Second Year Awards.*

William E. White Scholarships in Geological Sciences and Geological Engineering

Details of these awards are given in the section on *Second Year Awards.*

Graduation Awards

Applied Rock Mechanics Scholarship

Established in January 2012 by Jamie Archibald and the Rock Mechanics Group of the Robert M. Buchan Department of Mining to honour those in the mining industry who strive to augment rock mechanics training and enhance the safety of all who participate in this industry. Awarded on the basis of academic excellence to a student in the fourth year thesis course in the Robert M. Buchan Department of Mining, who has submitted a thesis that relates to practical applications of rock mechanics principles in mining, or to the development of fundamental applications of rock mechanics practice that may advance studies of enhanced mine safety. Selection will be made by the Faculty of Engineering and Applied Science Operations Committee (Scholarships).

Alan Bauer Memorial Prize in Mining Engineering

Established by friends, colleagues and students of Alan Bauer, former Head of the Department of Mining Engineering, as a tribute to his outstanding contributions in teaching and research to the department. Awarded on the recommendation of the Head of the Department to fourth year graduating students in Mining Engineering at Queen's. Two awards will be made annually for the thesis presentation component of course MINE 434. Awards will be presented on the basis of technical content and presentation skills.

Colin T. Bayne Memorial Award

Founded by the Class of Mechanical Engineering '76 and friends in memory of Colin Thomas Watson Bayne, B.Sc. '76. Awarded to the graduating Mechanical Engineering student who, in the opinion of the Department, has shown most proficiency in innovative design.

Diana Blake Memorial Book Prize

A memorial book prize established by the Alumni and Alumnae Associations of Queen's in memory of the late Diana Blake, who was Assistant Chief Librarian at Queen's and Vice-President of the Alumni Association at the time of her death in February, 1975. Awarded annually in turn to a graduating student in the Faculty of Arts and Science, the Faculty of Engineering and Applied Science, and the School of Business. The appropriate Society will be asked to nominate a student who has attained at least second class standing and who has made a significant contribution to campus life prior to 1 March of the graduating year. Nominations will be received and selection of the recipient will be made by the appropriate Faculty Awards Committee.

Dr. Wallace Graham Breck Memorial Prize in Engineering Chemistry

Established by the family of Dr. Wallace Graham Breck, Sc. 50, M.Sc. 51, PhD (Cantab University), and awarded annually to the graduating student who is the recipient of the University Medal in Engineering Chemistry in the Faculty of Engineering and Applied Science. Selection will be made by the Awards Committee of the Department of Chemical Engineering and approved by the Faculty of Engineering and Applied Science Operations Committee (Scholarships).

H.G. Conn Award

Named in honour of Professor H.G. Conn, who has contributed much to Queen's University. It is awarded to graduating students who have rendered valuable and distinguished service to the Engineering Society and the University in non-athletic, extra-curricular activities.

Conn-Gilbert Award for Excellence in Engineering

To be awarded to a Mechanical Engineering student, in the year in which the student graduates, who has the highest average on the core courses in Thermodynamics.

CSME Gold Medal

Awarded by the Canadian Society for Mechanical Engineering to the student graduating in Mechanical Engineering who has achieved the highest overall cumulative average in 2nd, 3rd and 4th years.

H.M. Edwards Memorial Award

Established by his family in memory of the late H.M. (Bert) Edwards, B.Sc. '44, MSCE (Purdue), faculty member in Civil Engineering 1946-1985, as a tribute to his outstanding contribution to the Civil Engineering Department and the Faculty. Awarded annually to the graduating student in Civil Engineering who, in the opinion of the Head of the Department and the Civil Engineering Scholarship Committee, has demonstrated notable proficiency in all fourth year courses.

Dynatec Corporation Prize

Details of this award are given in the section *Fourth Year Awards.*

D.S. Ellis Memorial Award

Given by the class of Science '55 as a memorial to Dean D.S. Ellis. Awarded to graduating student who, in the opinion of classmates, has contributed to the University life through extra-curricular activities and athletics and has maintained satisfactory academic standing.

Engineering Society Award

Awarded by the Engineering Society to honour a student in the fourth year who is not a member of the Engineering Society Executive and who has contributed considerably to the welfare of the Engineering Society.

Engineering Physics Design Award

Awarded to the graduating student in Engineering Physics whose Engineering Physics thesis is judged, by the examiners, to be the best on the basis of design, engineering content, innovation and presentation.

D.M. Jemmett Award

Awarded to a student graduating from the Electrical and Computer Engineering Department who has achieved the highest average in Electrical Engineering courses of all years. Average is based on marks of final examinations and not on results of any repeated courses.

B.E.C. Joyce Memorial Award

Awarded to student graduating in Chemical Engineering who, in the opinion of classmates and department staff, is the outstanding graduate in Chemical Engineering.

Shirley C. Kennedy Scholarship in Civil Engineering

Details of this award are given in the section *Second Year Awards.*

Thomas F. LaPierre Award

Awarded annually to a student graduating from the Electrical and Computer Engineering Department who has achieved the highest honours standing in the program.

S.D. Lash Scholarship

Awarded to a graduating student in the Department of Civil Engineering to encourage travel during the summer preceding the start of a graduate program at any University, in order to give the recipient an appreciation of practical problems in their field of interest. Application is by letter, describing the studies they wish to pursue and the places they would like to visit, to be submitted to the Department of Civil Engineering by March 31. Selection will be made by the Departmental Scholarship Committee.

Boyd Lemna Award

Established by Science '92 in honour of their classmate Boyd Lemna. Awarded annually by the Engineering Society to a mature graduating student(s) who has completed an engineering degree in four years. Preference will be given to students who are parents.

Annie Bentley Lillie Prize in Mathematics

Awarded to graduating student in program in Mathematics and Engineering who has highest average on courses in Mathematics in final year.

Thayer Lindsley Book Prize

Established in memory of Thayer Lindsley and awarded to the graduating student in Geological Engineering in the Faculty of Applied Science, or Geological Sciences in the Faculty of Arts and Science, who has contributed the most to his or her year as judged by staff and students in the Department of Geological Sciences and Geological Engineering.

Michele Mainland Memorial Graduating Scholarship in Chemical Engineering

Established in memory of Michele Mainland, B.Sc. '97, by family, friends, and fellow students to honour Michele's love of learning and education. Awarded to a student graduating in Chemical Engineering with the highest academic standing and who is continuing to post-graduate studies either at Queen's or at another institution. Candidates should submit a letter of application to the Head of the Department by 1 April detailing their intended course of study. The recipient will receive the award in the Fall Term on confirmation of registration in graduate school.

Michele Mainland Memorial Medal in Chemical Engineering

Established in memory of Michele Mainland by family, friends and fellow students in recognition of Michele's efforts and courage. Awarded to a graduating Chemical Engineering student who, in the opinion of classmates and department staff, best exemplifies Michele's personal qualities: persistence and cheerfulness in the face of adversity, sense of adventure, tenacity, courage and helpfulness to others.

C.W. Marshall Memorial Award

Awarded annually to graduating student in Civil Engineering who, in opinion of the instructors, has demonstrated notable proficiency in field of structural engineering during third and fourth years and whose academic proficiency has not been identified by a General Proficiency Medal or other distinctive honour.

J.D. McCowan Prize in Integrated Learning

Established by colleagues and friends in recognition of the contribution made by Dr. James D. McCowan to the Integrated Learning Initiative in the Faculty of Engineering and Applied Science. Awarded to a graduating student or graduating members of a student team that have made a significant contribution to the Integrated Learning Initiative during their time in the Faculty of Engineering and Applied Science. Selection will be made by the Engineering and Applied Science Operations Committee (Scholarships).

F.K. McKean, Science 1940, Prize in Mining Engineering

Established by the McKean family in memory of Fleetwood K. McKean, Science '40. Awarded to the student in Mining Engineering who best demonstrates good written communication in the final year thesis. Selection will be made by the Department of Mining Engineering by 31 March.

The Edward Hugh McLellan Memorial Scholarship in Coastal Geotechniques

Established in memory of Edward Hugh McLellan, Sc. '80. Awarded annually to the Civil Engineering student with the highest aggregate standing in CIVL 342 and CIVL 456.

Glen Chandler Milbourne Memorial Scholarship

The Glen Chandler Milbourne Memorial Scholarship has been established by his family, friends and colleagues to perpetuate the values Glen demonstrated during his time at Queen's. The scholarship is awarded on the basis of academic performance to a student graduating from the Materials Option in Mechanical Engineering, who best exemplifies Glen's interpersonal and communication skills, his dedication to teamwork and sportsmanship and his interest and proficiency in the metallurgical profession. In the case of students being equally eligible, preference will be given to a student who is continuing to graduate studies in the Materials and Metallurgical program at Queen's. The selection is made by the Head of the Department in consultation with faculty and students.

L.A. Munro Award in Engineering Chemistry

Established by Professor L.A. Munro, who for many years was a member of the Department of Chemistry at Queen's. The award is presented annually for general proficiency to a graduating student of the Engineering Chemistry program.

O'Connor Associates Award in Geotechnical Engineering

Awarded annually on the recommendation of the Head of the Department of Civil Engineering, in consultation with geotechnical engineering instructors, to a graduating student in Civil Engineering or Geological Engineering (Geotechnical Option) who has demonstrated notable proficiency in the area of geotechnical engineering.

Ontario Professional Engineers Foundation for Education Medal for Academic Achievement

Given by the Ontario Professional Engineers Foundation of Education, and awarded to the student with highest academic standing in the final year. Selection will be made the Engineering and Applied Science Operations Committee (Scholarships).

Paithouski Prize

Established in memory of Nicholas J. Paithouski (B.Sc. '40) by his son N. Joseph Paithouski (B.Sc. '80) and friends and awarded to the graduating engineering student who has demonstrated the most consistent improvement in academic performance. The cumulative annual point spread in sessional average over the most recent eight terms will be used as a basis for determining the winner. Selection will be made by the Engineering and Applied Science Operations Committee (Scholarships).

L.J. Patterson Prize in Mine Management

Founded by Lewis J. Patterson, retired President of Quebec Cartier Mining Company, who taught management within the Mining Engineering Department for 10 years. Awarded, on the recommendation of the Head of the Department, to a student graduating in Mining Engineering who has obtained the highest combined standing in fourth year mine management courses.

Queen's C.A.P. Prize Examination Award

Details of this award are given in the section *Second Year Awards.*

Carolyn F. Small Memorial Award for Design Innovation

Details of this award are given in the section *Second Year Awards.*

E.T. Sterne Prize

Founded by Dr. E.T. Sterne and awarded annually to student graduating in Chemical Engineering who has highest aggregate standing in Chemical Engineering subjects taken throughout undergraduate years.

J.B. Stirling Gold Medal in Applied Science

Awarded annually to a student of the graduating class who has made the highest standing throughout the four year program. A student who has failed a year is not eligible. Selection will be made by the Engineering and Applied Science Operations Committee (Scholarships).

Society of Chemical Industry Student Merit Award

Established by the Canadian Section of the Society of Chemical Industry to encourage scientific education in the universities and to recognize student achievement in scientific fields. Awards are given to the students with the highest standing in the final year in each of the four fields of chemical engineering, engineering chemistry, honours chemistry, and honours biochemistry, provided that they have first-class averages and have completed their program in the normal number of years. The award is a plaque bearing the crest of the Society of Chemical Industry and the winner's name, program, University and year.

M. Sullivan and Son Limited Scholarship

Established in December 2005 by the Sullivan family and awarded to a graduating student in Chemical Engineering or Engineering Chemistry in the Faculty of Engineering and Applied Science or Chemistry in the Faculty of Arts and Science on the basis of outstanding achievement for a research project in Chemistry. Selection will be made by the Departmental Awards Committee and approved by the Awards Committee of the Faculty of Engineering and Applied Science and the Faculty of Arts and Science.

Walter Thumm Memorial Scholarship in Physics

Details of this award are given in the section on *Third Year Awards.*

University Medals

May be awarded annually in each department to student of the graduating class who has highest average in all courses of third and fourth years, provided average is 80 percent or higher.

Peter R. White Memorial Award

Given as a memorial to Peter R. White by his friends and awarded to graduating student in Engineering and Applied Science who has made the most outstanding contribution to the creative arts and the development of inter-personal relations both on and off campus. Nominations will be submitted by the Engineering Society to the Engineering and Applied Science Operations Committee (Scholarships).

E.B. Wilson Memorial Prize in Mining Engineering

Established by family, friends, colleagues and students of the late Edward B. Wilson, Professor of Mining Engineering 1964-1983, as a tribute to his outstanding contribution to the Mining Department and excellence as a teacher. Awarded annually on the recommendation of the Head of the Department to the fourth year Mining Engineering student producing the highest rated undergraduate thesis on a topic involving operations research or computer applications in Mining.

Zurbrigg Memorial Scholarship

Established by H.F. Zurbrigg, Science '31, in memory of his parents and awarded to a Canadian graduate of the Faculty of Engineering and Applied Science who is continuing at Queen's either as a post-graduate in any faculty or as an undergraduate in the faculties of Law or Medicine. The award is made on the basis of scholarship and proficiency in the use of the English language. Applicants must submit by 31 March a letter to the Chair of the Engineering and Applied Science Scholarships Committee detailing their background and career objectives. The recipient will receive the award in the Fall Term on confirmation of registration.