1 The Faculty

1.1 Location

Macdonald Engineering Building
McGill University
817 Sherbrooke Street West
Montreal, QC H3A 2K6
Canada
Telephone: (514) 398-7257
Website: http://www.engineering.mcgill.ca

1.2 Administrative Officers

JOHN M. DEALY, B.S.(Kansas), M.S.E., Ph.D.(Mich.), Eng.  Dean
FRANK MUCCIARDI, B.Eng., M.Eng., Ph.D.(McG.), Eng.  Associate Dean (Student Affairs)
DAVID COVO, B.Sc.(Arch.), B.Arch.(McG.), M.R.A.I.C., O.A.Q.  Director, School of Architecture
JEANNE M. WOLFE, B.Sc.(Lond.), M.Sc.(W.Ont.), M.A.(McG.)  Director, School of Urban Planning
RICHARD J. MUNZ, B.A.Sc., M.A.Sc.(Wat.), Ph.D.(McG.), Eng.  Chair, Department of Chemical Engineering
ROBERT D. JAPP, B. Eng., M.Eng., Ph.D.(McG.), P.Eng.  Chair, Department of Civil Engineering and Applied Mechanics
DAVID A. LOWTHER, B.Sc.(London), Ph.D.(C.N.A.A.), P.Eng.  Chair, Department of Electrical and Computer Engineering
STUART J. PRICE, B.Sc., Ph.D. (Bristol)  Chair, Department of Mechanical Engineering
G.P. DEMOPOULOS, Dipl. Eng.(Athens), M.Sc., Ph.D.(McG.), Eng.  Chair, Department of Mining and Metallurgical Engineering
ANDRE LAPLANTE, B.A.Sc., M.A.Sc.(Montr.), Ph.D.(Tor.), Eng.  Secretary of Faculty
IDA GODEFROY  Assistant to the Dean
JUDY PHARO  Student Advisor

1.3 Historical Note

The Faculty of Engineering began in 1871 as the Department of Practical and Applied Science in the Faculty of Arts with degree programs in Civil Engineering and Surveying, Mining Engineering and Assaying, and Practical Chemistry. Diploma courses had been offered from 1859, and by 1871 the staff and enrolments had increased sufficiently to justify the creation of the Department. Continued growth led to the formation of the Faculty of Applied Science in 1878. By 1910 there were ten degree programs offered, including Architecture and Railroad Engineering. Subsequent changes in the overall pattern of the University led to the creation of the Faculty of Engineering in 1931 with a departmental structure very similar in name to that which exists at present.
1.4 The Faculty Today
The Faculty currently includes five engineering departments and two schools:

**The Departments**
- Chemical Engineering
- Civil Engineering and Applied Mechanics
- Electrical and Computer Engineering
- Mechanical Engineering
- Mining and Metallurgical Engineering

**The Schools**
- Architecture
- Urban Planning

The Faculty serves approximately 2200 undergraduate students and 700 graduate students in a wide variety of academic programs. Undergraduate programs leading to professional bachelor degrees are offered in all academic units except the School of Urban Planning. These programs are designed to qualify the graduates for immediate employment in a wide range of industries and for membership in the appropriate professional bodies. Additionally, a non-professional degree is offered in the School of Architecture for those who plan to work in related fields not requiring professional qualification. The curricula are also structured to provide suitable preparation for those who plan to continue their education in postgraduate studies either at McGill or elsewhere.

The academic programs, which are described in detail in section 4 on page 222, are divided into required and complementary sections. The required courses emphasize those basic principles which permit graduates to keep abreast of programs in technology throughout their careers. Exposure to current technology is provided by the wide variety of complementary courses which allow students to pursue in depth a particular interest.

An internship program involving a paid 8 to 16 month industrial experience is available to Engineering and Science students. Generally students will enter the internship program before starting their final year of undergraduate studies. Details can be found in section 2.8 on page 219. In addition, CO-OP programs are offered in Mining Engineering and Metallurgical Engineering.

Postgraduate programs leading to Master's and Doctoral degrees are offered in all sectors of the Faculty. Numerous areas of specialization are available in each of the departments and schools. All postgraduate programs including the professional degree program in Urban Planning are described in the Calendar of the Faculty of Graduate Studies and Research.

1.5 Special Facilities and Related Programs

1.5.1 ENGINEERING INFORMATION SYSTEMS
In addition to the services provided by the Computing Center, the Faculty, in conjunction with its departments and schools, maintains specialized computing and information resources in support of teaching and research. These vary from desktop PCs distributed throughout the Engineering complex to very high performance scientific workstations found in the research laboratories. Each unit organizes and maintains facilities that are designed around specific roles, e.g., CAD/CAM, microelectronic design, software engineering, circuit simulation, process control, polymers, structural mechanics, metal processing, etc., in addition to systems dedicated to administrative support.

The role of the Faculty is to provide access to these resources on a 24-hour basis and to provide computing and information services that are not covered by individual units. Currently this consists of approximately 160 workstations and three servers in two general-purpose laboratories. A Faculty-wide switched network is in place that provides global access to the over 1000 machines in the Engineering complex. The Faculty works in close cooperation with the McGill Computing Centre which provides remote access to the Faculty network.

1.5.2 AGRICULTURAL AND BIOSYSTEMS ENGINEERING
The Faculty of Engineering cooperates with the Faculty of Agricultural and Environmental Sciences in providing courses of instruction for a curriculum in agricultural and biosystems engineering to meet requirements for a professional degree awarded in the Faculty of Agricultural and Environmental Sciences. The second semester of the penultimate year of the program is given by the Faculty of Engineering on the Downtown Campus. Details of the curriculum are given on page 426 in the Agricultural and Environmental Sciences section.

Some of the courses offered by the Department of Agricultural and Biosystems Engineering may be of interest to students in the Faculty of Engineering. Students may consult the list of technical complementary choices in section 4.1.1 on page 223.

1.5.3 DEPARTMENT OF BIOMEDICAL ENGINEERING
Lyman Duff Medical Sciences Building
3775 University Street
Montreal, QC Canada H3A 2B4
Telephone: (514) 398-8278

Engineering undergraduates who are interested in the biomedical applications of engineering techniques should contact the Chair of their department or the graduate Chair of Biomedical Engineering. Some of the courses offered by the Bme may be of interest to Engineering students, and may be approved as complementary courses. A partial list follows (see Faculty of Graduate Studies and Research Calendar for more details):

**399-501A SELECTED TOPICS IN BIOMEDICAL ENGINEERING.**
Instructor: Prof. H.L. Galliana
3(3-0-6)

**399-503B BIOMEDICAL INSTRUMENTATION AND MEASUREMENT TECHNIQUE.**
Instructor: Prof. J. Bates
3(2-1-6)

**399-519A ANALYSIS OF BIOMEDICAL SYSTEMS & SIGNALS.**
Instructor: Prof. R.E. Kearney
3(2-0-8)

1.6 Library Facilities
The University has numerous libraries. Specifically serving Engineering, Architecture and Urban Planning is the Physical Sciences and Engineering Library. Other McGill libraries of interest to students in the Faculty of Engineering are: Blackader-Lauterman Library of Architecture and Art, Walter Hitschfeld Geographic Information Center, and Edward Rosenthal Mathematics and Statistics Library. Refer to page 34 of the General University Information section for further information.

2 General Information

2.1 Admission Requirements
The Faculty of Engineering offers programs leading to the degrees of B.Eng., B.Sc.(Arch.) and B.Arch. Enrolment in some programs is limited.

Specific information on admissions requirements for Quebec students, students from provinces of Canada other than Quebec and applicants from outside of Canada can be found in “Admission Requirements” on page 10 of the General University Information section.

2.2 Exchange Programs
The Faculty of Engineering participates in a number of exchange programs that provide undergraduates with an opportunity to study at École Polytechnique and other Quebec universities, and at selected colleges and universities in the United States, Mexico and Europe. A Faculty student who has completed at least one year of study and have maintained an average of 3.00 or better, Further information may be obtained from the Student Advisor, Office of the Associate Dean (Student Affairs) or the Exchange Officer, Admissions, Recruitment and Registrar’s Office.
2.3 Advanced Credit Examinations
Prior to their first registration, the Faculty of Engineering offers the opportunity for students entering the Faculty from a Quebec CEGEP program to receive advanced credit in 189-260 Intermediate Calculus upon successful completion of the Advanced Credit Examination. The 189-260 Intermediate Calculus examination will cover material that has a similarity to the syllabus of the CEGEP Calculus III course. In all engineering programs, students who are successful in the 189-260 Intermediate Calculus examination will automatically have the number of credits required for the completion of their program reduced by three.

2.4 Registration
Students who are currently registered and intend to return to the same degree program in the following academic session are required to register using the automated registration system MARS. MARS information sheets are available in the Student Affairs Office, Room 376, Macdonald Engineering Building. All returning students must see their Advisor for course confirmation during the first two weeks of the fall semester and, if changes are being made, during the first two weeks of the winter semester.

New students also register by MARS. Information is sent at the time of admission.

Non-Engineering students should obtain permission from the Associate Dean of their Faculty to register for Engineering courses listed in section 4.

2.4.1 REGISTRATION FOR CONTINUING EDUCATION COURSES
Students can register for Continuing Education courses through MARS. Students must refer to the Centre of Continuing Education Calendar and Timetable for course information and deadlines. For further information see the Records Office, Room 376, Macdonald Engineering Building.

2.4.2 COURSE WITHDRAWAL
Students may withdraw from a course using MARS without academic penalty provided they do so before the end of the seventh week of the semester. Beyond this time their names will appear on the mark reports and, in the event that they do not take the examination, they will be given a J grade.

2.5 Advising
All new students are required to seek academic advising about their programs from the Department in which they plan to study. Additional information may be obtained by calling:

- General Advising: (514) 398-7256
- Architecture: (514) 398-6702
- Chemical Engineering: (514) 398-4494
- Civil Engineering: (514) 398-6860
- Electrical and Computer Engineering: (514) 398-7344
- Mechanical Engineering: (514) 398-8070
- Metallurgical Engineering: (514) 398-4755 ext. 4365
- Mining Engineering: (514) 398-4755 ext. 0573
- Urban Planning: (514) 398-4075

In addition to departmental advising, the Faculty offers a free tutorial service, known as ACE, to help students in their first year of studies. Upper year Engineering students and graduate students provide the service daily. Hours will be posted.

2.6 Student Activities
The campus offers a wide variety of extra-curricular activities for students. All are urged to participate. Many of these are organized within the Faculty under the auspices of the Engineering Undergraduate Society (EUS), or the Architectural Undergraduate Society (AUS). Both of these organizations publish handbooks describing their operations and the activities of various Faculty clubs and societies. All undergraduate students automatically become members of the EUS or the AUS, as appropriate.

2.7 Scholarships and Bursaries
Scholarships, bursaries and loans are open to students in the Faculty of Engineering. Students should consult the Undergraduate Scholarships and Awards Calendar available from the Admissions, Recruitment and Registrar's Office, and on the Web (http://www.aro.mcgill.ca). Specific information concerning these awards may be obtained from the Student Advisor, Office of the Associate Dean (Student Affairs), Faculty of Engineering.

2.8 IYES: Internship Year for Engineering and Science
Employers value experience. The IYES Program allows students to gain professional work experience during the course of their undergraduate studies.

A student will switch to the Internship Program from the regular program at the point of accepting an Internship placement. Successful completion of an 8 to 16-month internship will qualify the student to graduate with the Internship Program designation.

Employment through the IYES Program typically begins in May and continues for up to 16 months (minimum 8 months) including a 4-month probationary training period. While employed by the participating companies, students work on assignments related to their field of study. Projects generally involve research and development or design.

Employers choose the most suitable students for their organization through the application, interview and ranking process.

SPECIALIZATION AREAS OF IYES STUDENTS
All students participating in this program must have between 15 and 45 credits remaining to complete their undergraduate studies in the following areas of Engineering or Science:

- Atmospheric Science
- Biotechnology
- Chemical Engineering
- Chemistry
- Civil Engineering
- Computer Engineering
- Computer Science
- Electrical Engineering
- Environmental Studies
- Engineering Physics
- Mathematics and Statistics
- Mechanical Engineering
- Physics

STUDENT BENEFITS
- professional experience related to course of study
- salary within the average range of those for entry level professional positions
- improved chance of obtaining a job upon graduation and at a higher starting salary
- opportunity to test choice of career and assess pertinence of post-graduate study before making a long-term commitment
- opportunity to develop communication skills and to acquire a business perspective that cannot be learned in school and is unlikely to be gained from a summer job
- participation in the IYES Program will be noted on the student's permanent record

COST
- There is no application fee.
- Every student hired through the Program will be assessed a charge of $700. Students will be billed this amount approximately one month after starting their internship.
- Participating companies are invited to match the student's contribution in the form of a tax deductible donation to IYES.

STUDENT ELIGIBILITY
- Canadian citizens or Permanent Residents of Canada
- full-time registration in an Engineering or Science undergraduate program with fewer than 45 credits and more than 15 credits remaining
The use of calculators during tests and examinations is at the discretion of the course instructor. If a calculator is permitted in the examination, the instructor may require that the students use a Faculty Standard Calculator, i.e. the CASIO fx-991 or the Sharp EL-546. These calculators are non-programmable, inexpensive, available through local dealers, e.g. EUS General Store in McCon nell Engineering Building, and have many features of interest to Engineering students. Any model fx-991 or EL-546 is acceptable, regardless of the letter suffix which appears after the model number. All Engineering students are expected to own one of the two Faculty Standard Calculators.

3 Academic Requirements

3.1 Degree Requirements

In order to obtain a Bachelor's degree, students must complete one of the departmental programs described in section 4.

3.1.1 ENTRANCE REQUIREMENTS

The degree programs in the Faculty of Engineering are designed for students who have completed a general and basic science program. This basic science requirement consists of two semesters of calculus, chemistry, physics, one semester of vectors, matrices and analytical geometry and one semester of humanities or social sciences. Students entering the Faculty of Engineering from Quebec complete these courses at the CEGEP and enter a seven-semester program. Students entering from outside Quebec with a high school diploma generally enter an eight-semester program and complete the basic science requirements at McGill (see section 3.1.2 on page 220).

Students who have completed Advanced Placement Exams, Advanced Levels, the International Baccalaureate, the French Baccalaureate, or McGill placement and/or advanced credit examinations may receive exemptions and/or credits for all or part of the basic science requirements. Similarly, students who have completed courses at other universities or colleges may receive exemptions and/or credits.

3.1.2 BASIC SCIENCE REQUIREMENTS FOR STUDENTS ENTERING FROM OUTSIDE QUEBEC (8-semester program)

Generally, students admitted to Engineering from outside Quebec are required to complete the basic science requirements outlined below, in addition to the departmental programs described in section 4.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>180-111B</td>
<td>General Chemistry for Physical Science &amp; Engineering Students</td>
<td>4 credits</td>
</tr>
<tr>
<td>180-121A</td>
<td>General Chemistry for Physical Science &amp; Engineering Students</td>
<td>4 credits</td>
</tr>
<tr>
<td>189-150A</td>
<td>Calculus A</td>
<td>4 credits</td>
</tr>
<tr>
<td>189-151B</td>
<td>Calculus B</td>
<td>4 credits</td>
</tr>
<tr>
<td>189-133A/B</td>
<td>Vectors, Matrices &amp; Geometry</td>
<td>3 credits</td>
</tr>
<tr>
<td>198-131A</td>
<td>Mechanics and Waves</td>
<td>4 credits</td>
</tr>
<tr>
<td>198-142B</td>
<td>Electromagnetism &amp; Optics</td>
<td>4 credits</td>
</tr>
<tr>
<td>xxx-xxx</td>
<td>Humanities/Social Sciences course</td>
<td>3 credits</td>
</tr>
</tbody>
</table>

Calculus courses 150/151 are designed for students who have completed a course in high school calculus. If a student has no previous calculus exposure, 150/151 may be replaced with 139/141 (Password card required). In the event that the student has some prior calculus, but is not sufficiently confident to proceed with 150/151, the appropriate sequence is 140/141. Students who complete the Calculus sequence 150/151 will receive exemption with credit from 189-260 (Intermediate Calculus), in the regular Engineering program. Students who are uncertain as to which calculus course sequence is appropriate for them should contact Ms. Pharo, Student Advisor in the Office of the Associate Dean (Student Affairs) (514) 398-7256.

The Humanities/Social Science course may be selected from a list outlined in the "Welcome" book. A copy of the booklet is mailed to all students admitted to the Engineering program at McGill. A Humanities/Social Sciences course is not required of students admitted to Electrical/Computer Engineering.

Students may write McGill Placement Tests to obtain credit for 180-111, 180-121, 189-140, 189-141, 189-133, 198-131 and 198-142, in the event that they have studied similar material previously. Details on the advanced placement examinations are provided in the "Welcome" book.

Students entering with advanced standing credits (Advanced Placements, Advanced Levels, International Baccalaureate examinations, McGill Placement Tests) are required to meet with the Student Advisor, Office of the Associate Dean (Student Affairs), Room 378, Macdonald Engineering Building, to finalize their program of studies. This must be done prior to meeting with the Departmental Advisor.

3.1.3 PRE-ARCHITECTURE PROGRAM

Students admitted to the Pre-Architecture program are required to complete the following courses:

<table>
<thead>
<tr>
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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>180-111B</td>
<td>General Chemistry for Physical Science &amp; Engineering Students</td>
<td>4 credits</td>
</tr>
<tr>
<td>180-121A</td>
<td>General Chemistry for Physical Science &amp; Engineering Students</td>
<td>4 credits</td>
</tr>
<tr>
<td>189-140A</td>
<td>Calculus I</td>
<td>3 credits</td>
</tr>
<tr>
<td>189-141B</td>
<td>Calculus II</td>
<td>4 credits</td>
</tr>
<tr>
<td>189-133A/B</td>
<td>Vectors, Matrices &amp; Geometry</td>
<td>3 credits</td>
</tr>
<tr>
<td>198-131A</td>
<td>Mechanics and Waves</td>
<td>4 credits</td>
</tr>
<tr>
<td>198-142B</td>
<td>Electromagnetism &amp; Optics</td>
<td>4 credits</td>
</tr>
</tbody>
</table>

Students may write McGill Placement Tests to obtain credit for 180-111, 180-121, 189-140, 189-141, 189-133, 198-131 and 198-142, in the event that they have studied similar material previously. Details on the advanced placement examinations are provided in the "Welcome" book.

3.2 Degrees and Requirements for Professional Registration

Professional
- Bachelor of Architecture
- Bachelor of Engineering
- Bachelor of Engineering (Honours)

Non-Professional
- Bachelor of Science (Architecture)

The B.Eng. programs are accredited by the Accreditation Board of the Canadian Council of Professional Engineers and fulfill the academic requirements for admission to the provincial professional organizations. The B.Arch. program is recognized in all provinces as fulfilling the educational requirements for entry to the architectural profession.

3.3 Complementary Studies

Engineering students must complete 6 credits (9 credits in Electrical and Computer Engineering) of additional complementary courses as follows:

(i) One 3-credit course on the impact of technology on society
A student must successfully complete the B.Eng. or B.Sc. (Arch.) programs within six years of entry. Candidates admitted to a lengthened program, or to a shortened program because of advanced standing, or who are participating in the IYES program, will have a correspondingly greater or lesser period in which to complete their program. Candidates entering the B.Arch. program must complete the degree requirements within two years. Extensions may be granted by the Committee on Standing in cases of serious medical problems or where other similarly uncontrollable factors have affected a student's progress.

3.4.1 LETTER GRADES

In the Faculty of Engineering, letter grades are assigned according to the grading scheme adopted by the professor in charge of a particular course. They have the designations:

- A, A-: Very Good
- B+, B, B-: Good
- C+, C: Satisfactory
- D: Conditional Pass
- F: Failed
- K: Incomplete
- J: Credit by examination only

Grades A, B and C indicate satisfactory results. Grade D indicates marginal results which may be acceptable for peripheral courses but not for core courses required by the program. The classification of a course as core or peripheral depends on the individual student's program and will be decided by the department concerned. Grade F is a permanent grade indicating unsatisfactory results. Grade J indicates an unexcused failure to submit assignments or an unexcused absence from an examination. It is equivalent to an F grade.

3.4.2 INCOMPLETE COURSE DEADLINES

An incomplete grade is indicated by a K. The maximum delay granted for completion of course work is three months, after which the student will automatically be given a grade of KF (incomplete/fail). The last day for submission of deferred grades is March 31st for A semester courses, August 15th for B semester courses, and December 1st for summer courses. The last date for submission of grades for summer courses for students graduating in November is September 15th.

The L grade indicates a deferred grade because of medical or other valid reason. An L grade will be replaced by a J grade if the student misses the next deferred or regular examination in the course, whichever occurs first.

3.4.3 SATISFACTORY/UNSATISFACTORY OPTION FOR ELECTIVE COURSES

The University allows students to designate certain elective courses to be graded under the Satisfactory/Unsatisfactory option. The option must be added on MARS before the end of the Drop/Add period and no change can be made thereafter. See Records Office, Room 376, Macdonald Engineering, for more information.

For the programs offered within the Faculty of Engineering, "elective" refers to the complementary course component of the Engineering programs involving a Social Science/Humanities course (see section 3.3 - category (ii) or a course dealing with the impact of technology on society [category (i)], or to elective courses taken outside the School of Architecture by Architecture students. It does not apply to the "technical complementaries" or "architectural complementaries" or to any other category of courses taken in the Engineering or Architecture programs.

A C-grade is considered a pass under the Satisfactory/Unsatisfactory option, while a D-grade is considered a failure under this option. However, the Faculty of Engineering will continue to accept a D-grade as a pass in the complementary courses listed in section 3.3, when the course is taken in the conventional manner. Only students in Satisfactory Standing are permitted to take a course under the Satisfactory/Unsatisfactory option.

NOTE: To be considered for in-course awards and/or the renewal of entrance scholarships, students must take at least 27 credits in the regular academic session exclusive of courses completed under the Satisfactory/Unsatisfactory option.
3.4.4 COURSE CREDITS
The credit assigned to a particular course reflects the amount of effort it demands of the student. One credit normally represents three hours total work per week. This is, in general, a combination of lecture hours and other contact hours such as laboratory periods, tutorials and problem periods as well as personal study hours. As a guide, the average division of time for a course is indicated in hours in the course listing after the course credit. For example, 3(3-0-6) indicates a credit of three units consisting of three lecture hours per week, no other contact hours and six hours of personal study per week.

3.4.5 GRADE POINT AVERAGES AND EXTRA COURSES
The Faculty calculates a semestral grade point average. Any courses taken which lie outside the program are classified as extra, are indicated by an "X" on transcripts and do not affect the grade point average. Students must receive Departmental approval for such courses and the course must be identified and recorded prior to writing the final examination.

3.4.6 STANDINGS
A student's standing is based on the CGPA according to the following criteria.
Satisfactory standing:
2.00 or better
Probationary standing:
1.20 – 1.99 first semester
1.50 – 1.99 subsequent semesters
Unsatisfactory standing:
less than 1.20 first semester – normally re-admitted to probationary standing by Faculty decision
less than 1.50 subsequent semesters
Candidates in satisfactory standing may proceed with the following conditions:

i) All core courses in which D or F grades were obtained must either be repeated successfully (grade C or better) or be replaced by an alternative approved course which is completed successfully.

ii) All other courses in which F grades were obtained must either be repeated successfully at some point before graduation or be replaced by some alternative approved course which is completed successfully before graduation.

Candidates in probationary standing may proceed for one semester under the same conditions noted above, but in addition must reduce their load to a maximum of 13 credits per semester and must achieve at the end of the semester either a CGPA of 2.00 or better or an SGPA of 2.50 or better. A student whose SGPA is 2.50 or better but whose CGPA is less than 2.00 may continue in probationary standing. Failure to achieve either of these grade point averages after the probationary semester will result in unsatisfactory standing.

Candidates with unsatisfactory standing must withdraw for at least one semester, after which they may be considered for re-admission by the Committee on Standing.

3.4.7 REPEATED COURSES
Students who fail to achieve the required results in a course must either repeat it successfully or complete a substitute course approved by their department. For students who fail prerequisite courses which are offered in only one semester, the departments responsible may, in appropriate cases, arrange "reading courses" during the other semester or during the summer months. Such courses taken during a regular semester constitute a normal part of the candidate's work load. If the student is on probation, these courses must be included in the workload reduction.

3.4.8 REASSESSMENT OF A GRADE
In accordance with the Charter of Student Rights, and subject to the conditions stated therein, students have the right to consult any written submission for which they have received a mark and the right to discuss this submission with the examiner. If, after such discussion, students want to have a formal final examination reread, they must apply in writing to the Student Affairs Office.

3.4.9 REREAD OF A GRADE
A student may request the rereading of a grade by completing an application form available from the Records Office. The application deadlines are the last day of March, July, and November for fall, winter, and summer courses respectively. Payment of the $35 fee will be charged to the student's McGill account. If the grade is improved as a result of the reread, the fee will not be charged. If the grade is decreased or unchanged, the fee will be charged.

3.4.10 SUPPLEMENTAL EXAMINATIONS
Courses administered by the Faculty of Engineering do not have supplemental examinations. However, Engineering students may be eligible to write supplemental examinations in courses administered by other faculties (typically in complementary studies and science courses). For more information, please contact the Engineering Student Records Office.

3.4.11 DEFERRED EXAMINATIONS
Students who miss a final examination due to illness should submit a medical certificate to the Records Office (Room 376 Macdonald Engineering Building) within one week of the examination and apply for a deferred examination. The medical certificate must state the date of the missed examination, and the nature and duration of the illness. Students are advised that deferrals are granted only for compelling reasons.

Further information on Deferred Examinations can be found on page 27 of the General University Information of the Calendar.

4 Academic Programs

Please note:

Denotes courses not offered in 1999-2000
Elective courses
Courses with Limited Enrolment

Where asterisks appear with a prerequisite, they have the following significance:

* A D grade is acceptable for prerequisite purposes.
** Under special circumstances, the Department may permit this course to be taken as a co-requisite.

The curricula and courses described in the following pages have been approved for the 1999-2000 session, but the Faculty reserves the right to introduce changes as may be deemed necessary or desirable.

4.1 Faculty Courses
A number of Faculty courses are offered and are listed below. These courses are of a more general nature than the departmental courses.

300-220A LAW FOR ARCHITECTS AND ENGINEERS, 3(3-0-6)
Aspects of the law which affect architects and engineers. Definition and branches of law; Federal and Provincial jurisdiction, civil and criminal law and civil and common law; relevance of statutes; partnerships and companies; agreements; types of property, rights of ownership; successions and wills; extraproportion; responsibility for negligence; servitudes/easements, privileges/liens, hypotheoses/mortgages; statutes of limitations; strict liability of architect, engineer and builder; patents, trade marks, industrial design and copyright; bankruptcy; labour law; general and expert evidence; court procedure and arbitration.

Mtre J.A. Woods

302-230B ENVIRONMENTAL ASPECTS OF TECHNOLOGY, 3(3-0-6)
The impact of urbanization and technology on the environment.
Topics include urbanization: causes, effects, land use regulations; transportation technology and environmental implications; environmental impact of energy conversions; energy policy alternatives; formulation of energy and environmental policy; air pollution: sources, effects, control; water pollution: sources, effects, control. Limited enrolment, MARS passwords distributed after the first class.

Staff

302-430A TECHNOLOGY IMPACT ASSESSMENT. 3 (3-1-5) The power of technology to shape our physical, economic and social environment: historical - effects of technological transitions (e.g. industrial revolution, post-industrial era) on culture and ecology; practical-technology impact assessment (TIA), methodologies, public participation, engineering contributions, regulations; implications of TIA on social and economic development, and to the education and career of the engineer. Limited enrolment. Restricted to final year students. Mars passwords distributed in Department of Chemical Engineering.  
Mr. Q. Samak

303-469A INFRASTRUCTURE AND SOCIETY. 3(3-2-4) (Prerequisite: 306-310A,B) Infrastructure systems, historical background and socio-economic impact; planning, organization, communication and decision support systems; budgeting and management; operations, maintenance, rehabilitation and replacement issues; public and private sectors, privatization and governments; infrastructure crisis and new technologies; legal, environmental, socio-economic and political aspects of infrastructure issues; professional ethics and responsibilities; case studies. 
Professor Mirza

Professors Laplante and Smith

306-308A SOCIAL & ECONOMIC IMPACTS OF TECHNOLOGY. 3(3-0-6) (Enrolment encouraged by students outside the Faculty of Engineering.) Critical examination of the socio-economic costs and benefits of technology, case studies of old engineering works and new technologies. The integration of applied ethics and engineering practice, analysis of basic concepts of technology assessment, the inter-connected processes of risk assessment, management, and communication. 
Professor Finch

306-310A,B ENGINEERING ECONOMY. 3(3-1-5) Introduction to the basic concepts required for the economic assessment of engineering projects. Topics include: accounting methods, marginal analysis, cash flow and time value of money, taxation and depreciation, discounted cash flow analysis techniques, cost of capital, inflation, sensitivity and risk analysis, analysis of R and D, ongoing as well as new investment opportunities. 
Professors Bilodeau and Laplante

4.1.1 FACULTY TECHNICAL COMPLEMENTARIES

Each Engineering program requires a certain number of technical complementary courses. Departments list the approved courses together with the program descriptions that appear in the following sections. In addition, some programs permit students to select one or more courses from the faculty-wide listing of technical complementaries that follow. Students should check the program description to determine if a course may be selected from the following list. It is advisable that students discuss their choice with an academic advisor, review the prerequisite requirements for the course choices, and if in doubt approach the course instructor to ensure that they have the appropriate background for the course selection. Refer to the following departmental sections for prerequisites and course descriptions.

Agricultural and Biosystems Engineering

330-435A,B Soil and Water Quality Management
336-200B Elements of Agricultural Engineering
336-217B Hydrology and Drainage
336-314B Agricultural Structures
336-322A Agro-Food Waste Management
336-325A Food Engineering
336-330B GIS and Biosystems Management

336-411A Off-Road Power Machinery
336-412A Agricultural Machinery
336-416A Engineering for Land Development
336-500B Advanced Applications of Microcomputers in Agriculture
336-504B Instrumentation and Control
336-518A Pollution Control for Agriculture
336-530B Advanced Food & Fermentation Engineering

Architecture

301-350A The Material Culture of Canada
301-377B Energy, Environment & Buildings
301-378A Site Usage
301-526B Philosophy of Structures
301-527B Civic Design
301-528A History of Housing

Chemical Engineering

302-206A Introduction to Chemical Engineering
302-204A Chemical Manufacturing Processes
302-220B Chemical Engineering Therodynamics
302-230B Environmental Aspects of Technology
302-430A Technology Impact Assessment
302-452B Particulate Systems
302-471A Industrial Water Pollution Control
302-472B Industrial Air Pollution Control
302-481A Polymer Engineering
302-487A Chem. Processing in the Electronics Industry
302-541A Thermal Plasma Technology
302-581B Polymer Composites Engineering
302-370A Elements of Biotechnology
302-474A Biochemical Engineering

Civil Engineering

303-207A Solid Mechanics
303-208A Civil Engineering Systems Analysis
303-225B Environmental Engineering
303-311A Geotechnical Mechanics
303-317A Structural Engineering
303-323A Hydrology and Water Resources
303-327B Fluid Mechanics & Hydraulics
303-430A Water Treatment & Pollution Control
303-433B Urban Planning
303-451A Geoenvironmental Engineering
303-469A Infrastructure & Society
303-526B Solid Waste Management
303-540A Urban Transportation Planning
303-541B Rail Engineering

Computer Science

308-203A,B Introduction to Computing II
308-250A Introduction to Computer Science
308-273A,B Introduction to Computer Systems
308-302A,B Programming Languages and Paradigms
308-305A Computer System Architecture
308-350A Numerical Analysis
308-360A Algorithms Design Techniques
308-424A Topics in Artificial Intelligence I

Electrical and Computer Engineering

304-404A Control Systems
304-411A Communications Systems
304-412B Discrete Time Signal Processing
304-425A Computer Organization and Architecture
304-427B Operating Systems
304-428B Software Engineering
304-461 Electric Machinery
304-462B Electromechanical Energy Conversion
304-526B Artificial Intelligence

Mechanical Engineering

305-471A Industrial Engineering
305-472A Case Studies in Project Management
305-474B Sel. Topics in Operations Research
305-522B Production Systems
305-554A Process Automation
305-577A Optimum Design
305-525B Introduction to Nuclear Engineering

Metallurgical Engineering
306-250A Introduction to Extraction Metallurgy
306-311A Computer Applications in Mineral and Materials Engineering
306-317A Materials Characterization
306-341B Introduction to Mineral Processing
306-362A Engineering Materials
306-367B Electronic Properties of Materials
306-412A Corrosion and Degradation
306-555A Thermal Remediation of Wastes
306-560B Joining Processing

Mining Engineering
306-200A Mining Technology
306-320B Extraction of Energy Resources
306-322B Rock Fragmentation
306-323B Rock/Soil Mass Characterization
306-325A Mineral Industry Economics
306-333B Materials Handling
306-420B Feasibility Study

Urban Planning
409-501A,B Principles and Practice of Planning I
409-612A History and Theory of Planning
409-614B Urban Environmental Planning
409-619B Transportation and Land Development
409-621B Theory of Urban Form
409-505B GIS in Planning

4.2 School of Architecture

Director
David Covo; B.Sc.(Arch.), B.Arch. (McG.), F.R.A.I.C., O.A.Q.

Emeritus Professors
John Bland; B.Arch.(McG.), A.A. Dipl., D.Sc.(Carleton), R.C.A., F.R.A.I.C., O.A.Q. (William C. Macdonald Emeritus Professor of Architecture)
Harold Spence-Sales; A.A.Dipl., M.R.T.P.I., F.C.I.P.

Professors
Bruce Anderson; B.Arch.(McG.), M.Arch.(Harv.), F.R.A.I.C., O.A.Q.
Derek Drummond; B.Arch. (McG.), F.R.A.I.C., O.A.A. (William C. Macdonald Professor of Architecture)
Alberto Pérez-Gómez; Dipl.Eng.(Nat.Pol.Inst.Mexico), M.A., Ph.D.(Essex) (Saidye Rosner Bronfman Professor of Architectural History)

Associate Professors
Annamarie Adams; B.A.(McG.), M.Arch., Ph.D.(Berkeley), M.R.A.I.C.
Vikram Bhatt; N.Dip.Arch.(Ahmedabad), M.Arch.(McG.)
Ricardo Castro; B.Arch.(Los Andes), M.Arch., M.A.(Art History) (Ore.) M.R.A.I.C.
David Covo; B.Sc.(Arch.), B.Arch. (McG.), F.R.A.I.C., O.A.Q., Avi Friedman; B.Arch.(Technion), M.Arch.(Mcg.), Ph.D. (Montr.), O.A.O., I.A.
Adrian Sheppard; B.Arch.(Mcg.), M.Arch.(Yale), F.R.A.I.C., A.A.P.P.Q., O.A.Q.
Pieter Sijpekes; B.Sc.(Arch.), B.Arch.(Mcg.)
Gentile Tondino; R.C.A.

Faculty Lecturers
Greg Caicco, Rhona Kenneally

Adjunct Professors

Research Associates
Jim Donaldson, Terrance Galvin, David Krawitz, Rafik Salama

Associate Members
Clarence Epstein, Tania Martin, Howard Schubert

Visiting Critics and Lecturers
Each year visitors are involved in the teaching of certain courses as lecturers and critics. These visitors change from year to year; in 1998, they were:

PROGRAMS
The McGill architectural program is divided into two parts. The first leads to a non-professional degree, Bachelor of Science (Architecture), as a preparation for professional studies in architecture. The second, consisting of a minimum of two semesters for those with the McGill B.Sc.(Arch.) degree, leads to the professional degree, Bachelor of Architecture, which is accredited by the Canadian Architecture Certification Board (CAGB), and by the National Council of Architectural Review Boards (NCARB) in the USA.

Students in the B.Sc.(Arch.) program who plan to go on to the professional degree in architecture must apply to the B.Arch. program and must have fulfilled a number of requirements in order to be accepted. These requirements include:
1. The B.Sc.(Arch.) degree, including the series of required and complementary courses stipulated for professional studies, with overall grade point averages of at least 2.65 in the B.Sc.(Arch.) program and at least 2.65 in the sequence of architectural design courses (201A, 202B, 303A, 304B, 405A, 406B);
2. A minimum of six months relevant work experience.

Other students may make appropriate substitutions for certain of the required courses in order to improve their preparation for studies in associated areas.

Special note to applicants:
The School of Architecture at McGill is presently restructuring the professional program in architecture, in order to develop the Master of Architecture as the first professional degree in architecture. The new structure retains the B.Sc.(Arch.) program, with a slight reduction in the total number of credits, and replaces the two-semester 34-credit B.Arch. program with a revised three-semester 45-credit M.Arch. program. Admission to the new professional M.Arch. program, once approved, will very likely be based on requirements similar to those listed above for the existing B.Arch. program.

The new program is scheduled for final approval early in 1999 and may be in place by September 1999. For further information, please direct enquiries to the Student Advisor by email at marylc@urbacr.lan.mcgill.ca or telephone (514) 398-6702.

Pre-Architecture – Students who are admitted to the eight-semester program enter a first year which includes the courses outlined in section 3.1.3 on page 220.
### CURRICULUM FOR THE B.Sc.(Arch.) DEGREE

#### REQUIRED COURSES

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>303-205A,B Statistics</td>
<td>3</td>
</tr>
<tr>
<td>303-229A,B Surveying for Architects</td>
<td>2</td>
</tr>
<tr>
<td>303-238B Strength of Materials</td>
<td>4</td>
</tr>
<tr>
<td>303-384 Strength of Materials</td>
<td>2</td>
</tr>
<tr>
<td>303-385 Structural Steel and Timber Design</td>
<td>3</td>
</tr>
<tr>
<td>303-386 Reinforced Concrete Design</td>
<td>2</td>
</tr>
<tr>
<td>303-392A Structures</td>
<td>18</td>
</tr>
</tbody>
</table>

#### Architectural Subjects

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDIT</th>
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</thead>
<tbody>
<tr>
<td>301-201A Communication, Behaviour &amp; Arch.</td>
<td>6</td>
</tr>
<tr>
<td>301-202B Arch. Graphics and Design Elements</td>
<td>6</td>
</tr>
<tr>
<td>301-217A Freehand Drawing I</td>
<td>1</td>
</tr>
<tr>
<td>301-218B Freehand Drawing II</td>
<td>1</td>
</tr>
<tr>
<td>301-240B Organization of Materials in Building</td>
<td>3</td>
</tr>
<tr>
<td>301-250A Architectural History I</td>
<td>3</td>
</tr>
<tr>
<td>301-251B Architectural History II</td>
<td>3</td>
</tr>
<tr>
<td>301-303A Design and Construction I</td>
<td>6</td>
</tr>
<tr>
<td>301-304B Design and Construction II</td>
<td>6</td>
</tr>
<tr>
<td>301-321A Freehand Drawing III</td>
<td>1</td>
</tr>
<tr>
<td>301-322B Freehand Drawing IV</td>
<td>1</td>
</tr>
<tr>
<td>301-324T Sketching School I</td>
<td>1</td>
</tr>
<tr>
<td>301-327T Summer Project I</td>
<td>1</td>
</tr>
<tr>
<td>301-405A Design and Construction III</td>
<td>6</td>
</tr>
<tr>
<td>301-406B Design and Construction IV</td>
<td>6</td>
</tr>
<tr>
<td>301-428T Summer Project II</td>
<td>1</td>
</tr>
<tr>
<td>301-435B Urban Planning I</td>
<td>2</td>
</tr>
<tr>
<td>301-446A Mechanical Services</td>
<td>2</td>
</tr>
<tr>
<td>301-447A Electrical Services</td>
<td>2</td>
</tr>
<tr>
<td>301-448B Environmental Acoustics</td>
<td>2</td>
</tr>
</tbody>
</table>

#### COMPLEMENTARY COURSES

Students must complete 18 credits of architectural complementaries which must include at least one course from each of the areas of concentration listed below in order to qualify for the B.Sc.(Arch.) degree.

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDIT</th>
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</thead>
<tbody>
<tr>
<td>301-372A 301-363A 301-350A,301-364B</td>
<td>6</td>
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<tr>
<td>301-388A 301-383B 301-375A,301-377B</td>
<td>6</td>
</tr>
<tr>
<td>301-522A 301-523B 301-378B,301-461B</td>
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<tr>
<td>301-528A 301-524A 301-521B,301-471A,301-472A</td>
<td>6</td>
</tr>
<tr>
<td>301-531A 301-525A 301-527B,301-526B</td>
<td>6</td>
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<tr>
<td>301-532B 301-529B 580-442B</td>
<td>6</td>
</tr>
<tr>
<td>301-533B</td>
<td>6</td>
</tr>
</tbody>
</table>

### TOTAL CREDITS, B.Sc.(Arch.): 102

### OUTSIDE ELECTIVES:

6 credits must be completed outside the School of Architecture, subject to School approval.

### CURRICULUM FOR THE B.Arch. DEGREE

#### REQUIRED COURSES

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDIT</th>
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</thead>
<tbody>
<tr>
<td>301-450B Specifications and Building Costs</td>
<td>2</td>
</tr>
<tr>
<td>301-451A Building Regulations and Safety</td>
<td>2</td>
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### Architectural Complementaries

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>301-252A 301-253B Intro. to Architectural History I</td>
<td>3</td>
</tr>
<tr>
<td>301-317C 301-318C Avant-Garde Art and Design</td>
<td>3</td>
</tr>
<tr>
<td>301-319C 301-471A,B Computer-Aided Building Design</td>
<td>3</td>
</tr>
<tr>
<td>301-350A 301-351A History of Domestic Architecture in Quebec</td>
<td>3</td>
</tr>
<tr>
<td>301-352B 301-353B New Approaches to Architecture</td>
<td>3</td>
</tr>
<tr>
<td>301-354A,B 301-355A,B Selected Topics in Architecture</td>
<td>3</td>
</tr>
<tr>
<td>301-356A 301-357A Energy, Environment and Buildings</td>
<td>3</td>
</tr>
<tr>
<td>301-358A Site Use</td>
<td>3</td>
</tr>
<tr>
<td>301-359A Summer Course Abroad</td>
<td>3</td>
</tr>
<tr>
<td>301-360A 301-361A Architecture, subject to School approval.</td>
<td>3</td>
</tr>
<tr>
<td>301-362A 301-363A History of Housing</td>
<td>3</td>
</tr>
<tr>
<td>301-364A 301-365A Housing Theory</td>
<td>3</td>
</tr>
<tr>
<td>301-366A 301-367A Arch. Intentions from Vitruvius to the Renaissance</td>
<td>3</td>
</tr>
<tr>
<td>301-368A 301-369A Origins of Modern Architecture</td>
<td>3</td>
</tr>
<tr>
<td>301-370A 301-371A New Approaches to Architectural History</td>
<td>3</td>
</tr>
<tr>
<td>301-372A 301-373A Selected Topics in Architecture I</td>
<td>3</td>
</tr>
<tr>
<td>301-374A 301-375A Selected Topics in Architecture II</td>
<td>3</td>
</tr>
<tr>
<td>301-376A 301-377A Enables Environments</td>
<td>3</td>
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### TOTAL CREDITS, B.Arch.: 96

### OUTSIDE ELECTIVES:

6 credits must be completed outside the School of Architecture, subject to School approval.

### CURRICULUM FOR THE B.Eng. DEGREE

#### REQUIRED COURSES

<table>
<thead>
<tr>
<th>COURSE</th>
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</tr>
</thead>
<tbody>
<tr>
<td>300-220A Law for Architects &amp; Engineers</td>
<td>3</td>
</tr>
<tr>
<td>306-310A,B Engineering Economy</td>
<td>6</td>
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</table>

### Architectural Subjects

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDIT</th>
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<tbody>
<tr>
<td>301-411A Design and Construction VI</td>
<td>7</td>
</tr>
<tr>
<td>301-413B Design and Construction VIII</td>
<td>7</td>
</tr>
<tr>
<td>301-429T Summer Project III</td>
<td>1</td>
</tr>
<tr>
<td>301-430T Sketching School II</td>
<td>1</td>
</tr>
<tr>
<td>301-436A Urban Planning II</td>
<td>2</td>
</tr>
<tr>
<td>301-449A Professional Practice</td>
<td>2</td>
</tr>
<tr>
<td>301-450B Specifications and Building Costs</td>
<td>2</td>
</tr>
<tr>
<td>301-451A Building Regulations and Safety</td>
<td>2</td>
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</tbody>
</table>

### TOTAL CREDITS, B.Eng.: 96

### OUTSIDE ELECTIVES:

6 credits must be completed outside the School of Architecture, subject to School approval.

### CURRICULUM FOR THE B.A. DEGREE

#### REQUIRED COURSES

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>301-450B Specifications and Building Costs</td>
<td>2</td>
</tr>
<tr>
<td>301-451A Building Regulations and Safety</td>
<td>2</td>
</tr>
</tbody>
</table>

### Architectural Subjects

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDIT</th>
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</thead>
<tbody>
<tr>
<td>301-411A Design and Construction VI</td>
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</tr>
<tr>
<td>301-413B Design and Construction VIII</td>
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<tr>
<td>301-429T Summer Project III</td>
<td>1</td>
</tr>
<tr>
<td>301-430T Sketching School II</td>
<td>1</td>
</tr>
<tr>
<td>301-436A Urban Planning II</td>
<td>2</td>
</tr>
<tr>
<td>301-449A Professional Practice</td>
<td>2</td>
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<tr>
<td>301-450B Specifications and Building Costs</td>
<td>2</td>
</tr>
<tr>
<td>301-451A Building Regulations and Safety</td>
<td>2</td>
</tr>
</tbody>
</table>

### TOTAL CREDITS, B.A.: 96

### OUTSIDE ELECTIVES:

6 credits must be completed outside the School of Architecture, subject to School approval.
COMPLEMENTARY COURSES

4 credits of complementaries; 2 credits must be taken from the architectural complementary list above.

TOTAL CREDITS, B.Arch

34

Following completion of the B.Sc.(Arch.)

COURSES OFFERED BY THE SCHOOL

- Denotes limited enrolment.
- ★ Denotes courses offered only in alternate years.

Unless otherwise indicated, students not registered in the B.Sc.(Arch.)/B.Arch. programs who wish to take courses offered by the School of Architecture must obtain a password card from the Student Advisor.

301-201A COMMUNICATION, BEHAVIOUR & ARCH. 6(2-10-6) Introduction to design; development of design judgement and communication skills in a series of exercises addressing light, scale, space, form and colour in the built environment; introduction to techniques of oral and graphic presentation, including model making, photography, sketching and architectural drawing. The course is based in the studio and includes lectures, seminars and field trips. **Professor Covo and Adjunct Faculty**

301-202B ARCH. GRAPHICS & ELEMENTS OF DESIGN. 6(2-10-6) (Prerequisite: 301-201A) Introduction to architectural design; consideration of building form in relation to program, structural system, material selection, site and climate; further development of skills in model making, conventional architectural drawing, axonometric and perspective drawing, sketching and architectural rendering. The course is based in the studio and includes lectures, seminars and field trips. **Professor Zuk and Adjunct Faculty**

301-217A FREEHAND DRAWING I. 1(0-3-0) Drawing in pencil and charcoal. Section 01 reserved for Architecture students. Section 02, reserved for others; limited enrolment, password card required. **Professors Tondino and Nash**

301-218B FREEHAND DRAWING II. 1(0-3-0) (Prerequisite: 301-217A) A continuation of course 301-217A. Section 01 reserved for Architecture students. Section 02, reserved for others; limited enrolment, password card required. **Professors Tondino and Nash**

301-240B ORGANIZATION OF MATERIALS IN BLDGS. 3(2-3-4) The characteristics of basic building materials: wood, steel, masonry and concrete. How building materials are shaped into building components, and how these components are integrated into the building envelope. Problems, laboratory projects and field trips to illustrate principles. **Professor Friedman**

301-250A ARCHITECTURAL HISTORY I. 2(2-0-4) The study of architecture and cities in their social, political and cultural contexts from the earliest settlements to the end of the Middle Ages. **Professor Castro**

301-251B ARCHITECTURAL HISTORY II. 2(2-0-4) (Prerequisite: 301-250B) The study of architecture and cities in their social, political and cultural contexts from the Renaissance to the present. In-depth study of the language of architectural history. **Professor Adams**

301-252A INTRO. TO ARCHITECTURAL HISTORY I. 3(3-0-6) The study of architecture and cities in their social, political and cultural contexts from the earliest settlements to the end of the Middle Ages. Introduction to the language of architectural history. Open only to students outside the School of Architecture. Limited enrolment, password card required. **Professor Castro**

301-253B INTRO. TO ARCHITECTURAL HISTORY II. 3(3-0-6) The study of architecture and cities in their social, political and cultural contexts from the Renaissance to the present. In-depth study of the language of architectural history. Open only to students outside the School of Architecture. Limited enrolment, password card required. **Professor Adams**

301-303A DESIGN AND CONSTRUCTION I. 6(2-10-6) (Prerequisite: 301-202B) An exploration of the design of buildings. Projects emphasize the major social, technological, environmental, and symbolic aspects of the design process. Introduction to specific modelling, presentation, and documentation techniques. Discussions, readings, field trips and practical exercises.

**Professors Bourke, Castro and Rousseau**

301-304B DESIGN AND CONSTRUCTION II. 6(2-10-6) (Prerequisite: 301-303A) Continuation of Design and Construction I with projects of increasing complexity. Projects deal with particular aspects of architectural design and/or explore approaches to design methodology. Discussions, readings, field trips and practical exercises.

**Professors Adams, Castro and Rousseau**

301-318C DESIGN SKETCHING. 4(2-5-5) (Prerequisite: 301-202B) Pictorial drawing in the design process: relationship of drawing type to design intention; strategies for visualization and representation based on perspective sketching, axonometric and oblique projection in selected media; studio work based on design exercises and problems varying in length from several minutes to several days. Limited enrolment; password card required. **Staff**

301-321A FREEHAND DRAWING III. 1(0-3-0) (Prerequisite: 301-218B) A continuation of course 301-218B. Section 01 reserved for Architecture students. Section 02, reserved for others; limited enrolment, password card required. **Professors Tondino and Nash**

301-322B FREEHAND DRAWING IV. 1(0-3-0) (Prerequisite: 301-321A) A continuation of course 301-321A. Section 01 reserved for Architecture students. Section 02, reserved for others; limited enrolment, password card required. **Professors Tondino and Nash**

301-324T SKETCHING SCHOOL I. 1(0-0-3) (Prerequisite: 301-218B) An eight-day supervised field trip in the late summer to sketch places or things having specific visual characteristics. Students are required to include Sketching School 1 in the B.Sc.(Arch.) program. **Professors Castro, Covo and Tondino**

301-327T SUMMER PROJECT I. 1(0-0-3) (Prerequisite: 301-202B) These projects are assigned by staff members before the end of the session to be submitted at registration for the fall semester. **Professors Adams, Castro and Sijpkes**

301-350A THE MATERIAL CULTURE OF CANADA. 3(2-1-6) A study of Material Culture in Canada, the "stuff" of our lives; using a multi-disciplinary approach to the interpretation of the non-textual materials which have shaped the lives of past and present Canadians, using the resources of the McCord Museum and other Montreal museums, galleries and collections. Section 01, reserved for Architecture, Section 02, reserved for Canadian Studies, Section 03, reserved for others. **Professors Adams, Kenneally and visitors**

301-364B ARCHITECTURAL MODELING. 3(2-1-6) (Prerequisite: 301-202B and 301-471B) Architectural modeling using digital media. Topics include: advanced 3-D modeling and rendering techniques; raster and vector image editing; digital animation; hypertext and the World Wide Web; issues of representation and methodology; comparison of various publishing media. Limited enrolment. (Credit weight change – Awaiting University Approval) **Professor Yip**

★ 301-372A HISTORY OF ARCHITECTURE IN CANADA. 2(2-0-4) (Prerequisite: 301-202B) (Given alternate years, alternating with 301-388A.) French, British and American influences in the
Maritime Provinces, Quebec and Ontario. Limited enrolment; password card required.  

Professor Gersovitz

301-375A LANDSCAPE. 2(2-2-2) (Prerequisite: 301-202B) Land form, plant life, microclimate; land use and land preservation; elements and methods of landscape design.  

Professor Emond

301-377B ENERGY, ENVIRONMENT AND BUILDINGS. 2(2-0-4) (Prerequisite: 301-202B or permission of instructor) Energy consumption in the built environment; architectural means to conserve energy; the potential and limitations of unconventional sources of energy; a comparative study of energy conserving buildings and their long-term environmental impact; effects of legislation and financing. Section 01 reserved for Architecture students. Section 02 for others; limited enrolment; password card required.

301-378A SITE USAGE. 3(2-0-7) (Prerequisite: 301-202B or permission of instructor) The study of the creation, form and usage of the exterior space generated in various patterns of low-rise housing; socio-cultural aspects of patterns; exterior space as a logical extension of the living unit; social control of the use of urban and suburban land; comparative model for low-rise housing patterns. Section 01 reserved for Architecture students. Section 02, for others; limited enrolment; password card required.

Professor Bhatt and Thibodeau

301-383B GEOMETRY, ARCHITECTURE AND ENVIRONMENT. 2(2-0-4) (Prerequisite: 301-202B or permission of instructor) Geometry in the formal structure of design. Grids, lattices, polygons and polyhedra; proportional systems. Evidence of these figures and structures in natural objects and phenomena. Graphical and physical models. Application to architecture and the human environment.

Professor Zuck

301-388A INTRODUCTION TO HISTORIC PRESERVATION. 2(2-2-2) (Prerequisite: 301-303A) Given alternate years, alternating with 301-372A.) Historic attitudes and terminologies of conservation; historic research techniques. Restoration technology of building materials and principles of interior design in the 19th and 20th centuries; current preservation planning.

Professor Gersovitz

301-405A DESIGN AND CONSTRUCTION III. 6(2-10-6) (Prerequisites: 301-304B and 301-428T) A structured investigation of architectural concepts; program interpretation with respect to relevant cultural, social and environmental contexts; applications of appropriate formal languages and building technologies in integrated proposals for a variety of building forms.

Professor Anderson, Sheppard and Zuck and Adjunct Faculty

301-406B DESIGN AND CONSTRUCTION IV. 6(2-10-6) (Prerequisite: 301-405A) A detailed study and comprehensive development of architectural proposals for complex building types and site conditions; the exploration of coherent initial concepts with respect to programmatic requirements, image and form; subsequent elaboration leading to meaningful and technologically viable designs for the built environment.

Professors Anderson, Bhatt, Sheppard and Adjunct Faculty

301-411A DESIGN AND CONSTRUCTION VI. 7(2-12-7) (Prerequisite: 301-406B) A series of studies of complex architectural and urban design issues with the intention of improving the student's facility to critically assess existing design solutions, to seek alternatives and to articulate clearly the rationale and the impact of alternative proposals.

Professor Davies, Adjunct Faculty and invited critics

301-413B DESIGN AND CONSTRUCTION VIII. 7(2-12-7) (Prerequisite: 301-406B and 301-411A) An individual, student selected and faculty approved study of complex environmental problems involving conflicting requirements, severe restraints, optimization, adaptability to growth and change, and the integration of building systems. Demonstration of systematic design methods leading to the design of a comprehensive environmental form.

Professor Davies and Staff

301-428T SUMMER PROJECT II. 1(0-0-3) (Prerequisite: 301-304B) See course 301-327T.

Professor Anderson, Sheppard and Zuck

301-429T SUMMER PROJECT III. 0(0-3) (Prerequisite: 301-406B) See course 301-327T.

Professor Staff

301-430T SKETCHING SCHOOL II. 1(0-0-3) (Prerequisite: 301-324T) Students are required to include Sketching School II in the B.Arch. program.

Professors Castro, Covo and Tondino

301-435B URBAN PLANNING I. 2(2-2-2) (Prerequisite: 301-405A) Theory and practice. An examination of different basic approaches to urban planning with special reference to Quebec. (Not normally open to Urban Planning students.) Section 01 reserved for Architecture students. Section 02, reserved for others; limited enrolment, password card required.

Professor Wolf

301-436A URBAN PLANNING II. 2(2-2-2) (Prerequisite: 301-406B) Urban Design and Project Development. Theory and practice. Detailed analysis of selected examples of the development process and of current techniques in urban design. Section 01 reserved for Architecture students. Section 02, reserved for others; limited enrolment, password card required.

Professor Fischler

301-446A MECHANICAL SERVICES IN BUILDINGS. 2(2-2-2) (Prerequisite: 301-304B) Problems encountered in providing mechanical services in buildings. Physiological and environmental aspects of heat, ventilation and air conditions, estimation of heating and cooling loads and selection and specification of equipment. Sprinkler systems and plumbing. Construction problems produced by installation of this equipment. Section 01, reserved for Architecture students; section 02, reserved for others, limited enrolment, password card required.

Professor Levine

301-447A ELECTRICAL SERVICES. 2(2-2-2) (Prerequisite: 301-304B) Production, measurement and control of light; design of lighting systems; electrical distribution in residential and commercial buildings; Canadian Electrical Code. Section 01, reserved for Architecture students; section 02, reserved for others, limited enrolment, password card required.

Professor Edwards

301-448B ENVIRONMENTAL ACOUSTICS. 2(2-2-2) (Prerequisite: 301-304B) Acoustics in architectural design, and in environmental control of buildings. Acoustical requirements in the design of auditoria such as theatres, lecture halls, opera houses, concert halls, churches, motion picture theatres, studios. Principles of noise and vibration control, sound insulating in building construction. Practical noise control in various types of buildings. Section 01, reserved for Architecture students; section 02, reserved for others, limited enrolment, password card required.

Professor Melanson

301-449A PROFESSIONAL PRACTICE. 2(2-2-2) (Prerequisite: 301-406B) The architect's relationship to his/her client; responsibility; business conduct; supervision; arbitration; issuing of certificates; competitions; standard forms of contracts; payment; liens; servicing; public health; building regulations; fees.

Professor Sheppard

301-450B SPECIFICATIONS AND BUILDING COSTS. 2(2-0-4) (Prerequisite: 301-406B) Principles of architectural construction specifications; research for specification production; development of written specification technical section. Principles of construction economics; measurement and cost estimating of construction work; cost analysis. Section 01, reserved for Architecture students; Section 02, reserved for others. Limited enrolment, password card required.

Professor Poddubiuk

301-451A BUILDING REGULATIONS AND SAFETY. 2(2-2-2) (Prerequisite: 301-406B) The study of building codes with specific empha-
sis on the National Building and National Fire Codes of Canada. Examples of existing buildings with assignments to illustrate regulations. Development of a systematic approach to the implementation of codes during the preliminary design stage of an architectural project. Section 01, reserved for Architecture students; section 02, reserved for others, limited enrolment, password card required.  

Professor Zorko

301-461B FREEHAND DRAWING AND SKETCHING. 1(0-3-0) (Prerequisite: 301-324C) Drawing and sketching in pencil, charcoal and other media both in the studio and out-of-doors.  

Professor Tondino

301-471A,B COMPUTER-AIDED BUILDING DESIGN. 2(2-2) (Prerequisite: 301-202B or equivalent) An introduction to selected applications of interactive computer-aided design in architecture; emphasis on development of simple algorithms in graphic, as well as non-graphic, modes in hands-on situations in the lab; field trips to several in use installations. Limited enrolment; password card required.  

Professor Schoenauer and Sijpkes

301-490A,B SELECTED TOPICS IN DESIGN. 2(2-0-4) (Prerequisite: 301-202B or permission of instructor) A course to allow the introduction of special topics in related areas of design.  

Staff

301-520B MORPHOLOGY OF THE METROPOLIS: MONTREAL. 3(2-1-6) (Prerequisite: 301-251B) The course deals with the historical, demographical and regional evolution of the metropolis of Montreal. Important quartiers, the Montreal urban grid, industrialization, reform movements, geographical diversity, and urban culture are discussed. Local building techniques and materials, known as the Quebec genre, and basic concepts of urban morphology and their relationships to the contemporary urban context will be explored. Section 01, reserved for Architecture students; Section 02, reserved for others. Password card required.  

Professor Rohan

301-521B STRUCTURE OF CITIES. 3(2-0-7) (Prerequisite: 301-202B or permission of instructor) Nature, pattern and life of modern cities. Urban environments, design and pattern of settlements. The principal historic examples of transient and permanent, from the standpoint of individual structure and pattern of settlements. The principal historic examples of housing including housing in the age of industrial revolution and contemporary housing. Limited enrolment. Section 01 reserved for Architecture, Section 02 reserved for Masters of Architecture students, Section 03 reserved for Urban Planning students, Section 04 reserved for Urban Systems Students, Section 05 reserved for Engineering Students. Enrolment Cap is placed on each section.  

Professors Schoenauer and Sijpkes

301-522B SIGNIFICANT TEXTS & BUILDINGS. 3(2-0-7) (Prerequisite: 301-251A) Alternating with 301-524B) Critical study of significant architectural thought since 1750 as it has been expressed in buildings and texts (treatises, manifestos, criticisms). A specific theme will be addressed every year to allow in-depth interpretations of the material presented and discussed. Limited enrolment; password card required.  

Professor Anderson

301-523B A RCH. INTENTIONS FROM V ITRUVIUS TO THE R ENAISSANCE. 3(2-0-7) (Prerequisite: 301-251A) Examination of architectural intentions (theory and practice) in the European context (especially France, Italy and England), during the crucial period that marks the beginning of the modern era. Section 01 reserved for Architecture students. Section 02 reserved for others; limited enrolment, password card required.  

Professor Pérez-Gómez

301-524A,B SELECTED TOPICS IN ARCHITECTURE I. 3(2-0-7) (Prerequisite: 301-251A or permission of instructor) A course to allow the introduction of new topics in Architecture as needs arise, by regular and visiting staff.  

Staff

301-524B NEW APPROACHES TO ARCHITECTURAL HISTORY. 3(2-0-7) (Prerequisite: 301-251A or permission of instructor) An exploration of the aims, tools, and methods of Architectural History as a discipline; the use of primary sources from the Canadian Centre for Architecture and other archives. Limited enrolment; password card required.  

Professor Pérez-Gómez

301-525A SEMINAR ON ARCHITECTURAL CRITICISM. 3(2-0-7) (Prerequisite: 301-251A) Alternating with 301-523B.) The development and current role of architectural criticism with particular reference to its affinities with art and literary criticism. Limited enrolment; password card required.  

Professor Castro

301-525A SEMINAR ON ANALYSIS AND THEORY. 3(2-0-7) (Prerequisite: 301-202B or permission of instructor) Analysis and evaluation of significant architectural projects with reference to contemporary architectural theories. Limited enrolment; password card required.  

Professor Zorko

301-526B PHILOSOPHY OF STRUCTURE. 3(2-0-7) (Prerequisite: 301-202B or permission of Instructor) Philosophy of Structure aims to investigate structure in its broadest sense. The course is divided in two halves; the first one gives an overview of the development of theoretical structural frameworks such as mathematics and geometry, while the second one highlights physical structures constructed by nature (geology, turbulence), man or animals. Not open to students who have taken 301-374B. Section 01, reserved for Architecture students; section 02, reserved for others; password card required.  

Professor Sijpkes

301-527B CIVIC DESIGN. 3(2-0-7) (Prerequisite: 301-378A) The elements of form in buildings and their siting design in the urban setting. Section 01 reserved for Architecture students. Section 02, reserved for others; Password card required, limited enrolment.  

Professor Drummmond

301-528A HISTORY OF HOUSING. 3(2-0-7) (Prerequisite: 301-251A or permission of instructor) Indigenous housing both transient and permanent, from the standpoint of individual structure and pattern of settlements. The principal historic examples of housing including housing in the age of industrial revolution and contemporary housing. Limited enrolment. Section 01 reserved for Architecture, Section 02 reserved for Masters of Architecture students, Section 03 reserved for Urban Planning students, Section 04 reserved for Urban Systems Students, Section 05 reserved for Engineering Students. Enrolment Cap is placed on each section.  

Professors Schoenauer and Sijpkes

301-529B HOUSING THEORY. 3(2-0-7) (Prerequisite: 301-528A or permission of instructor) A review of environmental alternatives in housing; contemporary housing and the physical and sociological determinants that shape it; Canadian housing, Section 01 reserved for Architecture students. Section 02 reserved for others; limited enrolment, password card required.  

Professor Schoenauer

301-531A ARCH. INTENTIONS FROM VITRUVIUS TO THE RENAISSANCE. 3(2-0-7) (Prerequisite: 301-251A) Architectural intentions embodied in buildings and writings of architects from antiquity to the Renaissance. Special emphasis is placed on the cultural connections of architecture to science and philosophy. Section 01 reserved for Architecture students. Section 02 reserved for others; limited enrolment, password card required.  

Professor Pérez-Gómez

301-532B ORIGINS OF MODERN ARCHITECTURE. 3(2-0-7) (Prerequisite: 301-251A) Examination of architectural intentions (theory and practice) in the European context (especially France, Italy and England), during the crucial period that marks the beginning of the modern era. Section 01 reserved for Architecture students. Section 02 reserved for others; limited enrolment, password card required.  

Professor Pérez-Gómez

301-540A,B SELECTED TOPICS IN ARCHITECTURE II. 3(2-0-7) A course to allow the introduction of new topics in Architecture as needs arise, by regular and visiting staff.  

Staff

301-541A,B SELECTED TOPICS IN ARCHITECTURE III. 3(2-0-7) A course to allow the introduction of new topics in Architecture as needs arise, by regular and visiting staff.  

Staff

580-442B ENABLING ENVIRONMENTS. 2(1-2-3) (Prerequisite: 301-303A for Architecture students; 580-326D for Occupational Therapy students) Students work in multi-disciplinary teams under the supervision of faculty and visitors on projects in the design and construction of environments for the disabled drawn from case histories of selected institutions. Course work may include group and individual field trips to hospitals, clinics or specific project sites. Limited enrolment.  

Professors Gisel, Covo and visitors
4.3 Department of Chemical Engineering

Chair
Richard J. Munz; B.A.Sc., M.A.Sc.(Wat.), Ph.D.(McG.), Eng.

Professors
David G. Cooper; B.Sc., Ph.D.(Tor.)
John M. Dealy; B.S.(Kansas), M.S.E., Ph.D.(Mich.), Eng.
W.J. Murray Douglas; B.Sc.(Qu.), M.S.E., Ph.D.(Mich.)
Arun S. Mujumdar; B.Ch.E.(Bombay), M.Eng., Ph.D.(McG.)
Juan H. Vera; B.Mat.(Chile), Ing.Qim.Ing.(U.T.E.), M.S.(Berkeley),
Dr.Ing.(Santa Maria), Ing.
Bohumil Volesky; M.Sc.(Czech, Tech., Univ.), Ph.D.(W.Ont.)

Associate Professors
Dimitrios Berk; B.Sc.(Bosphorus), M.E.Sc.(W.Ont.), Ph.D.(Calg.),
P.Eng.
Jean-Michel Charrier; Dipl. Ing., E.N.S.A.M.(Paris), M.S.,
Ph.D.(Akron), Ing.
Jean-Luc Meunier; Dipl. Ing., EPFL(Lausanne), M.Sc., Ph.D.,
INRS(Varennes), Ing.
Alejandro D. Rey; B.Ch.Eng.(CCNY), Ph.D.(Berkeley)
Jana Simandl; B.Eng.(McG.), Ph.D.(Calg.), P.Eng.

Assistant Professor (Special Category)
Paula Wood-Adams; B.Sc.(Alta), M.Eng, Ph.D.(McG.)

Associate Members
Thomas M.S. Chang; B.Sc., M.D., Ph.D.(McG.), F.R.C.P.(C)
Reinhold H. Crotogino; B.A.Sc.(U.B.C.), Ph.D.(McG.)
Harry L. Goldsmith; B.Ch.E., M.A.(Oxon.), Ph.D.(McG.)

PAPRICAN Adjunct Professors
George J. Kubes; B.Eng., M.Eng.(Prague), Ph.D.(Bratislava)
Gil B. Garnier; B.Appl.Sci., M.Appl.Sci.(Sherbrooke), Ph.D.(Virginia
Polytechnic Institute and State University)

Adjunct Professors
Bohumil Alince, Manon Bérubé, Pierre Bisaillon,
Richard Campeau, Lionel Charlier, Earl J. Chin,
Norman E. Cooke, Peter Csakany, Eric Denman, Pierre Duhaime,
András García-Rejon, Sylvain Gendron, Robert W. Gooding,
Serge Guoit, Norayr Gumagal, Bing Huang, R. Bruce Kerr,
Tadeusz Kudra, Caroline Ladanowski, Pascale Lagacé,
D. Cameron Lamond, Norman Liebergott, David J. McKeagan,
Raman Nayar, Ky T. Nguyen, Jean R. Paris, Michel Perrier,
Norman Peters, Ivan I. Pikulik, Alain A. Roche, John Sarlis, Paul
Stuart, Khoa Tran, Roger C. Urquhart, Leszek A. Utracki.

The central purpose of engineering is to pursue solutions to tech-
nological problems in order to satisfy the needs and desires of
society. Chemical engineers are trained to solve the kinds of prob-
lems that are typically found in the "chemical process industries",
which include the chemical manufacturing, plastics, pulp and pa-
per, petroleum refining, ceramics, and paint industries as well as
substantial portions of the food processing, textile, nuclear energy,
biochemical and pharmaceutical industries. The technological
problems and opportunities in these industries are often closely
linked to social and economic questions. For this reason, practi-
tioners of chemical engineering often deal with these questions
when they are working in management, pollution abatement, prod-
uct development, market and equipment design.

The discipline of chemical engineering is distinctive in being
based equally on physics, mathematics and chemistry. Application
of these three fundamental sciences is basic to a quantitative un-
derstanding of the process industries. Those with an interest in
the fourth major science, biology, will find several courses in the chem-
ical engineering curriculum which integrate aspects of the biologi-
cal sciences relevant to process industries such as food
processing, fermentation and water pollution control. Courses on
the technical operations and economics of the process industries
are added to this foundation. The core curriculum concludes with
process design courses taught by practicing design engineers.

Problem-solving, experimenting, planning and communication
skills are emphasized in courses throughout the core curriculum.

By means of complementary courses, students can also obtain
further depth in technical areas and breadth in non-technical sub-
jects. Some students elect to complete a minor in biotechnology,
management, materials engineering, computer science, environ-
mental engineering or chemistry.

The curriculum also provides the preparation necessary to
undertake postgraduate studies leading to the M.Eng. or Ph.D.
degrees in chemical engineering. Students completing this curric-
ulum acquire a broad, balanced education in the natural sciences
with the accent on application. Thus, for those who do not continue
in chemical engineering, it provides an exceptionally balanced
education in applied science. For others, it will form the basis of an
educational program that may continue with a variety of studies
such as business administration, medicine or law. Versatility is,
then, one of the most valuable characteristics of the graduate of
the chemical engineering program.

ACADEMIC PROGRAM

For those who have completed the Quebec CEGEP level program in
Pure and Applied Sciences, the Chemical Engineering Program
comprises 110 credits as outlined below. Certain students who
take advantage of summer session courses can complete the de-
partmental programs in three calendar years. Students who have
passed Chemistry 202 or 302 at the CEGEP level are exempt from
course 180-212 or 234, respectively (Introductory Organic Chem-
istry I and Selected Topics in Organic Chemistry), the correspond-
ing courses are transferred from required courses to elective
CEGEP students who have the appropriate calculus background
may write Advanced Credit Placement Examinations at a time and
place to be announced by the Faculty. Successful completion will
give 3 credits for course 189-260 Intermediate Calculus.

For appropriately qualified high school graduates from outside
Quebec, an extended credit program is available, as described in
section 3.1.2 on page 220.

In some cases students from university science disciplines have
sufficient credits to complete the requirements for the B.Eng.
(Chemical) program in two years. Those concerned should dis-
uss this with their advisor.

Students must obtain a C grade or better in all core courses. For
the Department of Chemical Engineering, core courses include all
required courses (departmental and non-departmental) as well as
complementary courses (departmental). A grade of "D" is a pass-
ing grade in other complementary courses and in any elective
courses taken.

CURRICULUM FOR THE B.ENG. DEGREE IN CHEMICAL
ENGINEERING

REQUİRED COURSES

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>180-212A,B Introductory Organic Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>180-233B Sel. Topics in Phys. Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>180-234A,B Sel. Topics in Org. Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>189-260A,B Intermediate Calculus</td>
<td>3</td>
</tr>
<tr>
<td>189-261A,B Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>189-265A,B Advanced Calculus</td>
<td>3</td>
</tr>
<tr>
<td>306-221A,B Engineering Professional Practice</td>
<td>1</td>
</tr>
<tr>
<td>306-310A,B Engineering Economy</td>
<td>3</td>
</tr>
<tr>
<td>308-208A,B Computers in Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

Chemical Engineering Courses

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>302-200A Intro. to Chemical Eng.</td>
<td>4</td>
</tr>
<tr>
<td>302-204B Chemical Manuf. Processes</td>
<td>3</td>
</tr>
<tr>
<td>302-220B Chem. Eng.Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>302-281A Instr. Measurements Lab.</td>
<td>4</td>
</tr>
<tr>
<td>302-314A Fluid Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>302-315B Heat and Mass Transfer</td>
<td>3</td>
</tr>
<tr>
<td>302-340B Process Modelling</td>
<td>3</td>
</tr>
<tr>
<td>302-351B Separation Processes</td>
<td>3</td>
</tr>
<tr>
<td>302-360A,B Technical Paper I</td>
<td>1</td>
</tr>
</tbody>
</table>
COMPLEMENTARY COURSES
Courses to be selected from those approved by the Department (see list of technical complementaries below).

See section 3.3 on page 220. The Chemical Engineering program requires 6 credits selected from categories (i) and (ii) of section 3.3.

TOTAL 110
If advanced credit is obtained for 189-260 Intermediate Calculus (see section 2.3 on page 219), the total number of credits is reduced by three.

For students starting their B.Eng. studies in September who have completed the Quebec Diploma of Collegial Studies, a program for the first two semesters of study is given below:

Semester 1

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>180-212A Organic Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>189-260A Intermediate Calculus</td>
<td>3</td>
</tr>
<tr>
<td>302-200A Intro. to Chemical Eng.</td>
<td>4</td>
</tr>
<tr>
<td>302-291A Instr. Meas. Lab.</td>
<td>4</td>
</tr>
<tr>
<td>306-221A,B Engineering Professional Practice</td>
<td>1 16</td>
</tr>
</tbody>
</table>

Semester 2

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>180-234B Organic Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>189-261B Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>302-204B Chemical Manuf. Processes</td>
<td>3</td>
</tr>
<tr>
<td>302-220B Chem. Eng. Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>308-208B Computers in Engineering</td>
<td>3 15</td>
</tr>
</tbody>
</table>

Students entering their second year of study or who are starting in January must plan their program of studies in consultation with their departmental adviser.

For students admitted to the 8-semester program (see section 3.1.2 on page 220), the additional courses are specified in the "Welcome" book, and can also be found on the Faculty website (http://www.engineering.mcgill.ca).

TECHNICAL COMPLEMENTARIES
A minimum of 9 credits of complementary courses must be chosen from a list of technical complementaries approved by the Department. The purpose of this requirement is to provide students with an area of specialization within the broad field of chemical engineering. Alternatively, some students use the technical complementaries to increase the breadth of their chemical engineering training.

At least two (2) technical complementary courses are to be selected from those offered by the Department (list below). Permission is given to take the third complementary course from other suitable undergraduate courses in the Faculty of Engineering (see for example the Faculty list of courses in section 4.1.1 on page 223).

The technical complementary courses currently approved by the Department are as follows:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>302-363A,B Projects in Chemical Engineering I</td>
<td>3</td>
</tr>
<tr>
<td>302-452B Particulate Systems</td>
<td></td>
</tr>
<tr>
<td>302-458A Computer Applications</td>
<td></td>
</tr>
<tr>
<td>302-464A,B Projects in Chemical Engineering II</td>
<td></td>
</tr>
</tbody>
</table>

Courses 481A and 581B comprise a Polymeric Materials sequence. Additional courses in this area are available in the Chemistry Department (e.g. 180-455A) or at the graduate level (302-681 to 684). The Department has considerable expertise in the polymer area.

Courses 370A and 474A make up a sequence in Biochemical Engineering-Biotechnology. Students interested in this area may take additional courses, particularly those offered by the Department of Food Science and Agricultural Chemistry, Faculty of Agricultural and Environmental Sciences, and courses in biochemistry and microbiology. The food, beverage and pharmaceutical industries are large industries in the Montreal area and these courses are relevant to these industries and to the new high technology applications of biotechnology.

The third area in which there is a sequence of courses is Pollution Control. The Department offers two courses in this area: 302-471A and 302-472B. As some water pollution control problems are solved by microbial processes, course 302-474B is also relevant to the pollution control area. Likewise as the solution to pollution problems frequently involves removal of particulate matter from gaseous or liquid streams, course 302-452B is also relevant. Additional courses in this area are listed under section 5.7 on page 261.

CURRICULUM COMMITTEE
The Curriculum Committee is composed of three students, elected by their classes, and two staff members. This Committee provides a forum for all matters involving undergraduate student/staff interactions. While the primary concern is with matters of curriculum and courses (their content, evaluation, scheduling, etc.), the Committee has also taken up a number of other matters in recent years, e.g. working space, facilities (equipment and libraries), etc.

CANADIAN SOCIETY FOR CHEMICAL ENGINEERING
The Chemical Engineering Student Society has for many years been affiliated both with the CSChE (Canadian Society for Chemical Engineering) and with the AIChE (American Institute of Chemical Engineers). For a nominal fee students receive "Canadian Chemical News", a monthly publication, and the AIChE Student Members Bulletin as well as other privileges of student membership in the two societies. The student chapter also organizes a series of local social, educational and sporting events. For exam-
ple, recent events have included student-professor banquets and Christmas parties, dances, speakers, broomball games and joint meetings with the Montreal Section of the CScE. The latter gives students a chance to mix with practising chemical engineers.

COURSES OFFERED BY THE DEPARTMENT

- Denotes courses not offered in 1999-2000
- Complementary courses
- Courses with Limited Enrolment

* A D grade is acceptable for prerequisite purposes only

302-200A INTRODUCTION TO CHEMICAL ENGINEERING. 4(3-2-8) (Restrictions: students with DCS in PAS, HS or equivalent.) Introduction to the design of industrial processes. Survey of unit operations, and systems of units. Elementary material balances, first and second laws of thermodynamics, use of property tables and charts, steady flow processes, heat engines, refrigeration cycles. Relationships between thermodynamic properties, property estimation techniques. Laboratory and design exercise.

Professors Vera and Wood-Adams

302-204B CHEMICAL MANUFACTURING PROCESSES. 3(2-3-4) (Prerequisite: 302-200A) Introduction to degrees of freedom. Problem solving in the design of simple processes (mixing, washing, decantation) and separation processes (evaporation, binary distillation). Elements of reaction engineering and process control and design.

Professor Berk

302-220B CHEMICAL ENGINEERING THERMODYNAMICS. 3(3-1-8) (Prerequisite: 302-200A) Application of thermodynamic equilibrium; free energy and equilibrium; phase rule; chemical reaction equilibrium for homogenous and multicomponent/multiphase systems. Application to the design of binary distillation. Laboratory exercise.

Professor Cooper

302-230B ENVIRONMENTAL ASPECTS OF TECHNOLOGY. 3(3-0-6) The impact of urbanization and technology on the environment. Topics include urbanization: causes, effects, land use regulations; transportation technology and environmental implications; environmental impact of energy conversions; energy policy alternatives; formulation of energy and environmental policy; air pollution; sources, effects, control; water pollution; sources, effects, control. MARS passwords distributed after the first class.

Professor Volesky


Professor Cooper

302-314A FLUID MECHANICS. 4(3-3-6) (Prerequisite: 302-204B. Corequisite: 189-265A.) Fluid properties; dimensional analysis; drag, packed/fluidized beds; macroscopic energy balances, Bernoulli’s equation and linear momentum theorem; flowmeters, pipeline systems, non-Newtonian fluids, microscopic balances leading to continuity and Navier-Stokes equations; boundary layer approximation; turbulence. Laboratory exercises.

Professor Mukhammad

302-315B HEAT AND MASS TRANSFER. 4(3-2-7) (Prerequisite: 302-314A) Transport of heat and mass by diffusion and convection; transport of heat by radiation; diffusion; convective mass transfer; drying; gas-liquid separations; absorption; mathematical formulation of problems and equipment design for heat and mass transfer; laboratory exercises.

Professor Meunier

302-340B PROCESS MODELLING. 3(3-1-5) (Prerequisites: 189-261A,B, 189-265A,B, 302-314A) Principles of mathematical modelling in chemical engineering; problem formulation; solution, discrete systems; difference and difference-differential equations, methods of solution; understanding system behaviour, optimization.

Professor Meunier


Professor Simandl

302-360A,B TECHNICAL PAPER I. 1(0-0-3) A technical paper prepared according to instructions issued by the Department.

Mr. Denman

302-363A,B PROJECTS IN CHEMICAL ENGINEERING I. 2(1-0-5) (Prerequisite: 302-200A*) Projects on social or technical aspects of chemical engineering practice. Students must suggest their own projects to be approved and supervised by a member of the staff. Students may work in groups.

Staff

302-370A ELEMENTS OF BIO TECHNOLOGY. 3(3-0-6) (Prerequisite: 180-234A,B) Industrially important proteins, carbohydrates and other biochemcials, industrially significant microbes; cell structure and metabolism; laboratory exercises.

Professor Volesky

302-380A MATERIALS SCIENCE. 3(3-1-5) (Prerequisite: 302-220B) Structure/property relationship. Atomic and molecular structure, bonds, electronic band structure. Order in solids: crystal structure, disorders, solid phases. Mechanical properties and fracture, physico-chemical properties, design.

Professor Meunier

302-392A PROJECT LABORATORY I. 4(3-6) (Prerequisites: 302-291B) Planning for the solution of experimental problems; design of experiments for logical and statistical interpretation; statistical analysis of experimental data; effective work in groups; selected laboratory exercises.

Professor Weber

302-393B PROJECT LABORATORY II. 5(2-10-4) (Prerequisites: 302-392A) Student groups execute and report on experimental projects.

Professor Weber and Staff


Professor Munz

- 302-430A TECHNOLOGY IMPACT ASSESSMENT. 3(3-1-5) The power of technology to shape man's physical, economic and social environment: effects of technological transitions on culture and ecology; TIA methodologies, public participation, engineering contributions, regulations; implications of TIA on social and economic development. Limited enrolment. Restricted to final year students by permission of instructor.

Professor Ladanowski


Dr. G.J. Kubes

302-452B PARTICULATE SYSTEMS. 3(3-0-6) (Prerequisites: 302-201A, 302-210B*) Study of operations involving multiphase systems with one of the phases finely sub-divided as bubbles, drops or particles. Applications in grinding, agglomeration, settling, fluidizaton etc.

Professor Munz


Professor Simandl

302-455B PROCESS CONTROL. 4(3-1-8) (Prerequisites: 302-315B; 302-423A) Dynamic modelling of processes, transfer functions, first and higher-order systems, dead-time, open and closed loop responses, empirical models, stability, feedback control, controller tuning, transient response, frequency response, feedforward and ratio control, introduction to computer control.
sampling, discrete models, Z-transform, introduction to multivariable control. Laboratory exercises. **Professor Wood-Adams**

302-456A/B **DESIGN PROJECT I.** 1(1-0-2) (Prerequisite: 302-393B. Corequisite: 302-453A.) Introduction to a process design and economic evaluation project for a major industrial operation. Students work in small groups under an experienced plant design supervisor. Must be taken in the semester preceding 302-547. **Professors Kamal and Simandl**

302-457A/B **DESIGN PROJECT II.** 5(1-2-12) (Prerequisite: 302-456A/B) A process plant design and economic evaluation for a major industrial operation. Students work in small groups, under an experienced plant design supervisor. Plant visit. Must be taken in the semester following 302-456. **Professors Kamal and Simandl**

302-458A **COMPUTER APPLICATIONS.** 3(2-3-4) (Prerequisites: 308-208A, B and 302-393B) Use of computers and software as problem solving aids in chemical engineering. Lectures on software engineering, computer architectures, and multitasking. In laboratory work, groups of students will produce software to be used and maintained by others. **Staff**

302-462A,B **TECHNICAL PAPER I.** 1(0-0-3) (Prerequisite: 302-360A) A technical paper prepared according to instructions issued by the Department. **Mr. Bisaillon**

302-464A,B **PROJECTS IN CHEMICAL ENGINEERING II.** 2(1-0-5) (Prerequisite: 302-363A,B) Projects on social or technical aspects used and maintained by others. **Professors Kamal and Simandl**

302-471B **INDUSTRIAL WATER POLLUTION CONTROL.** 3(3-0-6) (Prerequisite: 302-314A or equivalent) Effect of wastes on streams, water quality and standard analyses, waste water sampling techniques, waste water treatment technology and processes; design of treatment operations and equipment; physical, chemical and biological methods; specific industrial applications with emphasis on Canadian case studies; industrial effluent treatability studies. **Professor Volesky**

302-472B **INDUSTRIAL AIR POLLUTION CONTROL.** 3(2-0-7) (Prerequisite: 302-314A or equivalent) Air quality standards, air surveys, process design considerations, dispersion theory and stack design; dust cleaning methods, design of scrubbers, case studies in the Canadian context. **Professor Munz**

302-474A **BIOCHEMICAL ENGINEERING.** 3(3-0-6) (Prerequisites: 302-370A, 302-423A) Microbial growth kinetics; biological reactors, application of transport phenomena; instrumentation and control; selected topics in downstream processing; novel bioreactor systems. Laboratory exercises. **Professor Volesky**

302-481A **POLYMER ENGINEERING.** 3(3-0-6) (Prerequisites: 180-212A,B) The application of engineering fundamentals to the preparation and processing of polymers. Classification and characterization of polymers, reaction media and kinetics of polymerization, reactor design, mechanical behaviour of polymers, visco-elasticity and rheology, processing techniques; extrusion, molding, etc. **Professor Volesky**

302-484B **MATERIALS ENGINEERING.** 3(3-0-6) (Prerequisites: 302-315B, 302-380A) Processes for forming and producing engineering materials such as amorphous, semicrystalline, textured and crystal-oriented substances, short and long fibre-reinforced polymers, ceramics and ceramic composites. Effect of processing variables on the properties of the finished article. Process of blending and alloying. Shaping, bonding and joining operations. **Professor Carrière**

302-487A **CHEM. PROCESSING IN THE ELECTRONICS INDUSTRY.** 3(3-0-6) (Prerequisite: 180-233B) Chemical processes and unit operations in the manufacture of microelectronic components and their supports. Fabrication of silicon wafers, purification, crystal growth. Imaging processes, deposition of semiconductive materials, plasma and chemical etching. Reclamation of reagents from waste streams. Safety and environmental concerns. **Professor Cooper**

302-494A,B,D **RESEARCH PROJECT & SEMINAR.** 3(1-6-2) (Prerequisite: 302-393B) Independent study and experimental work on a topic chosen by consultation between the student and Departmental Staff. **Staff**

302-495A,B,D **RESEARCH PROJECT & SEMINAR.** 4(1-9-2) (Prerequisite: 302-393B) Independent study and experimental work on a topic chosen by consultation between the student and the Departmental staff. **Staff**

302-571B **SMALL COMPUTER APPLICATIONS IN CHEM. ENG.** 3(2-0-7) (Prerequisite: 302-458 or permission of the instructor.) The use of small computers employing a high level language for data acquisition and the control of chemical processes. Real-time system characteristics and requirements, analog to digital, digital to analog conversions and computer control loops are examined. Block level simulation. **Professor Huang**

302-581B **POLYMER COMPOSITES ENGINEERING.** 3(3-0-6) (Prerequisite: 302-481 or permission of instructor.) Characteristics of thermoplastic and thermosetting polymeric matrices and particulate/labor dispersed elements. Associated structure characterization. Processing techniques. Quantitative engineering analyses to correlate structure with properties and processing. Product/process design. Applications in chemical process equipment, construction, transportation (land, marine, aerospace), general industrial and consumer goods. **Professor Carrière**

302-591B **ENVIRONMENTAL BIOREMEDIATION.** 3(3-0-6) The presence and role of microorganisms in the environment, the role of microbes in environmental remediation either through natural or human-mediated processes, the application of microbes in pollution control and the monitoring of environmental pollutants. **Dr. Guiot**

4.4 Department of Civil Engineering and Applied Mechanics

**Chair**


**Emeritus Professors**

Louis J. Arcand; B.Sc., M.Eng.(McG.) Q.L.S., M.C.I.S., M.A.S.P.


Stuart B. Savage; B.Eng.(McG.), M.S.Eng.(Cal.Tech.), Ph.d.(McG.), F.R.S.C.

**Professors**

Vincent H. Chu; B.S.Eng.(Taiwan), M.A.Sc.(Tor.), Ph.D.(M.I.T.), Eng.


Ronald G. Rice; B.Sc.(Tor.), S.M.(M.I.T.), Dipl. U&R.P., Ph.D.(Tor.), Eng.


Suresh C. Shrivastava; B.Sc.(Eng.) (Vikram), M.C.E.(Del.), Sc.D.(Col.), Eng.

**Associate Professors**


Ronald Gehr; B.Sc.(Eng.)(Rand), M.A.Sc., Ph.D.(Tor.), P.Eng.


James Nicell; B.A.Sc., M.A.Sc., Ph.D.(Windsor), P.Eng.
Assistant Professors
Susan J. Gaskin; B.Sc.(Queen's), Ph.D. (Canterbury)
Subhasis Ghoshal; B.C.E. (India), M.S.(Missouri), Ph.D. (Carnegie Melon)
Yixin Shao; B.S., M.S.(Tsingjiang), Ph.D.(Northwestern)

Adjunct Professors

Civil engineers have traditionally applied scientific and engineering knowledge to the task of providing the built environment, from its conception and planning to its design and construction, maintenance and rehabilitation. Examples include buildings, bridges, roads, railways, dams, and facilities for water supply and treatment, and waste disposal. With the aging and deterioration of an already vast infrastructure, its maintenance and rehabilitation has become an increasingly important role of the civil engineering profession. Also, with worldwide concern about the detrimental impact of human activities on the environment, civil engineers are now in the forefront of developing and providing the means for both prevention and remediation of many aspects of environmental pollution.

The program in Civil Engineering is comprehensive in providing the fundamentals in mechanics and engineering associated with the diverse fields of profession, in offering choices of specialization, and in fully reflecting the advances in science, mathematics, engineering and computing that have transformed all fields of engineering in recent years. The resulting knowledge and training enables graduates to not only enter the profession thoroughly well prepared, but also to adapt to further change.

The required courses ensure a sound scientific and analytical basis for professional studies through courses in solid mechanics, fluid mechanics, soil mechanics, environmental engineering, water resources management, structural analysis, systems analysis and mathematics. Fundamental concepts are applied to various fields of practice in both required and complementary courses.

By a suitable choice of complementary courses, students can attain advanced levels of technical knowledge in the specialized areas mentioned above. Alternatively, students may choose to develop their interests in a more general way by taking a combination of complementary courses within the Department with several from other departments or faculties.

Students who wish to extend their knowledge in certain areas beyond the range that the program complementary courses allow, can also take a Minor program. Minors are available in fields such as Arts, Economics, Management, Environmental Engineering, and Construction Engineering and Management. These require additional credits to be taken from a specified list of topics relating to the chosen field. Further information on the various Minor programs may be found in section 5. Details of how the Minors can be accommodated within the Civil Engineering program will be made available at the time of preregistration counselling.

Experience has shown that graduates of the program who choose to pursue advanced studies elsewhere receive favourable consideration by all the leading universities in North America and abroad.

ACADEMIC PROGRAMS

Considerable freedom exists for students to influence the nature of the program of study which they follow in the Department of Civil Engineering and Applied Mechanics. A variety of advanced complementary courses is offered in five main groupings: Environmental Engineering, Geotechnical Engineering, Hydro-technical Engineering, Structural Engineering, and Transportation Engineering.

Guidance on the sequence in which required core courses should be taken is provided for students in the form of a sample program which covers the entire period of study. The technical complementary courses selected, usually in the last two semesters of the program, will depend upon the student's interests. U0 and U1 students should consult the "Welcome" book for the prescribed courses for the first two semesters. All students must meet with their advisor to confirm the courses for which they are registered.

Courses taken in Semester 3 or later will depend on a student's interests and ability. Information and advice concerning different possibilities are made available in the Department prior to registration. All programs require the approval of a staff adviser. Programs for students transferring into the Department with advanced standing will be dependent upon the academic credit previously achieved, and such a program will be established only after consultation with a staff adviser.

CURRICULUM FOR THE B.ENG. DEGREE IN CIVIL ENGINEERING

REQUIRED COURSES

<table>
<thead>
<tr>
<th>COURSE CODE</th>
<th>COURSE NAME</th>
<th>CREDIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>186-221A</td>
<td>Geology</td>
<td>3</td>
</tr>
<tr>
<td>189-260A,B</td>
<td>Intermediate Calculus</td>
<td>3</td>
</tr>
<tr>
<td>189-261A,B</td>
<td>Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>189-265A,B</td>
<td>Advanced Calculus</td>
<td>3</td>
</tr>
<tr>
<td>305-261B,C</td>
<td>Measurement Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>305-290A</td>
<td>Graphics</td>
<td></td>
</tr>
<tr>
<td>306-221A,B</td>
<td>Engineering Professional Practice</td>
<td>1</td>
</tr>
<tr>
<td>306-310A,B</td>
<td>Engineering Economy</td>
<td>3</td>
</tr>
<tr>
<td>308-208A,B</td>
<td>Computers in Engineering</td>
<td>3</td>
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Departmental courses

<table>
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<tr>
<th>COURSE CODE</th>
<th>COURSE NAME</th>
<th>CREDIT</th>
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<tbody>
<tr>
<td>303-202B</td>
<td>Construction Materials</td>
<td>4</td>
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<tr>
<td>303-205A,B</td>
<td>Statics</td>
<td>3</td>
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<tr>
<td>303-206B</td>
<td>Dynamics</td>
<td>3</td>
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<tr>
<td>303-207A,B</td>
<td>Solid Mechanics</td>
<td>4</td>
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<tr>
<td>303-208A</td>
<td>Civil Engrg Systems Analysis</td>
<td>3</td>
</tr>
<tr>
<td>303-210C</td>
<td>Surveying</td>
<td>2</td>
</tr>
<tr>
<td>303-225B</td>
<td>Environmental Engineering</td>
<td>4</td>
</tr>
<tr>
<td>303-290A</td>
<td>Thermodynamics &amp; Heat Transfer</td>
<td>3</td>
</tr>
<tr>
<td>303-302B</td>
<td>Probabilistic Systems</td>
<td>3</td>
</tr>
<tr>
<td>303-311A</td>
<td>Geotechnical Mechanics</td>
<td>4</td>
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<tr>
<td>303-317A</td>
<td>Structural Engineering I</td>
<td>3</td>
</tr>
<tr>
<td>303-318A,B</td>
<td>Structural Engineering II</td>
<td>2</td>
</tr>
<tr>
<td>303-319B</td>
<td>Transportation Engineering</td>
<td>3</td>
</tr>
<tr>
<td>303-320A</td>
<td>Numerical Methods</td>
<td>4</td>
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<td>303-323A</td>
<td>Hydrology &amp; Water Resources</td>
<td>3</td>
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<tr>
<td>303-324B</td>
<td>Construction Project Management</td>
<td>3</td>
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<tr>
<td>303-327B</td>
<td>Fluid Mechanics &amp; Hydraulics I</td>
<td>4</td>
</tr>
<tr>
<td>303-331B*</td>
<td>Proj Methodology and Communication</td>
<td>3</td>
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<tr>
<td>303-418A,B</td>
<td>Project</td>
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<tr>
<td>303-432A,B</td>
<td>Technical Paper</td>
<td>63</td>
</tr>
</tbody>
</table>

* To be replaced by 455-206B Communication in Engineering (3)

COMPLEMENTARY COURSES

Fifteen credits to be selected from those listed below or from other suitable undergraduate or 500-level graduate courses. In exceptional cases, and with the Chair's approval, 600-level graduate courses may be taken as complementary courses. Not all of these courses are offered annually. A list of those to be given will be available prior to the commencement of lectures.

Up to two technical complementary courses may be taken outside the Department, subject to approval by the student's advisor prior to registration (see list of Faculty technical complements in section 4.1.1 on page 223). Permission of the Department Chair is required to take more than two. No course that is similar to one available in the Department of Civil Engineering and Applied Mechanics may be taken outside, unless prior arrangements have been made, such as to accommodate courses given in alternate years.

Tables and figures may be provided here to illustrate the course requirements and their distribution throughout the curriculum.
303-416B (3) Geotechnical Engineering
303-421B (3) Municipal Systems
303-428A (3) Fluid Mechanics & Hydraulics II
303-430A (3) Water Treatment & Pollut Control
303-433B (3) Urban Planning
303-440A (3) Traffic Engineering
303-446A (3) Construction Engineering
303-451A (3) Geoenvironmental Engineering
303-460A (3) Matrix Structural Analysis
303-462A (3) Design of Steel Structures
303-463B (3) Design of Concrete Structures
303-470A,B (3) Research Project
303-512B (3) Advanced Civil Engrg Materials
303-514A (3) Structural Mechanics
303-526B (3) Solid Waste Management
303-527A (3) Renov & Preserv of Infrastructure
303-540A (3) Urban Transportation Planning
303-541B (3) Rail Engineering
303-550B (3) Water Resources Management
303-553A (3) Stream Pollution and Control
303-555B (3) Environmental Data Analysis
303-572A (3) Computational Hydraulics
303-573A (3) Hydraulic Structures
303-574B (3) Fluid Mech of Water Pollution
303-575B (3) Fluid Mechanics of Air Pollution
303-576B (3) Hydrodynamics
303-577A (3) River Engineering
303-579B (3) Water Power Engineering
303-585B (3) Groundwater Hydrology
303-586A (3) Earthwork Engineering
303-587A (3) Pavement Design

Two courses (6 credits) to be selected in consultation with academic advisor as prescribed by section 3.3 on page 220.

TOTAL CREDITS

If advanced credit given for 189-260A,B, Intermediate Calculus (see section 2.3 on page 219)

TOTAL CREDITS

COURSES OFFERED BY THE DEPARTMENT

- Denotes courses not offered in 1999-2000

Where asterisks appear with a prerequisite, they have the following significance:

* a D grade is acceptable for prerequisite purposes.

** under special circumstances, the Department may permit this course to be taken as a co-requisite.

303-202B CONSTRUCTION MATERIALS. 4(4-2-6) (Prerequisite: 303-290A) Classification of materials; atomic bonds; phase diagrams; elementary crystallography, imperfections and their relationship to mechanical behaviour; engineering properties and uses of ferrous and non-ferrous metals, ceramics, cement, concrete, timber and timber products, polymers, composites; smart materials and systems; electrochemical reactions and corrosion, prevention and protection; environmental influences; group laboratory projects. Professor Mirza

303-205A,B STATICS. 3(3-2-4) Systems of forces and couples, resultants, equilibrium, trusses, frames and beams, reactions, shear forces, bending moments; centroids, centres of gravity, distributed forces, moments of inertia. Friction, limiting equilibrium, screws, belts. Professors Chouinard and Shrivastava

303-206B DYNAMICS. 3(3-2-4) (Prerequisite: 303-205A,B) Co-requisites: 189-260A,B and 189-261A,B) Kinematics and kinetics of particles, systems, and rigid bodies; mass-acceleration, work-energy, impulse-momentum. Moving coordinate systems. Lagrange’s equations. Vibrations and waves. Professor Gaskin


303-208A CIVIL ENGRG SYSTEMS ANALYSIS. 3(3-1-5) (Prerequisites: 189-265A,B and 308-208A,B) Introduction to civil engineering systems; system modelling process; systems approach and optimization techniques; application of linear programming; simplex method; duality theory; sensitivity analysis; transportation problem; assignment problem; network analysis including critical path method; integer linear programming methods. Professor Nguyen

303-210C SURVEYING 2 (*). (Prerequisite: 308-208A,B) The construction and use of modern survey instruments; transit, level, etc.; linear and angular measurements and errors; horizontal and vertical curves; error analysis, significance of figures; use of computers and software; recent developments. Mr. Scola

* Two weeks after winter session examination period.

303-225B ENVIRONMENTAL ENGINEERING. 4(4-2-6) (Prerequisite: 303-290A. Co-requisites: 189-261A,B; 180-293B) Principles of ecology, ecosystems and environmental chemistry and physics, cycles of elements; mass balance analyses; sources and characteristics of pollution; pollution problems and engineered solutions as applied to air, water and soil media; environmental law, policy and impact. Professor Ghoshal

303-229A SURVEYING FOR ARCHITECTS. 2(2-3-1) Measurement of elevations, directions and distances using engineer's level, transit and tape; development of plot plans and topographic maps; volumetric calculations of cuts and fills; area measurements using planimeter; traverse computations; architectural applications. Mr. Scola


303-283B STRENGTH OF MATERIALS. 4(4-1-7) (Prerequisite: 303-205A,B*) Structural behaviour, trusses, statically determinate beams, frames, and arches; moments of inertia, stress, strain, properties of materials; bending and shearing stresses; torsion; fixed and continuous beams; reinforced concrete beams; columns; combined stresses; Mohr's circle. Dr. Babarutsi

303-290A THERMODYNAMICS & HEAT TRANSFER. 3(3-2-4) Macroscopic vs. microscopic viewpoint; states and processes; energy conservation and transformation. Phase equilibrium; equations of state; thermodynamic properties; work; heat: First Law of thermodynamics; internal energy; enthalpy; specific heat; thermodynamic processes: reversibility, polytropic processes, applications of First Law; Second Law; entropy; introduction to heat transfer. Professor Nicell

303-302B PROBABILISTIC SYSTEMS. 3(3-1-5) (Prerequisites: 189-260A,B and 308-208A,B*) An introduction to probability and statistics with applications to Civil Engineering design. Descriptive statistics, common probability models, statistical estimation, regression and correlation, acceptance sampling. Professor MacKenzie

303-311A GEOTECHNICAL MECHANICS. 4(3-3-6) (Prerequisite: 303-207A,B) Identification and classification of soils; physical and engineering properties; principle of effective stress; permeability, compressibility, shear strength, stress-strain characteristics; groundwater flow and seepage; earth pressure and retaining...
structures; stress distributions in soils; settlement; bearing capacity of shallow foundations. **Professor Selvadurai**

303-317A STRUCTURAL ENGINEERING I. 3(3-1-5) (Prerequisites: 303-202B and 303-207A,B) The design process; loads, sources, classifications, load factors, combinations; limit states design; structural systems and foundations; choice of materials; virtual work and energy methods; statical and kinematic indeterminacy; slope deflection method, introduction to matrix methods; analysis of indeterminate systems; force envelopes. **Professor McClure**

303-318B STRUCTURAL ENGINEERING II. 3(3-1-5) (Prerequisite: 303-317A) Durability and service life; fire resistance and protection; steel, reinforced concrete and timber; behaviour and design of components in tension, compression, bending and shear; ten- derness, global and local instability; axial load and moment interaction; curvature, deflection, ductility; connections; bond and anchorage of reinforcement; simple footings. **Professor Mirza**

303-319B TRANSPORTATION ENGINEERING. 3(3-1-5) (Prerequisites: 303-208A and 303-208A,B, Co-requisite: 303-302B) Introduction to design and operating principles and procedures for surface transportation systems, including vehicle motion and performance, pavements, geometric design of roadbeds, vehicle flow and capacity, traffic control, demand, supply and cost concepts. **Professor Rice and Ms. Hirou**

303-320A NUMERICAL METHODS. 4(3-3-6) (Prerequisites: 308-208A,B and 189-265A,B) Numerical procedures applicable to civil engineering problems: integration, differentiation, solution of initial-value problems, solving linear and non-linear systems of equations, boundary-value problems for ordinary-differential equations, and for partial-differential equations. **Professor Chouinard**

303-323A HYDROLOGY AND WATER RESOURCES. 3(3-2-4) (Prerequisite: 303-302B) Precipitation, evaporation and transpiration. Streamflow, storage reservoirs. Groundwater hydrology. Morphology of river basins. Statistical analysis in hydrology, stochastic modelling and simulation. Case studies in hydroelectric power development, flood damage mitigation, irrigation and drainage. **Professor Nguyen**

303-324B CONSTRUCTION PROJECT MANAGEMENT. 3(3-1-5) (Prerequisites: 303-301A,B and 303-208A) Construction fundamentals; procedures and responsibilities; tender documents, specifications, proposals, contracts; construction project organization, estimating, planning, scheduling, control; liability, claims procedures, arbitration; job safety; security and loss control; case histories, site visits. **Mr. Taylor**

303-327B FLUID MECHANICS & HYDRAULICS I. 4(3-6-3) (Prerequisites: 303-206B and 189-265A,B) Fluid properties, statics and kinematics; forces due to fluids in motion, Bernoulli’s equation, analysis of experiments, streamline curvature, boundary layers, pipe flow, hydraulic machinery and introduction to open channel flow. **Professor Chu**

303-331B PROJ. METHODOLOGY & COMMUNICATION. 3(2-3-4) (Prerequisite: 308-208A,B) Engineering project, problem definition and need analysis; problem solving techniques; information search and management; effective team work; proper documentation of engineering projects; effective oral and written communication; case studies and class exercises. **TBA**

303-382B PARTIAL DIFF. EQUATIONS IN ENGINEERING. 3(3-1-5) (Prerequisites: 189-261A,B, 189-265A,B and 303-281A*) Classification of PDEs; Laplace’s Equation, steady fluid flow, Diffusion Equation; pressure transients in porous media, moisture and chemical diffusion, heat conduction; Wave Equation; waves and vibrations in strings, membranes and bars. Uniqueness of solution; variables separable solutions in rectangular and cylindrical coordinates; product solutions, elementary applications of integral transforms. **Professor Selvadurai**


303-385A STRUCTURAL STEEL & TIMBER DESIGN. 3(3-1-5) (Prerequisite: 303-283B, Corequisite: 301-240B) Structural loadings, load factors, code requirements and design procedures. Characteristics of structural steel and structural timber in building construction. Structural design of axially loaded tension and compression members, joists, beams, girders, trusses and framing systems. **Mr. Vrana**

303-388B REINFORCED CONCRETE DESIGN. 2(2-2-2) (Prerequisite: 303-283B) Physical properties of concrete; behaviour and design of reinforced concrete members in compression, tension, bending, shear and combined loadings; bond and anchorage; reinforced concrete slabs and precast concrete elements; structural framing systems. **Mr. Vrana**

303-416B GEOTECHNICAL ENGINEERING. 3(3-1.5-4.5) (Prerequisite: 303-311A) Site investigation, in-situ measurement of engineering properties of soils; braced excavations; bearing capacity of shallow foundations; upper bound solutions; soil structure interaction; design aspects of footing and rafts, coefficient of subgrade reaction; deep foundations; bearing capacity of piles, pile settlement; stability of slopes; infinite slopes; frost action in soils. **Professor Japp**

303-418A,B PROJECT. 3(0-4-5) (Prerequisite: Completion of an approved set of required and complementary courses.) A study or design topic in any of the branches of Civil Engineering or their combination. Project may be analytical or experimental. Chosen in consultation with a staff member, whose approval is necessary. Guidance provided by Department staff and by practising engineers. Project normally carried out in a student’s last semester. **Professors Shao, Shrivastava and Staff**

303-421B MUNICIPAL SYSTEMS. 3(3-2-4) (Prerequisite: 303-327B) Design of water-related municipal services; sources of water and intake design; estimation of water demand and wastewater production rates; design, construction and maintenance of water distribution, wastewater and stormwater collection systems; pumps and pumping stations; pipe materials, network analysis and optimization; storage; treatment objectives for water and wastewater. **Professor Nicell**

303-428A FLUID MECHANICS & HYDRAULICS II. 3(3-3) (Prerequisite: 303-327B) Open channel flow, internal hydraulics, hydraulic transient in pipes. **Professor Gaskin**

303-430A WATER TREATMENT & POLLUTION CONTROL. 3(3-3) (Prerequisites: 303-225B and 303-327B) Principles of water and sewage treatment. Water and sewage characteristics; design of conventional unit operations and processes; laboratory analyses of potable and waste waters. **Professor Gehr**

303-432A,B TECHNICAL PAPER. 1(0-0-3) (Prerequisite: 303-331B) A technical paper, on a suitable topic, is to be prepared in accordance with detailed instructions which are provided by the Department. This paper will normally be written in the U3 year and may be submitted in September or January. **Staff**

303-433B URBAN PLANNING. 3(3-1-5) (Prerequisites: 303-421A and 306-310A,B. Co-requisite: 303-319B) The City in History. The planning profession, evolution of planning in North America, Canada and Quebec. Planning theories, the general or master plan, planning processes and techniques, planning and design of residential subdivisions. Local planning issues, housing policies, planning laws. **Professor Wolfe**

303-440A TRAFFIC ENGINEERING. 3(3-1-5) (Prerequisite: 303-319B) Driver, vehicle and traffic flow characteristics; origin-destination studies, traffic studies and analysis, accident studies, queueing theory applications, gap acceptance, simulation, highway capacity, traffic regulations and control measures, intersection control. **Mr. Byrns**

303-446A CONSTRUCTION ENGINEERING. 3(3-1-5) (Prerequisite: 303-324B) Project management principles; construction equipment economics, selection, operation; characteristics of building,
heavy, marine, underground and route construction projects; international projects.

Mr. Triassi

303-451A GEOENVIRONMENTAL ENGINEERING. 3(3-1-5-4.5) (Prerequisites: 303-225B and 303-311A) Geoenvironmental hazards; land management of waste; regulatory overview, waste characterization; soil-waste interaction; geosynthetics; low permeability clay barriers; contaminant transport; containment systems; collection and removal systems; design aspects; strategies for remediation; rehabilitation technologies.

Professor Ghosal

303-460A MATRIX STRUCTURAL ANALYSIS. 3(3-2-4) (Prerequisites: 303-206B and 303-317A) Computer structural analysis, direct stiffness applied to two and three dimensional frames and trusses, matrix force method, nonlinear problems, buckling of trusses and frames, introduction to finite element analysis.

Professor Chouinard

303-462A DESIGN OF STEEL STRUCTURES. 3(3-3-3) (Prerequisite: 303-311B) Design of structural steel elements: plate girders, members under combined loadings, eccentrically loaded connections, structural systems. Design of structural steel systems: composite floor systems, braced frames, moment resisting frames. TBA

303-463B DESIGN OF CONCRETE STRUCTURES. 3(3-3-3) (Prerequisite: 303-311B) Design of continuous beams and slabs, columns under biaxial bending, retaining and structural walls, two-way and flat slabs, and combined footings. Slenderness effects in columns. Introduction to masonry structures.

Professor Mitchell

303-469A INFRASTRUCTURE & SOCIETY. 3(3-2-4) (Prerequisites: 306-310A, B) Infrastructure systems: planning, organization, communication and decision support systems; budgeting and management; operations, maintenance, rehabilitation and replacement issues; public and private sectors, privatization and governments; infrastructure crisis and new technologies; legal, environmental, socio-economic and political aspects of infrastructure issues; professional ethics and responsibilities; case studies.

Professor Mirza

303-470A,B RESEARCH PROJECT. 3(0-1-8) (Prerequisite: 60 credits in the Civil Engineering and Applied Mechanics program) Open to students with a high CGPA. A research project must be carried out and a technical paper prepared under the supervision of a member of staff. The project must be established with the consent of the Staff Supervisor, and must be approved by the Department before registration. May be taken in conjunction with the required course 303-418A and the project therefore can be carried out and a technical paper prepared under the supervision of a member of staff. TBA

Staff

303-492A STRUCTURES. 2(2-2-2) (Prerequisites: 303-385A and 303-388B) A study of structural systems in concrete, steel, timber; a philosophy of structure; choice of structure; economic factors in design; recent developments and trends in structure; lateral stability by frame action, bracing shear walls; mechanics of certain structural forms.

Professor Mitchell

303-512B ADVANCED CIVIL ENGRG MATERIALS. 3(3-3-3) (Prerequisite: 303-202B) Production, structure and properties of engineering materials; ferrous alloys, treatments, welding, special steels, cast iron; ceramic materials; polymers; composite materials; concrete, admixtures, structure, creep, shrinkage; asphalt and asphaltic materials; clay materials and bricks; impact of environment on material response, durability, quality assessment and control, industrial specifications; recent advances.

Professor Shao

303-514A STRUCTURAL MECHANICS. 3(3-1-5) Stress, strain, and basic equations of linear elasticity. General and particular solutions of plane and axisymmetric problems. Stress concentration and failure criteria. Unsymmetrical bending of beams; shear centres; torsion of thin-walled structural members. Curved beams. Formulation and applications of energy principles, and their connection to finite-element method.

Professor Shrivastava

303-526B SOLID WASTE MANAGEMENT. 3(3-2-4) (Prerequisite: 303-225B) Characterization of municipal and industrial solid wastes. Review of solid and hazardous waste impacts, regulations and treatment options. Collection and transportation of solid wastes. Methods of reclamation and disposal. Introduction to the design of landfill sites and incinerators.

Professor Nicell

303-527A RENOV. & PRESERV. OF INFRASTRUCTURE. 3(3-2-4) (Prerequisites: 303-302B and 303-319B) Maintenance, rehabilitation, renovation and preservation of infrastructure; infrastructure degradation mechanisms; mechanical, chemical and biological degradation; corrosion of steel; condition surveys and evaluation of buildings and bridges; repair and preservation materials, techniques and strategies; codes and guidelines; case studies.

Professor Mirza

303-528A REHABILITATION CASE STUDIES. 3(0-0-9) Topical case studies from industrial and governmental experience in rehabilitation of infrastructure. Course conducted in collaboration with the other four institutions. Each student is required to submit a technical report.

TBA

303-540A URBAN TRANSPORTATION PLANNING. 3(3-1-5) (Prerequisite: 303-319B or permission of instructor.) Process and techniques of urban transportation engineering and planning, including demand analysis framework, data collection procedures, travel demand modeling and forecasting, and cost-effectiveness framework for evaluation of project and system alternatives.

Professor Rice and Mr. Trottier

303-541B RAIL ENGINEERING. 3(3-1-5) Principles of rail system design, including vehicle motion calculations, supporting way design, and rail vehicle design. Planning and operational characteristics for rail freight systems and urban rail systems, with an assessment of operational and technological developments.

Professor Nguyen and Mr. Trottier

303-546A,B SELECTED TOPICS IN CIVIL ENG. I. 3(3-0-6). (Prerequisite: Permission of instructor.) Special topics related to Civil Engineering will be presented by staff and visiting lecturers.

303-547A,B SELECTED TOPICS IN CIVIL ENG. II. 3(3-0-6) (Prerequisite: Permission of instructor.) Special topics related to Civil Engineering will be presented by staff and visiting lecturers.

303-548A,B SELECTED TOPICS IN CIVIL ENG. III. 3(3-0-6) (Prerequisite: Permission of instructor.) Special topics related to Civil Engineering will be presented by staff and visiting lecturers.

303-550B WATER RESOURCES MANAGEMENT. 3(3-0-6) (Prerequisite: 303-323A or equivalent.) State-of-the-art water resources management techniques; case studies of their application to Canadian situations; identification of major issues and problem areas; interprovincial and international river basins; implications of development alternatives; institutional arrangements for planning and development of water resources; and, legal and economic aspects.

Professor Nguyen

303-553A STREAM POLLUTION AND CONTROL. 3(3-2-4) (Prerequisite: 303-225B) Water quality standards; physical, chemical, and bacterial contamination of surface waters; effects of specific types of pollution such as thermal, point and non-point sources; stream self-purification; effects on lake eutrophication; pollution surveys and methods of control; laboratory tests.

Professor Gehr

303-554A ENVIRONMENTAL ENGINEERING SEMINAR 3(3-0-6) (Prerequisite: Permission of instructor.) The course will expose the students to various environmental engineering issues. Lectures will be given by faculty and invited speakers from industry. Each student is required to prepare a written technical paper and make an oral presentation.

Professor Gehr


Professor Nguyen

303-570B WAVES AND COASTAL ENGINEERING. 3(3) (3-0-6) (Prerequisite: 303-327B) Waves: wave transformation and prediction, waterlevels; coastal geomorphology; geology, sediment transport,
coastal processes; coastal engineering; shore protection, harbours, dredging, coastal management.  

- **303-572A COMPUTATIONAL HYDRAULICS.** 3(3-0-6) (Prerequisite: 303-327B or equivalent.) Computation of unsteady flows in open channels; abrupt waves, flood waves, tidal propagations; method of characteristics; mathematical modelling of river and coastal currents.  
  **Professor Chu**

- **303-573A HYDRAULIC STRUCTURES.** 3(3-0-6) (Prerequisites: 303-323A and 303-327B) Hydraulic aspects of the theory and design of hydraulic structures. Storage dams, spillways, outlet works, diversion works, drop structures, stone structures, conveyance and control structures, flow measurement and culverts. Mr. Holder

- **303-574B FLUID MECHANICS OF WATER POLLUTION.** 3(3-0-6) (Prerequisite: 303-327B or equivalent.) Mixing, dilution and dispersion of pollutants discharged into lakes, rivers, estuaries and oceans; salinity intrusion in estuaries and its effects on dispersion; biochemical oxygen demand and dissolved oxygen as water quality indicators; thermal pollution; oil pollution.  
  **Professor Chu**

- **303-575B FLUID MECHANICS OF AIR POLLUTION.** 3(3-0-6) (Prerequisite: 303-327B or equivalent.) Fundamentals of fluid mechanics; properties and sources of air pollution; the atmospheric boundary layer; atmospheric diffusion; atmospheric stability; aerodynamics of plumes; coagulation and settling of particles; molecular diffusions.  
  **TBA**

- **303-576B HYDRODYNAMICS.** 3(3-0-6) (Prerequisite: 303-327B or equivalent.) Equations of motion, Bernoulli, Cauchy and Birknes' theorems, virtual mass, complex variables and conformal mapping. Free surface flows, dynamic and kinematic boundary conditions. Shallow water flows, waves of finite amplitude. Flows on a geophysical scale, Ekman layers, homogeneous lake circulation, seiches. Linear waves, refraction and diffraction around breakwaters.  
  **TBA**

- **303-577A RIVER ENGINEERING.** 3(3-0-6) (Prerequisite: 303-327B) Mechanics of the entrainment, transportation and deposition of solids by fluids; sediment properties; threshold of movement; ripples, dunes and antidunes; suspended load; bed load; stable channel design; meandering of rivers; wave-induced transport; turbidity currents; transport of solids in pipelines; aeolian transport.  
  **Professor Gaskin**

- **303-579B WATER POWER ENGINEERING.** 3(3-0-6) (Prerequisites: 303-323A and 306-310A,B) A practical approach to the planning and design of hydro-electric power installations. Fundamental theory of water availability and demand; flow, power and load duration curves; classification of power resources; project planning, economic analysis including costs and benefits; special features of hydro plants; and appurtenances for hydro plants.  
  **TBA**

- **303-585B GROUNDWATER HYDROLOGY.** 3(3-0-6) (Prerequisite: Permission of instructor.) Groundwater geology; steady-state and transient-state regional groundwater; infiltration and recharge; hydrological cycle; chemical constituents; adsorption/desorption processes; Groundwater exploration techniques; pumping tests; groundwater pollution; diffusion and dispersion; thermal processes; groundwater resource management.  
  **Professor Selvadurai**

- **303-586A EARTHWORK ENGINEERING.** 3(3-0-6) (Prerequisite: Permission of instructor.) Stability of natural slopes and cuts, stability analysis; design of earth and rock fills, dykes and dams; techniques to improve stability; compaction of soil, compaction control; soil improvement by in-situ processes; reinforced earth.  
  **TBA**

- **303-587A PAVEMENT DESIGN.** 3(3-0-6) (Prerequisite: Permission of instructor.) Properties of bituminous materials, design of bituminous concrete mixes, construction control; evaluation of design parameters, factors controlling their variability: soil stabilization; frost effects; stresses and displacements in layered systems, analysis of rigid and flexible pavement systems; design of highway and airport pavements; pavement evaluation and strengthening; recycling.  
  **TBA**

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### 4.5 Department of Electrical and Computer Engineering

**Chair**

David A. Lowther; B.Sc.(Lond.), Ph.D.(C.N.A.A.), Eng.  

**Associate Chair**

Jonathan P. Webb; B.A. Ph.D.(Cantab.)

**Emeritus Professors**

Eric L. Adler; B.Sc.(Lond.), M.A.Sc.(Tor.), Ph.D.(McG.), F.I.E.E.E., Eng.  


**Professors**


Clifford H. Champness; M.Sc.(Lond.), Ph.D.(McG.) (part-time)  


Peter Kabal; B.A.Sc., M.A.Sc., Ph.D.(Tor.)  


David A. Lowther; B.Sc.(Lond.), Ph.D.(C.N.A.A.), Eng.  


Johnathan Webb; B.A., Ph.D.(Cantab.)  

Gar Lam Yip; B.Sc.(Lond.), A.C.G.I., M.Sc.(Queen's), Ph.D.(Tor.), Eng.  

**Associate Professors**

James Clark; B.Sc., Ph.D.(Br.Col.)  

Frank Ferrie; B.Eng., Ph.D.(McG.)  


Harry Leib; B.Sc.(Technion), Ph.D.(Tor.)  

Steve McGee; B.Eng., Ph.D.(McG.)  

Hanna Michalska; B.Sc., M.Sc.(Warsaw), Ph.D.(Lond.)  

David V. Plant; M.S., Ph.D.(Brown)  

Gordon Roberts; B.A.Sc.(Waterloo), M.A.Sc., Ph.D.(Tor.), Eng.  

Ishiang Shih; M.Eng., Ph.D.(McG.)  

**Assistant Professors**

Benoit Boulet; B.Sc.(Laval), M.Eng.(McG.) Ph.D.(Tor.)  

Jeremy R. Cooperstock; A.Sc.(U.B.C.), M.Sc., Ph.D.(Tor.)  

Mourad El-Gamal; B.Sc.(Cairo), M.Sc.(Nashville), Ph.D.(McG.)  

Karim Khordoc; B.Eng., M.Eng., Ph.D.(McG.)  

Andrew Kirk; B.Sc.(Brist.), Ph.D.(London)  

Radu Negilescu; M.Sc.(Romania), M.Sc.(France), Ph.D.(Wat.)  

Zilic Zeljko; B.Eng.(Zagreb), M.Sc., Ph.D.(Tor.)  

**Visiting Professors**

Michael Kaplan; M.Sc., Ph.D.(Cornell)  

Birendra Prasada; M.Eng.(Ban.), Ph.D.(McG.)  

**Lecturer**

Kenneth L. Fraser; B.Eng., M.Eng.(McG.), Eng.  

Florence Danilo; M.Eng.(McG.)  

**Associate Members**

Jason H.T. Bates; B.Sc.(Cant.), Ph.D.(Otago)  

Martin Buehler  

Gregory Dudek; B.Sc.(Queen's), M.Sc., Ph.D.(Tor.)  

Alan C. Evans; M.Sc.(Surrey), Ph.D.(Leeds)  

William R. Funnell; M.Eng., Ph.D.(McG.)  

Henrietta L. Galiana; M.Eng., Ph.D.(McG.)  

Jean Gotman; M.E.(Dartmouth, N.S.), Ph.D.(McG.)  

Robert E. Kearney; M.Eng., Ph.D.(McG.)  

**Adjunct Professors**

Vinod K. Agarwal, Eduard Cerny, Benoit Champagne, Paul Freedman, M. Gavrilovic, Jeremiah F. Hayes, Cheng K. Jen,
General Information on Programs

The Department of Electrical and Computer Engineering offers undergraduate degree programs in Electrical Engineering, Electrical Engineering (Honours), and Computer Engineering. All programs provide students with a strong background in mathematics, basic sciences, engineering science, engineering design and complementary studies, in conformity with the requirements of the Canadian Engineering Accreditation Board (CEAB).

The program in Electrical Engineering gives students a broad understanding of the key principles that are responsible for the extraordinary advances in the technology of computers, microelectronics, automation and robotics, telecommunications and power systems. These areas are critical to the development of our industries and, more generally, to our economy. A graduate of this program is exposed to all basic elements of electrical engineering and can function in any of our client industries. This breadth is what distinguishes an engineer from, say, a computer scientist or physicist.

The program in Electrical Engineering (Honours) is designed for students who wish to pursue postgraduate work and look to a career in advanced research and development. The technical complementsaries are selected from graduate courses, facilitating the transition to postgraduate studies. Students in this curriculum benefit from smaller classes and have more contact with professional staff and graduate students. However, the program is quite demanding. Students are expected to register for at least 14 credits per semester; they may register for a smaller number only with the permission of the Chair of this Department. Students in the Honours program must maintain a minimum GPA of 3.0. Those who fail to maintain this standard are transferred to the regular program.

The program in Computer Engineering provides students with greater depth and breadth of knowledge in the hardware and software aspects of computers. Students are exposed to both theoretical and practical issues of both hardware and software in well-equipped laboratories. Although the program is designed to meet the growing demands by industry for engineers with a strong background in modern computer technology, it also provides the underlying depth for graduate studies in all fields of Computer Engineering.

In addition to technical complementary courses, students in all three programs take general complementary courses in social sciences, administrative studies and humanities. These courses allow students to develop specific interests in areas such as psychology, economics, management or political science.

Entrance Requirements and Advanced Standing

The curricula for the various programs offered by the Department are outlined below. Students entering Electrical or Computer Engineering from CEGEP may obtain advanced credit for 189-260 Intermediate Calculus by passing the Advanced Credit examination described in section 2.3 on page 219.

Entry into the Honours Program

The Honours Program is a limited enrollment program and entry is highly competitive. There is no direct entry to the Honours program in the first year. Students may enter the Honours Program in the following ways:
- Students from CEGEP (7 semester) will be admitted, on the basis of their grades, at the start of the third semester.
- Students from outside Quebec (8 semester) will be admitted, at the start of the fifth semester, on the basis of their grades.

Though not required to do so, students in the Honours Program wishing to enter the Honours Program are encouraged to take the following advanced math and physics courses:
- 189-325 Ordinary Differential Equations instead of 189-261
- 189-247 Linear Algebra instead of 189-270
- 189-248 Advanced Calculus I instead of 189-265
- 189-249 Advanced Calculus II instead of 189-381
- 198-251 Mechanics instead of 303-281

To remain in the Honours program and to be awarded the Honours Degree, a student must have completed at least 14 credits in each semester since entering Electrical Engineering and maintained a CGPA of at least 3.0 since entering Electrical Engineering. For more information, please contact the Departmental office at (514) 398-7344.

**CURRICULUM FOR THE B.ENG. DEGREE IN ELECTRICAL ENGINEERING (HONOURS)**

<table>
<thead>
<tr>
<th>REQUIRED COURSES</th>
<th>COURSE CREDIT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-Departmental Courses</strong></td>
<td></td>
</tr>
<tr>
<td>189-260 Intermediate Calculus</td>
<td>3</td>
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<tr>
<td>189-247 Linear Algebra</td>
<td>3</td>
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<tr>
<td>or 189-270 Linear Algebra (3)</td>
<td></td>
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<tr>
<td>or 189-248 Advanced Calculus I</td>
<td>3</td>
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<tr>
<td>or 189-265 Advanced Calculus (3)</td>
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</tr>
<tr>
<td>189-249 Advanced Calculus II</td>
<td>3</td>
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<tr>
<td>or 189-381 Complex Variables &amp; Transforms (3)</td>
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<tr>
<td>189-325 Ordinary Differential Equations</td>
<td>3</td>
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<tr>
<td>or 189-261 Differential Equations (3)</td>
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<tr>
<td>189-386 Applied Partial Differential Equations</td>
<td>3</td>
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<tr>
<td>or 303-382 Partial Differential Equations in Eng. (3)</td>
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<tr>
<td>198-251 Mechanics</td>
<td>3</td>
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<tr>
<td>or 303-281 Analytical Mechanics (3)</td>
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<tr>
<td>198-271 Quantum Physics</td>
<td>3</td>
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<tr>
<td>306-221 Engineering Professional Practice</td>
<td>1</td>
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<tr>
<td>306-310 Engineering Economy</td>
<td>3</td>
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<tr>
<td>308-202 Intro. to Computer Science I</td>
<td>3</td>
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<tr>
<td>455-206 Communication in Engineering</td>
<td>3</td>
</tr>
<tr>
<td><strong>Technical Complementaries</strong></td>
<td></td>
</tr>
<tr>
<td>304-200 Fundamentals of Electrical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>304-210 Circuit Analysis</td>
<td>5</td>
</tr>
<tr>
<td>304-221 Intro to Computer Engineering I</td>
<td>3</td>
</tr>
<tr>
<td>304-222 Intro to Computer Engineering II</td>
<td>3</td>
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<tr>
<td>304-303 Signals &amp; Systems I</td>
<td>3</td>
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<tr>
<td>304-304 Signals &amp; Systems II</td>
<td>3</td>
</tr>
<tr>
<td>304-305 Probability &amp; Random Signals</td>
<td>3</td>
</tr>
<tr>
<td>304-323 Digital System Design</td>
<td>5</td>
</tr>
<tr>
<td>304-330 Electronic Circuits I</td>
<td>3</td>
</tr>
<tr>
<td>304-334 Electronic Circuits II</td>
<td>5</td>
</tr>
<tr>
<td>304-351 Electromagnetic Fields</td>
<td>3</td>
</tr>
<tr>
<td>304-352 Electromagnetic Waves</td>
<td>3</td>
</tr>
<tr>
<td>304-361 Power Engineering</td>
<td>3</td>
</tr>
<tr>
<td>304-488 Honours Thesis I</td>
<td>3</td>
</tr>
<tr>
<td>304-499 Honours Thesis II</td>
<td>3</td>
</tr>
</tbody>
</table>

* CGPA of 3.3 is required to register for 189-247 and 189-248.

**COMPLEMENTARY COURSES**

Technical Complementaries: 12

Four technical complementary courses (12 credits), which must be Electrical Engineering Courses at the 500-level (or 304-427, 304-428). Students must choose their technical complementary courses so that they complete at least 9 credits in one of the following concentrations. However, with Departmental approval, the Honours Thesis I and II (304-498 and 304-499) can count as 6 of the 9 credits.

**Computer Systems Technology**

304-428 Software Engineering
304-525 Computer Architecture
304-427 Operating Systems
304-532 Computer Graphics
304-548 Introduction to VLSI

Control and Automation

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### Integrated Circuits and Electronics
- 304-527 Optical and Photonic Systems
- 304-533 Physical Basis of Semiconductors
- 304-545 Microelectronics Technology
- 304-548 Introduction to VLSI
- 304-571 Introduction to Photonics
- 304-573 Microwave Electronics

### Power Engineering
- 304-502 Control Engineering
- 304-549 Expert Systems in Electrical Design
- 304-560 Power Systems II
- 304-563 Power Systems Operation and Planning
- 304-565 Power Electronics

### Telecommunications
- 304-511 Communication Systems
- 304-521 Data Communications
- 304-523 Speech Communications
- 304-527 Optical and Photonic Systems
- 304-528 Telecommunication Networks
- 304-592 Microwave Theory and Techniques
- 304-593 Antennas and Propagation
- 304-596 Optical Waveguides

### Laboratory Complementaries
- Two 400-level laboratory courses in Electrical Engineering.

### General Complementaries
- Two courses (6 credits) in Social Sciences, Administrative Studies or Humanities, selected from an approved list (category ii - section 3.3) in consultation with an academic advisor. At least one 3-credit course must be from category A (Humanities and Social Sciences) in section 3.3.

### TOTAL CREDITS
110

### CURRICULUM FOR THE B.ENG. DEGREE IN ELECTRICAL ENGINEERING (REGULAR)

### REQUIRED COURSES

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDIT</th>
</tr>
</thead>
</table>
| Non-Departmental Courses
| 189-260 Intermediate Calculus | 3 |
| 189-261 Differential Equations | 3 |
| or 189-325 Differential Equations (3) | |
| 189-265 Advanced Calculus | 3 |
| or 189-248 Advanced Calculus (3) | |
| 189-270 Applied Linear Algebra | 3 |
| or 189-247* Linear Algebra (3) | |
| 189-381 Complex Variables & Transforms | 3 |
| 198-271 Quantum Physics | 3 |
| 303-281 Mechanics | 3 |
| or 198-251 Mechanics (3) | |
| 303-382 PDE in Engineering | 3 |
| 306-221 Engineering Professional Practice | 1 |
| 306-310 Engineering Economy | 3 |
| 308-202 Intro. to Computing I | 3 |
| 455-206 Communication in Engineering | 3 |

* CGPA of 3.3 is required to register for 189-247 and 189-248.

### Departmental Courses
- 304-200 Fundamentals of Electrical Engineering | 3 |
- 304-210 Circuit Analysis | 5 |
- 304-221 Intro to Computer Engineering I | 3 |
- 304-222 Intro to Computer Engineering II | 3 |
- 304-303 Signals & Systems I | 3 |
- 304-304 Signals & Systems II | 3 |
- 304-305 Probability & Random Signals | 3 |
- 304-323 Digital System Design | 5 |
- 304-330 Electronic Circuits I | 3 |
- 304-334 Electronic Circuits II | 5 |
- 304-351 Electromagnetic Fields | 3 |
- 304-352 Electromagnetic Waves | 3 |
- 304-361 Power Engineering | 3 |
- 304-494 Design Project | 3 |

### COMPLEMENTARY COURSES
- Technical Complementaries
  - Five courses (15 credits) from the list of 400-level courses in Electrical Engineering that must include all the courses of one of the areas of concentration listed below:

### Computer Systems Technology
- 304-425 Computer Organization and Architecture
- 304-427 Operating Systems
- 304-428 Software Engineering

### Control & Automation
- 304-404 Control Systems
- 304-412 Discrete Time Signal Processing
- 304-426 Microprocessor Systems

### Integrated Circuits & Electronics
- 304-425 Computer Organization and Architecture
- 304-431 Electronic Design
- 304-432 Physical Basis of Transistor Devices

### Power Engineering
- 304-404 Control Systems
- 304-462 Electromechanical Energy Conversion
- 304-464 Power System Analysis I

### Telecommunications
- 304-411 Communications Systems
- 304-412 Discrete Time Signal Processing
- 304-451 Microwave and Optical Transmission

### Laboratory Complementaries
- Two 400-level laboratory courses in Electrical Engineering.

### General Complementaries
- Two courses (6 credits) in Social Sciences, Administrative Studies or Humanities, selected from an approved list (category ii - section 3.3 on page 220) and one course (3 credits) on the impact of technology (category i - section 3.3) in consultation with an academic advisor. At least one 3-credit course must be from category A (Humanities and Social Sciences) in section 3.3.

### TOTAL CREDITS
110

### CURRICULUM FOR THE B.ENG. DEGREE IN COMPUTER ENGINEERING

### REQUIRED COURSES

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDIT</th>
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</thead>
</table>
| Non-Departmental Courses
| 189-260 Intermediate Calculus | 3 |
| 189-261 Differential Equations | 3 |
| or 189-325 Differential Equations (3) | |
| 189-265 Advanced Calculus | 3 |
| or 189-248 Advanced Calculus (3) | |
| 189-270 Applied Linear Algebra | 3 |
| or 189-247* Linear Algebra (3) | |
| 198-271 Quantum Physics | 3 |
| 303-281 Mechanics | 3 |
| or 198-251 Mechanics (3) | |
| 303-382 PDE in Engineering | 3 |
| 306-221 Engineering Professional Practice | 1 |
| 306-310 Engineering Economy | 3 |
| 308-202 Intro. to Computing I | 3 |
| 455-206 Communication in Engineering | 3 |

* CGPA of 3.3 is required to register for 189-247 and 189-248.

### Departmental Courses
- 304-200 Fundamentals of Electrical Engineering | 3 |
- 304-210 Circuit Analysis | 5 |
- 304-221 Intro to Computer Engineering I | 3 |
- 304-222 Intro to Computer Engineering II | 3 |
- 304-303 Signals & Systems I | 3 |
- 304-304 Signals & Systems II | 3 |
- 304-305 Probability & Random Signals | 3 |
- 304-323 Digital System Design | 5 |
- 304-330 Electronic Circuits I | 3 |
- 304-334 Electronic Circuits II | 5 |
- 304-351 Electromagnetic Fields | 3 |
- 304-352 Electromagnetic Waves | 3 |
- 304-361 Power Engineering | 3 |
- 304-494 Design Project | 3 |

### COMPLEMENTARY COURSES
- Technical Complementaries
  - Five courses (15 credits) from the list of 400-level courses in Electrical Engineering that must include all the courses of one of the areas of concentration listed below:

### Computer Systems Technology
- 304-425 Computer Organization and Architecture
- 304-427 Operating Systems
- 304-428 Software Engineering

### Control & Automation
- 304-404 Control Systems
- 304-412 Discrete Time Signal Processing
- 304-426 Microprocessor Systems

### Integrated Circuits & Electronics
- 304-425 Computer Organization and Architecture
- 304-431 Electronic Design
- 304-432 Physical Basis of Transistor Devices

### Power Engineering
- 304-404 Control Systems
- 304-462 Electromechanical Energy Conversion
- 304-464 Power System Analysis I

### Telecommunications
- 304-411 Communications Systems
- 304-412 Discrete Time Signal Processing
- 304-451 Microwave and Optical Transmission

### Laboratory Complementaries
- Two 400-level laboratory courses in Electrical Engineering.

### General Complementaries
- Two courses (6 credits) in Social Sciences, Administrative Studies or Humanities, selected from an approved list (category ii - section 3.3 on page 220) and one course (3 credits) on the impact of technology (category i - section 3.3) in consultation with an academic advisor. At least one 3-credit course must be from category A (Humanities and Social Sciences) in section 3.3.

### TOTAL CREDITS
110

### CURRICULUM FOR THE B.ENG. DEGREE IN COMPUTER ENGINEERING

### REQUIRED COURSES

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDIT</th>
</tr>
</thead>
</table>
| Non-Departmental Courses
| 189-260 Intermediate Calculus | 3 |
| 189-261 Differential Equations | 3 |
| or 189-325 Differential Equations (3) | |
| 189-265 Advanced Calculus | 3 |
| or 189-248 Advanced Calculus (3) | |
| 189-270 Applied Linear Algebra | 3 |
| or 189-247* Linear Algebra (3) | |
| 198-271 Quantum Physics | 3 |
| 303-281 Mechanics | 3 |
| or 198-251 Mechanics (3) | |
| 303-382 PDE in Engineering | 3 |
| 306-221 Engineering Professional Practice | 1 |
| 306-310 Engineering Economy | 3 |
| 308-202 Intro. to Computing I | 3 |
| 455-206 Communication in Engineering | 3 |
COURSES OFFERED BY THE DEPARTMENT

189-362 Discrete Mathematics 3
189-381 Complex Variables & Transforms 3
198-271 Quantum Physics 3
303-281 Mechanics 3
or 198-251 Mechanics (3)
306-221 Engineering Professional Practice 1
306-310 Engineering Economy 3
308-202 Intro. to Computing I 3
308-250 Intro. to Computer Science 3
308-302 Programming Languages 3
455-206 Communication in Engineering 2 40

* CGPA of 3.3 is required to register for 189-247 and 189-248.

Departmental Courses

304-200 Fundamentals of Electrical Engineering 3
304-210 Circuit Analysis 5
304-221 Intro to Computer Engineering I 3
304-222 Intro to Computer Engineering II 3
304-303 Signals & Systems I 3
304-304 Signals & Systems II 3
304-305 Random Signals & Noise 3
304-323 Digital System Design 5
304-330 Electronic Circuits I 3
304-334 Electronic Circuits II 5
304-353 Electromagnetic Fields & Waves 3
304-425 Computer Architecture 3
304-427 Operating Systems 3
304-494 Design Project 3 48

COMPLEMENTARY COURSES

Technical Complementaries

Three courses (9 credits) selected from the list of courses below:
304-404 Control Systems 3
304-411 Communications Systems 3
304-412 Discrete-Time Signal Processing 3
304-426 Microprocessor Systems 3
304-428 Software Engineering 3
304-431 Electronic Design 3
304-526 Artificial Intelligence 3
304-531 Real-Time Systems 3
304-532 Computer Graphics 3
304-548 Introduction to VLSI Systems 3
308-420 File Systems 3
308-431 Algorithms & Data Structures 3
308-535 Computer Networks 3
308-575 Fundamentals of Parallel Computing 3

Laboratory Complementaries

Two 400-level laboratory courses in Electrical Engineering 4

General Complementaries

Two courses (6 credits) in Social Sciences, Administrative Studies or Humanities, selected from an approved list (category ii - section 3.3 on page 220) and one course (3 credits) on the impact of technology (category i - section 3.3) in consultation with an academic advisor. At least one 3-credit course must be from category A (Humanities and Social Sciences) in section 3.3.

TOTAL CREDITS 110

Courses Offered by the Department

- Denotes courses not offered in 1999-2000
- Denotes courses with limited enrolment

All courses with limitations listed for section A01 have a section A02 open to other students but with password control.

Courses with laboratory components: the average number of hours per week of scheduled lab time is indicated by the second of the three bracketed numbers after the course title, e.g. (1-3-2) means 3 hours per week. Lab schedules are determined at the start of classes.

304-200A,B Fundamentals of Electrical Engineering.
3(3-0-6) (Corequisites: 189-261 or 189-325) An introduction to part of the broad scope of electrical engineering: electrostatics, capacitance, conduction, magnetic fields, inductance, circuits and components, sine waves in time and space, electrical machines and transformers, signal amplification. Professor McFee

Section A01: Limited to Electrical Honours, Regular, and Computer Engineering students only.

304-210A,B Circuit Analysis.
5(3-4-8) (Prerequisite: 304-200) Circuit models, KCL and KVL, branch relations, resistive circuit analysis, network theorems, one- and two-port networks, networks in sinusoidal steady-state, power considerations, transient analysis of first- and second-order networks, response to exponential driving functions, frequency response of networks. Laboratory experiments involving basic instrumentation. Measurements on fundamental electrical circuits and systems. Professor McFee and Professor Michalska

For A Term : Section A01: Limited to Electrical Honours and Computer Engineering students only.

For B Term : Section A01: Limited to Regular Electrical Engineering students only.

304-221A,B Introduction to Computer Engineering I. 3(3-1-5)

Section A01: Limited to Electrical Honours, Regular, and Computer Engineering students only.


Section A01: Limited to Electrical Honours, Regular, and Computer Engineering students only.


Section A01: Limited to Electrical Honours, Regular, and Computer Engineering students only.

304-304B Signals and Systems II. 3(3-0-6) (Prerequisite: 304-303) Fourier representation of continuous-time signals, extensions to generalized signals, sampled signals, sampling theorem. Discrete-time signal models, convolution systems, difference equations, state models, recursive and non-recursive systems. Frequency analysis of discrete-time systems, analysis in the Z-domain. Discretization models of continuous systems. The discrete Fourier Transform (DFT), linear filtering based on DFT methods. Professor Blaustein

Section A01: Limited to Electrical Honours, Regular, and Computer Engineering students only.

304-305A,B Probability and Random Signals. 3(3-0-6) (Corequisite: 304-303) The basic probability model, the heuristics of model-building and the additivity of probability; classical models; conditional probability and Bayes rule; random variables and vectors, distribution and density functions, expectation; statistical in-
dependence, laws of large numbers, central limit theorem; introduction to random processes and random signal analysis.

Staff

304-322A, B DIGITAL SYSTEM DESIGN. 5(3-6-6) (Prerequisites: 304-221 and 304-210) Minimization and synthesis of combination-alogic and finite state machines. Synthesis of synchronous and asynchronous sequential circuits. Principles of control design. Basic concepts in design for testability. The laboratory experiments involve the design and testing of digital systems using small and medium-scale integrated circuits. CAD software is used in the design process. Professor Clark

For A Term : Section A01: Limited to Regular Electrical Engineering students only.

For B Term : Section A01: Limited to Electrical Honours and Computer Engineering students only.

304-330A, B ELECTRONIC CIRCUITS I. 3(3-0-6) (Prerequisite: 304-210. Corequisite: 304-303 and 198-271) Operational amplifier circuits; conduction in semiconductors, PN junction diodes, diode circuit applications; JFET, MOSFET and BIPOLAR transistors, terminal characteristics, small and large signal models; simple amplifier configurations, three-terminal properties of small-signal models; frequency response of simple amplifier configurations; simple multistage amplifiers. Professor Plant

Section A01: Limited to Electrical Honours, Regular, and Computer Engineering students only.

304-330A, B ELECTRONIC CIRCUITS II. 5(3-6-6) (Prerequisite: 304-330) Differential and multistage amplifiers, power amplifiers, feedback amplifiers, active filters, tuned amplifiers, oscillators; MOS and BIPOLAR digital circuits including gates, latches and multivibrators; A/D and D/A conversion techniques. Professor Roberts

For A Term : Section A01: Limited to Electrical Honours and Computer Engineering students only.

For B Term : Section A01: Limited to Regular Electrical Engineering students only.

304-351A, B ELECTROMAGNETIC FIELDS. 3(3-1-5) (Prerequisites: 304-200 and 189-265) Maxwell's equations, electrostatics, magnetostatics and induction for power-frequency electrical engineering problems. Professor McFee

Section A01: Limited to Electrical Honours, Regular, and Computer Engineering students only.

304-352A ELECTROMAGNETIC WAVES AND OPTICS. 3(3-1-5) (Prerequisite: 304-351 and 303-382) Transient and steady state wave propagation in transmission lines. Telephone and radio frequency lines. Smith's chart and impedance matching. Maxwell's equations, Helmholtz's equations, Poynting's theorem. Plane waves, polarization, Snell's law, critical and Brewster's angle. Rectangular waveguides, optical fibres, dispersion. Radiation and antennas. Professor Yip

Section A01: Limited to Electrical Honours, Regular, and Computer Engineering students only.

304-353A ELECTROMAGNETIC FIELDS AND WAVES. 3(3-1-5) (Prerequisites: 304-210 and 189-265) Maxwell's equations. Waves in free space and on transmission lines. Electric and magnetic force and energy. Magnetic materials. Faraday's law. Applications to engineering problems. Professor Webb


304-411A COMMUNICATIONS SYSTEMS. 3(3-6-6) (Prerequisite: 304-304 and 304-305) Linear and nonlinear modulation; demodulation methods; noise in communications systems, coherent and incoherent demodulation; power, bandwidth, and performance tradeoff; data transmission fundamentals; acquisition and synchronization; pulse code modulation; multiple access methods; introduction to wireless networks; international standards; fundamentals of information theory. Staff

304-412B DISCRETE TIME SIGNAL PROCESSING. 3(3-0-6) (Prerequisite: 304-304) Discrete-time signals and systems; Fourier and Z-transform analysis techniques, the discrete Fourier transform; elements of FIR and IIR filter design, filter structures; FFT techniques for high speed convolution; quantization effects. Professor Kabal


304-426A, B MICROPROCESSOR SYSTEMS. 3(1-3-5) (Prerequisites: 304-323 and 455-206) Introduction to current microprocessors, their architecture, programming, interfacing and operating systems. The course includes lectures, use of crossassemblers, and simulators as well as laboratory experiments on actual microprocessor hardware. (This course may be counted as a technical complementary or a lab complementary.) Limited Enrolment (50).

Professor Cooperstock

304-427B OPERATING SYSTEMS. 3(3-3-3) (Prerequisite: 304-222) Operating system services, file system organization, disk and cpu scheduling, virtual memory management, concurrent processing and distributed systems, protection and security. Aspects of the DOS and UNIX operating systems and the C programming language. Programs that communicate between workstations across a network. Professor Dr. Pinchuk

304-428B SOFTWARE ENGINEERING. 3(2-2-5) (Prerequisite: 304-222) Designing, development and commissioning of large software systems. Software life cycle; requirements specification, module decomposition, module specification, implementation and test planning. Software reliability and security, multi-user environments. Project management issues. The course involves a group project.

Professor Staff

304-431A ELECTRONIC DESIGN. 3(2-4-3) (Prerequisites: 304-323 and 304-330) The computer-aided design of digital circuits. Hardware description languages, automatic synthesis, design for testability, technology mapping, simulation, timing analysis, generation of test vectors and fault coverage analysis. CAE tools supporting this design methodology are presented in the laboratory. The course includes a design project based on the gate array technology. This course may be counted as a technical complementary or a lab complementary. Limited enrolment (30).

Professor Ferrie

304-432B PHYSICAL BASIS OF TRANSISTOR DEVICES. 3(3-0-6) (Prerequisites: 304-351 and 304-330) Quantitative analysis of diodes and transistors. Semiconductor fundamentals, equilibrium and non-equilibrium carrier transport, and Fermi levels. PN junction diodes, the ideal diode, and diode switching. Bipolar Junction Transistors (BJT), physics of the ideal BJT, the Ebers-Moll model. Field effect transistors, metal-oxide semiconductor structures, static and dynamic behaviour, small-signal models. Professor Plant

304-435A, B MIXED-SIGNAL TEST TECHNIQUES. 3(3-4-2) (Prerequisites: 304-304, 304-305, and 304-334) Purpose and economics of mixed-signal test, DC measurements. Accuracy and repeatability. DSP-based theory and its applications to parametric testing of analog filters, DACs, and ADC. Timing and PLL measurements.
Design for Testability. Laboratory experiments will be performed using a Teradyne A567 mixed-signal production tester.

Professor Roberts


Professor Yip

304-461A ELECTRIC MACHINERY, 3(3-0-6) (Prerequisite: 305-383) (Not open to students in Electrical Engineering.) Electric and magnetic circuits. Notions of electromechanical energy conversion applied to electrical machines. Basic electrical machines - transformers, direct-current motors, synchronous motors and generators, three-phase and single phase induction machines. Elements of modern electronically controlled electric drive systems.

Professor Galiana


Professor Ooi

304-464B POWER SYSTEMS ANALYSIS I, 3(3-0-6) (Prerequisite: 304-361) Basic principles of planning and operating interconnected power systems with emphasis on Canadian conditions. Mathematical models for system. Steady-state analysis of power systems, load flow formulation and solution algorithms. Operating strategies, economic dispatch, voltage reactive power regulation, frequency and tie-line power control.

Professor Galiana

304-472A SYSTEMS DESIGN, 3(2-2-5) (Prerequisite: At least 42 credits of Departmental courses and permission of the instructor.) A design course where the class works as a team to design a large project in either control, power, communications or computer systems. The design is carried out in close collaboration with an industrial partner who acts as a consultant to the project.

Staff

304-485B IC FABRICATION LABORATORY, 2(1-3-2) (Prerequisite: 304-334, 455-206. Corequisite: 304-432 or 504-533) Essential processes for silicon semiconductor device fabrication: etching, diffusion, photolithography. Fabrication of large area PN junctions, selective area PN junctions and MOSFETs. Design and fabrication of simple MOS circuits. Electrical characterization of devices and circuits. Limited Enrolment (8).

Professor Shih

304-486B POWER LABORATORY, 2(1-3-2) (Prerequisites: 455-206, 304-361 and 304-334) Techniques of electric power, efficiency, torque, speed measurements. Starting, running and control of electric machines: dc, synchronous, induction types. Power electronic controllers. Each group of students has access to a compact experiment bench containing a set of micro-machines and all the necessary equipment. Limited Enrolment (14).

Professor Ooi

304-487A,B COMPUTER ARCHITECTURE LABORATORY, 2(0-3-3) (Prerequisite: 455-206. Corequisite: 304-425 or 504-525) Basic software tools used in the design, synthesis and analysis of computer and communication systems such as data-paths, switching circuits, and arithmetic and logic circuits. Behavioral and structural modeling of hardware designs in the IEEE standard hardware description language VHDL. Synthesis and implementation of hardware designs using Programmable Logic Devices. Limited enrollment (50).

Staff


Mr. Fraser

304-490A,B DIGITAL SIGNAL PROCESSING LABORATORY, 2(0-3-3) (Prerequisite: 455-206. Corequisite: 304-412 or 304-512) Experiments involving the digital processing of signals using computer-aided design tools for design, processing and visualization and real-time processing using DSP chips. Filter structures and design, multi-rate signal processing, filter banks, fast transforms, adaptive filtering, signal coding and quantization. Limited Enrolment (30). Password card required.

Professor Kabal

304-491A,B COMMUNICATION SYSTEMS LABORATORY, 2(0-3-3) (Prerequisite: 455-206. Corequisite: 304-411 or 304-511) Experimental studies and simulation of analog and digital transmission techniques. Performance of AM and FM systems. FSK and PSK modulation techniques and spectra. Sampling of analog signals, PCM and TDM techniques. Limited Enrolment (30). Password card required.

Professor Leib

304-493A,B CONTROL AND ROBOTICS LABORATORY, 2(0-3-3) (Prerequisite: 455-206. Corequisite: 304-404 or 304-502) Experimental studies for the design of control systems, with particular emphasis on motion control as applicable to robotics. Fundamentals of sensors and actuators. Linear compensator specification and design in the time and the frequency domain. Pole placement. Effect of model uncertainty on performance. Limited Enrolment (16).

Professor Hayward

304-494A,B ELECTRICAL ENGINEERING DESIGN PROJECT, 3(0-5-4) (Prerequisite: 455-206 and at least 42 Departmental credits.) A laboratory design project undertaken with close supervision by a staff member. The project consists of defining an engineering problem and seeking the solution through experimental investigation. Results are reported in a seminar at the end of term and in a technical paper. Limited Enrolment (50).

Mr. Fraser

304-498A,B,C HONOURS THESIS I, 3(0-3-6) (Prerequisite: 455-206 and at least 42 Departmental credits.) A research project undertaken with close supervision by a staff member. The work consists of defining an engineering problem, reviewing the associated literature, and seeking the solution through experimental investigation. A literature review and a written thesis proposal are required along with a seminar presentation at end of term. Password card required.

Staff

304-499A,B,C HONOURS THESIS II, 3(0-3-6) (Prerequisite: 304-498) A research project undertaken with close supervision by a staff member. A continuation of 304-498. The work consists of carrying out the research plan developed in 304-498 along with a seminar presentation at end of term. Password card required.

Staff


Staff


Professor Bélanger


Professor Caines

304-504B COMPUTER CONTROL, 3(3-0-6) (Prerequisites: 304-404 and 304-502) Sampling and aliasing. Conversion of continuous-time controllers using s-to-z transformations; pre- and post-filtering. Discrete time state representation and z-transfer
function of sampled linear, time-invariant systems. Correspondence between system theoretic results for continuous- and discrete-time systems. Sampled-data design, including deadbeat and LQG control. Quantization. Specification of computer system. Study of control system design through case studies.

Staff

304-505B MULTIVARIABLE NONLINEAR CONTROL SYSTEMS. 3(3-0-6) (Prerequisite: 304-501) Basic ODE formulation of non-linear systems; structural properties; Lyapunov and LaSalle stability theory and nonlinear and multivariable controller design; input-output stability; small gain theorem, conservation, passivity; system linearization, zero and inverse dynamics and regulator design; discontinuous and sliding mode control; applications to deterministic adaptive control.

Professors Caines and Michalska

304-507A OPTIMIZATION AND OPTIMAL CONTROL. 3(3-0-6) (Pre-requisites: 189-265 or 189-248 and 189-270 or 189-247) General Introduction to optimization methods including steepest descent, conjugate gradient, Newton algorithms. Generalized matrix inverses and the least squared error problem. Introduction to constrained optimality; convexity and duality; interior point methods. Introduction to dynamic optimization; existence theory, relaxed controls, the Pontryagin Maximum Principle. Sufficiency of the Maximum Principle.

Professor Michalska


Professor Caines

304-511A COMMUNICATION SYSTEMS. 3(3-0-6) (Prerequisite: 304-304 and 304-305) Amplitude and angle modulation including AM, FM, FDM and television systems; introduction to random processes; sampling and quantization, PCM systems, TDM: digital modulation techniques, Maximum-Likelihood receivers, synchronization issues; elements of information theory including information sources, source coding and channel capacity.

Professor Leib

304-512A DIGITAL SIGNAL PROCESSING. 3(3-0-6) (Prerequisite: 304-304 and 304-305) Review of discrete-time systems and signals including Fourier and Z-transform theory and the discrete Fourier transform; structures for discrete-time systems, FIR and IIR filter design techniques, FFT techniques, the discrete Hilbert transform, Fourier analysis of stationary and non-stationary random signals.

Professor Kabal


Professor Rumin


Professor Kabal

304-523B SPEECH COMMUNICATIONS. 3(3-0-6) (Prerequisite: 304-412 or 304-512) Human speech production: articulatory and acoustic descriptions; models of speech production; speech perception; digital processing of the speech signal; vocoders (formant, linear predictive, cepstral); automatic speech recognition by computer; speech synthesis-by-rule; speaker recognition/verification.

Dr. O’Shaughnessy


Staff

304-526B ARTIFICIAL INTELLIGENCE. 3(3-0-6) (Prerequisite: 304-222) Fundamentals of automated reasoning in expert systems: Semantics and satisfaction, inference procedures, logical implication, proofs, unification, resolution, soundness and completeness. Searching strategies and problem solving. Limits of monotonic logic: forms of non-monotonic reasoning. The course includes a term project which consists of writing a small inference engine in Lisp.

Professor Cooperstock

304-527 OPTICAL AND PHOTONIC SYSTEMS. 3(3-0-6) (Prerequisite: 304-304 and 304-352) A structure introduction to modern optical engineering. Topic covered include the propagation of light through space, refraction, diffraction, polarization, lens systems, ray-tracing, aberrations, computer-aided design and optimization techniques. Gaussian beam analysis, micro-optics and computer generated diffractive optical elements. Systems and applications will be stressed throughout.

Professor Kirk


Dr. Kaplan

304-529A IMAGE PROCESSING & COMMUNICATION. 3(3-0-6) (Prerequisite: 304-304) Introduction to vision in man and machine; computer vision systems; biological vision systems; biological signal processing; edge detection; spatial- and frequency-domain processing; color. Low-level visual processing in computer vision, psychophysics, and neurobiology, and their similarities and differences.

Professor Levine

304-531B REAL TIME SYSTEMS. 3(3-3-3) (Prerequisites: 304-222 and 304-323) Real-time engineering applications of computers to on-line control, communication systems and data acquisition. Aspects of hardware, software, interfacing, operating systems, and their integration into a complete system are addressed.

Professor Khordoc

304-532A COMPUTER GRAPHICS. 3(3-3-3) (Prerequisite: 304-222) Introduction to computer graphics systems and display devices: raster scan, scan conversion, graphical input and interactive techniques - window environments; display files; graphics languages and data structures; 2D transformations; 3D computer graphics, hidden line removal and shading; graphics system design; applications. Laboratory project involving the preparation and running of graphics programs.

Ms. Leszkoicz

304-533B PHYSICAL BASIS OF SEMICONDUCTOR DEVICES. 3(3-0-6) (Prerequisites: 198-350, 304-330 and 304-376) Quantitative analysis of diodes and transistors. Semiconductor fundamentals, equilibrium and non-equilibrium carrier transport, and Fermi levels. PN junction diodes, the ideal diode, and diode switching. Bipolar Junction Transistors (BJT), physics of the ideal BJT, the Ebers-Moll model. Field effect transistors, metal-oxide semiconductor structures, static and dynamic behaviour, small-signal models.

Professor Plant

304-534A ANALOG MICROELECTRONICS. 3(3-0-6) (Prerequisite: 304-334) Design of analog ICs using specialized analog CAD tools such as SPICE. Voltage and current amplifier design which encompasses the study of biasing circuits, current sources and mirrors, input and output stages, and frequency compensation;

**Professor Roberts**

304-545A MICROELECTRONICS TECHNOLOGY 3(3-0-6) (Prerequisite: 304-432 or 304-533) Basic techniques in the fabrication of microelectronic circuits. Four-point probe, alloyed contacts, diffusion processes, ion implantation epitaxy, silicon dioxide, photolithography, selected diffusion and metallization, transistor fabrication, dry etching, monolithic integrated circuits, isolation, mask making, thin and thick film components, MOS gate voltage and integrated circuits.

**Professor Webb**


**Professor McFee**

304-548A INTRODUCTION TO VLSI SYSTEMS 3(2-2.5) (Prerequisites: 304-334 and 304-323) An interdisciplinary course for electrical engineering and computer science students. A structured design methodology for managing the complexity of VLSI systems and the necessary feedback loop between the design process and the fabrication process. A detailed introduction to VLSI fabrication processes, including terrorization and integrated circuits.

**Professor McFee**


**Professor Rumin**

304-559X FLEXIBLE AC TRANSMISSION SYSTEMS 3(3-0-6) (Prerequisite: 304-361 and 304-334) Operating principles of controllers of flexible AC transmission systems (FACTS). Transformer, thyristor and gate-tum-off thyristor (GTO) technologies. Modulation methods: harmonic elimination, pulse width modulation. Applications in: shunt and series advanced static VAR Controllers (ASVC), phase shifters, unified power flow controllers (UPFC).

**Professor Ooi**

304-560A Power Systems Analysis II 3(3-0-6) (Prerequisite: 304-464) Main power system analysis tools for system and component design. Balanced and unbalanced operation of three-phase systems, symmetrical components, fault analysis, transient behaviour due to switching and lightning. Applications for a wide range of typical situations such as line design, circuit breaker rating, protective relaying, and insulation coordination are covered.

**Professor Ooi**


**Professor Galiana**

304-565A INTRODUCTION TO POWER ELECTRONICS 3(3-0-6) (Prerequisite: 304-334) Semiconductor power switches – thyristors, GTO’s, bipolar transistors, MOSFET’s. Switch mode power amplifiers. Buck and boost principles. Modulation methods -PWM, delta, hysteresis current control. Rectifiers, inverters, choppers.

**Professor Plant**

304-571A PHOTONICS 3(3-0-6) (Prerequisites: 304-304, 304-305, 304-352 and 304-533) Physical basis of optoelectronic devices including Light Emitting Diodes, semiconductor optical amplifiers, semiconductor lasers, quantum well devices, and solid state lasers. Quantitative description of detectors, optical modulation, optical logic devices, optical interconnects, and optomechanical hardware. Throughout the course, photonic systems applications will be addressed.

**Professor Ooi**

304-573A MICROWAVE ELECTRONICS 3(3-0-6) (Prerequisite: 304-432 or 304-533) Physical basis of modern microwave devices and circuits. Microwave transistors and tunnel diodes, transferred electron devices, transit time devices and infra-red devices. Microwave generation and amplification, microwave FET circuits. Noise and power amplification.

**Professor Shih**

304-592A MicroWave Theory and Techniques 3(3-0-6) (Prerequisite: 304-352) Transmission lines, waveguides and surface waveguides for large capacity guided microwave trunk communications, microwave circuit theory, Smith’s chart, impedance matching and transformation, passive microwave devices, resonators, periodic structures and filters, microwave antennas for satellite communications.

**Professor Yip**

304-593A ANTENNAS & PROPAGATION 3(3-0-6) (Prerequisite: 304-352) Near and far field behaviour of radiators; antennas as a boundary value problem; practical antenna parameters; wire antennas, antenna arrays, aperture methods of antenna analysis; measurement of input impedance, field patterns, gain and noise; point-to-point propagation, fading beyond the horizon and long distance propagation, ionospheric, atmospheric and earth’s surface considerations; tropospheric scatter.

**Staff**

304-596B OPTICAL WAVEGUIDES 3(3-0-6) (Prerequisite: 304-352) Introduction to wave and ray optics, ray equation. Kirchoff-Huygens diffraction theory, Fourier optics, Gaussian beams, propagation characteristics of optical fibers and dielectric waveguides for wideband optical fiber communication systems, waveguide group velocity and dispersion, thin-film waveguides. Discussion of optical fiber communication systems and guided-wave photonic devices.

**Professor Yip**

GRADUATE 600-LEVEL COURSES

Generally, undergraduate students are not permitted to enroll in graduate 600-level courses. However, in exceptional circumstances, the Faculty of Graduate Studies and Research does grant this permission upon the request of the Department on behalf of the student. Please consult the Faculty of Graduate Studies and Research Calendar for 600-level courses.

4.6 Department of Mechanical Engineering

**Chair**

Stuart J. Price; B.Sc., Ph.D.(Bristol), P.Eng.

Emeritus Professors

David R. Axelrad; Dipl.-Ing.(Vienna), M.Eng.Sc.(Sydney), (Dr. Techn.)(Vienna), A.M.I.M.E., M.N.A.Sc., Eng. (Thomas Workman Emeritus Professor of Mechanical Engineering)

William Bruce; B.A.Sc., M.A.Sc.(Toronto), Eng.

John C. Chenna; Dipl.-Ing.(Swiss Fed. Inst.), Eng., F.E.I.C.


Professors
The Department offers an Honours Program which is particularly suitable for those with a high aptitude in mathematics and physics and which gives a thorough grounding in the basic engineering sciences. The complementary courses in this program can be utilized to take courses with applied engineering orientation, such as those offered in the regular program, or if preferred, to obtain an even more advanced education in engineering science.

Options in Aeronautical Engineering, Automation and Design are available for students in either the Regular or Honours Programs who wish to specialize in these areas.

While the program is demanding, there is time for many extra-curricular activities. Students are active in such professional societies as the CASI (Canadian Aeronautics and Space Institute), and the SAE (Society of Automotive Engineers), and the ASME (American Society of Mechanical Engineers) and in various campus organizations.

Relations between faculty and students are extremely close. Social functions, at which students and professors meet to exchange views and get to know each other better, are organized frequently.

### CURRICULUM FOR THE B.ENG. DEGREE IN MECHANICAL ENGINEERING (REGULAR)

#### REQUIRED COURSES

**COURSE**

<table>
<thead>
<tr>
<th>Non-Departmental Subjects</th>
<th>COURSE</th>
<th>CREDIT</th>
</tr>
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<tbody>
<tr>
<td>189-260A, B</td>
<td>Intermediate Calculus</td>
<td>3</td>
</tr>
<tr>
<td>189-261A, B</td>
<td>Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>189-265A, B</td>
<td>Advanced Calculus</td>
<td>3</td>
</tr>
<tr>
<td>189-266A, B</td>
<td>Linear Algebra and BVP</td>
<td>4</td>
</tr>
<tr>
<td>303-207A, B</td>
<td>Solid Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>304-461A</td>
<td>Electric Machinery</td>
<td>3</td>
</tr>
<tr>
<td>306-221A, B</td>
<td>Engineering Professional Practice</td>
<td>1</td>
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<tr>
<td>306-260A, B</td>
<td>Materials Science and Engineering</td>
<td>3</td>
</tr>
<tr>
<td>306-310A, B</td>
<td>Engineering Economy</td>
<td>3</td>
</tr>
<tr>
<td>308-208A, B</td>
<td>Computers in Engineering</td>
<td>3</td>
</tr>
<tr>
<td>455-206A, B</td>
<td>Communication in Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

**Departmental Courses**

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDIT</th>
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</thead>
<tbody>
<tr>
<td>305-201A</td>
<td>Intro. to Mechanical Engineering</td>
</tr>
<tr>
<td>305-210A, B</td>
<td>Mechanics I</td>
</tr>
<tr>
<td>305-220A, B</td>
<td>Mechanics II</td>
</tr>
<tr>
<td>305-240A, B</td>
<td>Thermodynamics I</td>
</tr>
<tr>
<td>305-260A, C</td>
<td>Machine Tool Laboratory</td>
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<tr>
<td>305-261B, C</td>
<td>Measurement Laboratory</td>
</tr>
<tr>
<td>305-291B</td>
<td>Graphics</td>
</tr>
<tr>
<td>305-292A</td>
<td>Design I</td>
</tr>
<tr>
<td>305-314A</td>
<td>Dynamics of Mechanisms</td>
</tr>
<tr>
<td>305-315A</td>
<td>Dynamics of Vibrations</td>
</tr>
<tr>
<td>305-321B</td>
<td>Mechanics of Deformable Solids</td>
</tr>
<tr>
<td>305-331A, B</td>
<td>Fluid Mechanics I</td>
</tr>
<tr>
<td>305-341A</td>
<td>Thermodynamics II</td>
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<tr>
<td>305-346A, B</td>
<td>Heat Transfer</td>
</tr>
<tr>
<td>305-362A, B</td>
<td>Mechanical Laboratory</td>
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<tr>
<td>305-383A, B</td>
<td>Applied Electronics and Instrumentation</td>
</tr>
<tr>
<td>305-393B</td>
<td>Design II</td>
</tr>
<tr>
<td>305-409B</td>
<td>Numerical Methods in Mechanical Engineering</td>
</tr>
<tr>
<td>305-412B</td>
<td>Dynamics of Systems</td>
</tr>
<tr>
<td>305-430A</td>
<td>Fluid Mechanics II</td>
</tr>
<tr>
<td>305-463D</td>
<td>Mechanical Engineering Project</td>
</tr>
</tbody>
</table>

#### COMPLEMENTARY COURSES

2 courses (6 credits) at the 300 level or higher to be selected from Mechanical Engineering.

The other course (3 credits) may be from the Faculty of Engineering or an approved course in the Faculty of Science, including Mathematics.
2 courses (6 credits): 1 course from the Impact of Technology on Society and 1 course from Humanities and Social Sciences selected from an approved list (see section 3.3 on page 220).

TOTAL CREDITS 109

If advanced credit is given for 189-260 Intermediate Calculus (see section 2.3 on page 219), the total number of credits is reduced by three.

Students entering in September or January must plan their program of studies in accordance with the regulations described in the "Welcome" book. After registering by MARS, students must consult with their academic adviser.

In addition students admitted to the 8-semester program (see section 3.1.2 on page 220), must take note of the additional courses that are specified in the "Welcome" book. These can also be found on the Faculty website (http://www.engineering.mcgill.ca).

LIST OF COMPLEMENTARY COURSES (DEPARTMENTAL)
(Each is 3 credits)

305-500A,B Selected Topics in Mechanical Engineering
305-501A,B Selected Topics in Mechanical Engineering
305-522B Production Systems
305-524B Computer Integrated Manufacturing
305-526C Manufacturing and the Environment
305-528A Product Design
305-529C Discrete Manufacturing Systems
305-530B Mechanics of Composite Materials
305-531B Aerelasticity
305-532B Aircraft Performance Stability and Control
305-533A Subsonic Aerodynamics
305-534B Air Pollution Engineering
305-537B High Speed Aerodynamics
305-538B Unsteady Aerodynamics
305-539A Computational Aerodynamics
305-540B Design: Modelling and Decision
305-541B Kinematic Synthesis
305-542B Spacecraft Dynamics
305-543A Design with Composite Materials
305-545A Advanced Stress Analysis
305-552B Advanced Applied Mathematics
305-554A Industrial Process Automation
305-555B Applied Process Control
305-557B Electromechanical Design
305-561B Biomechanics of Musculoskeletal Systems
305-562B Advanced Fluid Mechanics
305-565B Fluid Flow & Heat Transfer Equipment and Systems
305-572A Mechanics of Robotic Systems I
305-573B Mechanics of Robotic Systems II
305-576A Computer Graphics and Geometric Modelling
305-577A Optimum Design
305-578B Advanced Thermodynamics
305-581A Nonlinear Dynamics and Chaos

TYPICAL PROGRAM OF STUDIES FOR REGULAR OR HONOURS

For students starting their B.Eng. studies in September who have completed the Quebec Diploma of Collegial Studies, a program for the first two semesters of study is given below:

Semester 1 (Fall)
189-260A Intermediate Calculus
305-201A Intro. to Mechanical Engineering
305-210A Mechanics I
305-260A Machine Tool Laboratory
306-221A Engineering Professional Practice
308-208A Computers in Engineering
Semester 2 (Winter)

305-261A Differential Equations
305-265B Advanced Calculus
305-220B Mechanics II
305-261B Measurement Laboratory
305-291B Graphics
455-206B Communication in Engineering

For all Minors and Options, students should complete a special form available from the Undergraduate Program Secretary indicating their intention to take the Minor or the Option.

AERONAUTICAL ENGINEERING OPTION

Students in this Option should take five courses in the area of Aeronautical Engineering. Specifically they must take the following two required courses:
- 305-532B Aircraft Performance, Stability and Control
- 305-533A Subsonic Aerodynamics

and at least one of the following:
- 305-432A Aircraft Structures
- 305-434A Turbomachinery

The remaining two courses may be chosen from the above or from the following courses:
- 305-531B Aerelasticity
- 305-537B High Speed Aerodynamics
- 305-538B Unsteady Aerodynamics
- 305-539A Computational Aerodynamics

All courses must be passed at a level C or better.

Students should also discuss the matter with their adviser and complete a special form indicating their intention to take this Option.

AUTOMATION OPTION

Students in this Option should take six courses in the area of Control, Robotics and/or CAD/CAM. They must take the following four required courses:
- 305-532B Aircraft Performance, Stability and Control
- 305-533A Subsonic Aerodynamics
- 305-534A Turbomachinery
- 305-432A Aircraft Structures

The remaining two courses may be chosen from the above or from the following courses:
- 305-531B Aerelasticity
- 305-537B High Speed Aerodynamics
- 305-538B Unsteady Aerodynamics
- 305-539A Computational Aerodynamics

All courses must be passed at a level C or better.

Students should also discuss the matter with their adviser and complete a special form indicating their intention to take this Option.

DESIGN OPTION

The Design Option Program is comprised of six courses as follows:

305-495A Design III
305-496B Design IV

Plus any four below:

305-497A Value Engineering
305-540B Design: Modelling and Decision
305-541B Kinematic Synthesis
305-543A Design and Manufacturing with Composite Materials
305-557B Electromechanical Design
305-565B Fluid Flow & Heat Transfer Equipment
305-576A Computer Graphics and Geometric Modelling
305-577A Optimum Design

COURSES OFFERED BY THE DEPARTMENT

- Denotes courses not offered in 1999-2000
- Complementary courses
- Courses with Limited Enrolment

305-201A INTRODUCTION TO MECHANICAL ENGINEERING. 2(3-0-3)

The practice of Mechanical Engineering: its scope and context. The role of Design. Introduction to the Design process. The role of engineering analysis and socio-economic factors in Design. Introduction to the individual mechanical engineering subjects and their role in Design. Case studies. **Professor Ahmed and Staff**

Static: beams, trusses frames. Coordinate systems. Kinematics, relative motion; momentum and force, conservation of momentum; Newton’s Laws; concepts of force and impulse; angular momentum and its conservation; central force motion; various classes of forces (gravity, friction, elastic, etc.) and pseudo-forces. Energy: kinetic, potential and mechanical work. Centre of mass and moment of inertia; Planar rigid-body dynamics. **Professors J. Lee and Zsombor-Murray**


305-240A,B THERMODYNAMICS I. 3(3-1-5) Basic definitions, state variables and functions, macroscopic vs. microscopic points of view. Equation of state for a perfect gas. First law of thermodynamics: work and heat; internal energy; enthalpy; basic energy transfer processes. Control volume energy analysis. Heat engine cycles; refrigerators and heat pumps; air compressors. Second law of thermodynamics; entropy; availability; irreversibility. **Professors J.Lee, Frost and Baliga**

305-250A,B THERMODYNAMICS II. 3(3-1-5)  (Prerequisites: 305-240) Advanced thermodynamics. Heat and work. Entropy; irreversibility. Heat engines; refrigeration and air conditioning. Second law of thermodynamics; entropy; availability; irreversibility. **Professors M. Ahmed**

305-260A,C MACHINE TOOL LAB. 2(1-3-2) Basic machine tool operations, numerical control of machine tools, and metrology. The use of hand tools, and sheet metal work. Introduction to rapid prototyping and nontraditional machining methods. Extensive laboratory hands-on exercises. **Professor Buehler and Staff**

305-261B,C MEASUREMENT LAB. 2(2-3-1) Basic experimental laboratory measurements, such as measurement of strain, pressure, force, position, and temperature. **Professor Horii and Staff**

305-290A GRAPHICS. 3(3-3-0) (This course is intended for Civil Engineering students.) Traditional descriptive geometry of points, lines and planes, done with modern tools. Constructed solutions with vector diagram projection; comparison with equivalent vector algebraic methods. Graphical statics, concurrent force problems, including pure axial force plane structures. Structural drafting pertaining to steel, concrete and timber construction, standards and conventions. Drafting room and computer lab exercises are assigned. **Professor Zsombor-Murray**

305-291B GRAPHICS. 3(3-3-3) Descriptive geometry of points, lines and planes, intersection and developments, auxiliary view and direct methods. Drawing standards. Working drawings and conventions, fits and tolerances, representation of welding, surface finish, threaded fasteners, standard mechanical components: motors, cylinders, bearings, gears and other elements. Sections and pictorials. Bills of material and cataloging. Computer lab exercises are assigned. **Professor Zsombor-Murray**

305-292A DESIGN I. 3(1-3-5) (Prerequisites: 305-260 and 305-291. Pre- or Co-requisites: 303-207, 455-206) Introduction to design. Problem formulation; idea generation; feasibility study; preliminary design; design; optimal design. The student's creative ability will be developed by having to participate in a number of design projects. Case-study methods will be used to analyse actual design projects. **Professor Post**

305-314A DYNAMICS OF MECHANISMS. 3(3-1-5) (Prerequisite: 305-210) First principles of analysis; motion; position; displacement; velocity; acceleration; force; inertia and its effects. Kinematic and dynamic analysis of rigid bodies in pure rotation and in pin-connected systems; dynamic balance. Rigid bodies in rolling contact; planetary gear-trains. Bodies in sliding contact; lower and higher sliding pairs. **Professor Ahmed**

Professor Misra


Professors Paidoussis and Lessard

305-321B MECHANICS OF DEFORMABLE SOLIDS, 3(3-1-5) (Prerequisite: 303-207) Modern phenomenological theories of the behaviour of engineering materials. Stress and strain concepts and introduction to constitutive theory. Applications of theory of elasticity and thermoelasticity. Introduction to finite element stress analysis methods.

Professors Lessard and Nemes

305-331A,B FLUID MECHANICS I, 3(3-1-5) (Prerequisite: 305-210. Pre- or Co-requisites: 305-220, 305-240 and 189-266) Review of fluid properties; stress in a continuum; fluid kinematics; rates of strain, rotation. Control volume analysis; conservation of mass, linear momentum and energy; Euler and Bernoulli equations; Flow measurement. Dimensional analysis and dynamical similarity. Laminar and turbulent flow in pipes and boundary layers.

Professors Price and T. Lee


Professors J. Lee and Frost

305-346A,B HEAT TRANSFER, 3(3-1-5) (Prerequisites: 305-331 and 189-266) Steady-state conduction. Fin Theory. Unsteady-state conduction. Convective heat transfer; governing equations, dimensionless parameters, analogy between momentum, heat and mass transfer; design correlations. Natural convection. Heat exchangers. Radiative heat transfer; black-and-gray-body radiation; shape factors; enclosure theory.

Professors Baliga and Mydlarski

305-362A,B MECHANICAL LAB I, 2(0-3-3) (Prerequisite: 305-261) Experiments will be performed in four areas: 305-240 Thermodynamics, 305-315 Vibrations, 305-331 Fluid Mechanics I, and 305-346 Heat Transfer. Students should sign up to do experiments in one or more areas the term following the completion of one or more of the above courses. Students will not formally register for this course until the term in which they will complete all of the experiments.

Professors Frost and Lessard

305-383A,B APPLIED ELECTRONICS & INSTRUMENTATION, 3(3-2-4) (Prerequisites: 305-261 and 189-261) Discrete and integrated components, both analogue and digital. Characteristics of passive elements. Semiconductors, amplifiers, filters, oscillators, modulators, power supplies and nonlinear devices. Introduction to digital electronics. Transducer/signal conditioner interfacing considerations.

Professors Hori and Mr. Zorbas

305-393B DESIGN II, 3(3-3-3) (Prerequisites: 305-292 and 306-260. Pre- or co-requisite: 305-314) The design of machine elements for strength requirements in consideration of various methods of manufacture. Synthesis of mechanical systems to fulfill performance requirements, following the engineering design process. Failure theory and fatigue life determination. Students form groups to work on a design project.

Professor T. Lee

305-403D,N THESIS (HONOURS), 6(0-6-12) (Prerequisite: Candidates must have completed courses in the Mechanical Engineering Program weighted at a minimum of 60 credits.) This course, together with course 305-404B, involves a research or design project undertaken by each student, encompassing interrelated aspects of engineering theory and requiring a theoretical and/or experimental investigation. Students will work under the supervision of one or more staff members; completed work will be submitted in the form of a thesis. The grade awarded for this part of the course depends on the assessment of the quality of theoretical and/or experimental work undertaken by the students.

Professors Axelrad, Price and Staff

305-404A,B THESIS (HONOURS), 2(0-3-3) (Corequisite: 305-403) This course is part of the same thesis project as course 305-403D. The grade for this part of the course covers the orderly development and presentation of ideas, and their incorporation in the thesis.

Professors Axelrad, Price and Staff

305-409B NUMERICAL METHODS IN MECH. ENG. 3(3-1-5) (Prerequisites: 189-261, 189-266 and 308-208) Numerical techniques for problems commonly encountered in Mechanical Engineering are presented. Chebyshev interpolation, quadrature, roots of one or more variables, matrices, curve fitting, splines and ordinary differential equations. The emphasis is on the analysis and understanding of the problem rather than the details of the actual numerical program.

Professor Bach


Professor Angeles


Professor Hori


Professor J. Lee


Mr. Edwards

305-434A TURBOMACHINERY, 3(3-0-6) (Prerequisite: 305-331) A broad general treatment of energy transfer between a fluid and a rotor, velocity vector diagrams, and non-dimensional characteristics. Applications to hydraulic pumps and turbines. Two dimensional cascade theory leading to study of axial gas compressors.
and turbine stages. Three dimensional free and forced vortex config-
urations. Centrifugal compressors and radial inflow turbines.

Dr. H. Moustapha

305-447A COMBUSTION. 3(3-0-6) (Prerequisite: 305-240) Equi-
librium analysis of reacting systems, Hugoniot analysis, flame
propagation mechanisms, introduction to chemical kinetics, mod-
els for laminar flame propagation, ignition, quenching, flammability
limits, turbulent flames, flame instability mechanisms, detonations,
solid and liquid combustion.

Professors J. Lee and Frost

305-452A MATHEMATICAL METHODS IN ENGINEERING. 3(3-1-5)
(Prerequisite: Candidates must have completed courses in the
Mechanical Engineering Program weighted at 60 credits (mini-
mum).) The underlying theory and application of mathematical
methods in fluid dynamics, vibration, stress and strain analysis,
heat transfer, etc. The eigenvalue problem, methods in analysis.

Professor Post and Staff

305-463D MECHANICAL ENGINEERING PROJECT. (4) (Prerequisite:
305-393) Team project work typically involving design, fabrication,
performance-testing and application of a real-world mechanical
device/system or experimental facility. The project work will be
complemented by a scheduled set of lectures in the Fall term on
topics related to formulation/management of open-ended prob-
lems.

Professor Post and Staff

3(3-0-6) (Prerequisite: U3 and permission of the instructor) Introduction to
principles of the integrated multidisciplinary approach to project
management in use by engineering firms. Working in teams stu-
dents will have the opportunity to assess the real-life pressures in
project management by working on an actual recent project and
presenting their results to a professional evaluation panel.

Staff

305-474B SEL. TOPICS IN OPERATIONS RESEARCH. 3(3-0-6)
(Prerequisites: 189-266 and 308-208) Introduction to the general
mathematical programming problem in the context of engineering
design; linear programming, queueing theory, Monte Carlo simula-
tion. The above techniques will be used to study the optimization
of engineering systems. The applications of linear programming
in its various manifestations will be examined in depth.

Dr. Mackenzie

305-495A DESIGN III. 3(0-6-3) (Prerequisite: 305-463) A design
project course of two terms together with 305-495B. Project ap-
proval required. Allows the completion of a project of greater com-
plexity than Design II and Mechanical Engineering Project with
emphasis on analytical solutions, stressing, planning for produc-
tion. No lectures. Weekly consultations. Interim and final reports
required.

Professor T. Lee

305-496B DESIGN IV. 3(0-6-3) (Prerequisite: 305-495) Continu-
ation of 305-495A. The two together constitute a design project
course of two terms. The two courses permit the completion of a
project of greater complexity than Design II and Mechanical Engi-
neering Project with emphasis on analytical solutions, stressing,
planning for production. No lectures. Weekly consultations. Interim
and final reports required.

Professor T. Lee

305-500A,B SEL. TOPICS IN MECHANICAL ENG. 3(3-0-6) A
course to allow the introduction of new topics in Mechanical Engi-
neering as needs arise, by regular and visiting staff.

305-501A,B SEL. TOPICS IN MECHANICAL ENG. 3(3-0-6) A
course to allow the introduction of new topics in Mechanical Engi-
neering as needs arise, by regular and visiting staff.

305-522B PRODUCTION SYSTEMS. 3(3-0-6) Characteristics of
production systems. System boundaries, input-output, feedback
time-lag effects, dynamics of production systems. Design for man-
ufacturability. Process planning, process/machine tool selection,
break-even analysis, CAPP. Production planning, scheduling and
control of operations; quality management. Competitive strategies;
FMS, CIM. Hands-on experience with industrial factory simulation
software.

Professor Kops

305-524B COMPUTER INTEGRATED MANUFACTURING. 3(3-0-6)
(Prerequisite: Permission of the instructor) A study of the present
impact of computers and automation on manufacturing. Computer
aided systems. Information modelling. Information system struc-
tures. Study of several types of production systems. Integration
issues: inter-and intra-enterprise. Laboratory experience with
manufacturing software systems.

Professor Thomson

305-526C MANUFACTURING AND THE ENVIRONMENT. 3(3-0-6)
(Prerequisite: Permission of the instructor) Course topics include:
clean manufacturing, product and process design for minimizing
materials and energy use, the product life cycle, impact of technol-
ogy on the environment, environmental impact assessment, regul-
atory process, and managing the “political” process.

Staff

305-528A PRODUCT DESIGN. 3(3-0-6) (Prerequisite: Permission of
the instructor) A study of the design issues present in product
life cycle demands. Computer aided systems. Rapid
prototyping. Design for manufacturability. Integration of mechan-
eics, electronics and software in products. Effect on design of prod-
cuct cost, maintainability, recycling, marketability.

Staff

305-529C DISCRETE MANUFACTURING SYSTEMS. 3(3-0-6)
(Prerequisite: Permission of the instructor) An overview of present
day production machines and systems with special emphasis on
automation, computer control and integration techniques. Material
handling, automatic inspection, process monitoring, maintenance.
Socio-economic and environmental issues. Laboratory experi-
ence with factory simulation.

Staff

305-530B MECHANICS OF COMPOSITE MATERIALS. 3(3-0-6)
(Prerequisite: 305-321 or equivalent) Fiber reinforced composites. Stress, strain, and strength of com-
posite laminates and honeycomb structures. Failure modes and
failure criteria. Environmental effects. Manufacturing processes.
Computer techniques are utilized throughout the course.

Professor Lessard

305-531B AEROELASTICITY. 3(3-1-5) (Prerequisites: 305-319 or
305-315 and 305-533) Wing divergence using strip theory aerody-
namics. Effect of aircraft flexibility on the control and stability. Flut-
ter calculations for two dimensional wings with discussion of three
dimensional effects. Some examples of aeroelastic instability, and
the relevant analysis of non-aerodynamic problems.

Professor Price and Dr. Alighanbari

305-532B AIRCRAFT PERFORM, STABILITY & CONTROL. 3(3-1-5)
(Prerequisites: 305-412, 305-533) Aircraft performance criteria
such as range, endurance, rate of climb, maximum ceiling for
steady and accelerated flight. Landing and take-off distances.
Static and dynamic stability in the longitudinal (stick-fixed and
stick-free) and coupled lateral and directional modes. Control re-
sonse for all three modes.

Professor Price and Mr. Asselin

305-533A SUBSONIC AERODYNAMICS. 3(3-1-5) (Prerequisite:
305-331) Kinematics: equations of motion; vorticity and circulation,
conformal mapping and flow round simple bodies. Two dimension-
allow round aerfoils. Three dimensional flows; high and low as-
pect-ratio wings; airscrews. Wind tunnel interference. Similarity rules for subsonic irrotational flows. **Professor Mateescu**

- **305-534B AIR POLLUTION ENGINEERING.** 3(3-0-6) (Prerequisites: 305-240, 305-331, 305-341 and 305-447 or consent of instructor.) Pollutants from power production and their effects on the environment. Mechanisms of pollutant formation in combustion. Photochemical pollutants and smog, atmospheric dispersion. Pollutant generation from internal combustion engines and stationary power plants. Methods of pollution control (exhaust gas treatment, absorption, filtration, scrubbers, etc.). **Professors J. Lee and Frost**


- **305-540B DESIGN: MODELLING & DECISION.** 3(3-3-3) 3-D geometric modelling for design; principles and practice. Selected topics/case studies requiring use of: 3-D CAD; component selection and integration; use of machine element design analysis software; practice in developing simple applications. Use of modern software for design decision making. Introduction to mechanism animation. Introduction to design for NC production. **T. Yee**


- **305-542B SPACECRAFT DYNAMICS.** 3(3-0-6) (Prerequisite: 305-220. Corequisite: 305-319 or 305-412) Review of central force motion; Hohmann and other coplanar transfers, rotation of the orbital plane, patched conic methods. Orbital perturbations due to the earth’s oblateness, solar-lunar attraction, solar radiation pressure and atmospheric drag. Attitude dynamics of a rigid spacecraft; attitude stabilization and control; attitude maneuvers; large space structures. **Professor Misra and Staff**


- **305-554A PROCESS AUTOMATION.** 3(2-3-4) (Prerequisites: 305-261 and 308-208 or 304-221) Introduction to digital logic and microprocessor assembler. Logic and programming laboratory exercises pertaining to simple combinatorial, sequential and analogue elements and their applications to control and signal conditioning. **Professor Zsombor-Murray**

- **305-555B APPLIED PROCESS CONTROL.** 3(2-3-4) (Prerequisite: 305-554 or equivalent) Hardware and software aspects of real-time computers in process control and related applications. Fundamental hardware, Digital and analogue transducers, actuators, sensors, filters, interfaces and processors. Fundamental software: Process assembler language and machine architecture, real-time operating systems, process-oriented subsystems, interrupts, drivers, service routines. **Professor Zsombor-Murray**


- **305-561B BIOMECHANICS OF MUSCULOSKELETAL SYSTEMS.** 3(3-0-6) (Prerequisites: 305-321, 305-315 or 305-412) The musculoskeletal system; general characteristics and classification of tissues and joints. Biomechanics and clinical problems in orthopaedics. Modelling and force analysis of musculoskeletal systems. Passive and active kinematics. Load-deformation properties of passive connective tissue, passive and stimulated muscle response. Experimental approaches, case studies. **Professor Ahmed**

- **305-562A ADVANCED FLUID MECHANICS.** 3(3-0-6) Conservation laws, control volume analysis, Navier stokes equations, dimensional analysis and limiting forms of N-S equation, laminar viscous flows, boundary layer theory, inviscid potential flows, lift and drag, introduction to turbulence. **Professors J. Lee and L. Cortelezzi**


- **305-572A MECHANICS OF ROBOTIC SYSTEMS I.** 3(3-0-6) (Prerequisites: 189-266 and 305-220 or permission of the instructor. Not open to students who have taken 305-573.) Manipulator hardware structure, planning and control. Rigid-body three-dimensional statics, kinematics and dynamics. Direct and inverse kinematics and dynamics. Trajectory planning. Manipulator control. In-depth study of serial manipulators. **Professor Angeles**

- **305-573B MECHANICS OF ROBOTIC SYSTEMS II.** 3(3-0-6) (Prerequisite: Permission of the instructor.) Numerical methods for
the kinematic inversion of serial manipulators. The handling of re-
dundancies and singularities. Kinematics and dynamics of parallel
manipulators, manipulator performance evaluation and optimiza-
tion, multiginger hand grasping and manipulation, robot compli-
ant and constrained motion. Obstacle avoidance.

Professor Angeles

② 305-576A COMPUTER GRAPHICS AND GEOM. MODELLING.
3(2-3-4) (Prerequisites: 189-266 and 305-290 or 305-291) Review of
pertinent linear algebra and projective geometry. Explicit, implic-
it and parametric polynomial forms. Splines: curves and surfaces.
Properties: curvature, twist, continuity. Ruled surfaces and other
quad patches. Constructive solid models; Octree/Voxel, sweep
wire frame, Boolean, boundary representation. Mechanical Engi-
neering applications.

Professor Zsombor-Murray

③ 305-577A OPTIMUM DESIGN. 3(2-3-4) The role of optimization
within the design process: Design methodology and philosophy.
Constrained optimization: The Kuhn-Tucker conditions. Tech-
niques of linear and non-linear programming. The simplex and
the complex methods. Sensitivity of the design to manufacturing
errors. Robustness of the design to manufacturing and operation
errors.

Professor Angeles

③ 305-578B ADVANCED THERMODYNAMICS. 3(3-0-6) Review of
classical mechanics; Boltzmann statistics, thermodynamics of
ideal gases; Fermi-Dirac and Bose-Einstein statistics, Gibbsian
ensembles; elementary kinetic theory of transport processes.
Boltzmann equation, Boltzmann H-theorem and entropy, KBG ap-
proximation, discussion on the solution of Boltzmann equation;
Maxwell transport equations, derivation of Navier Stokes equa-
tions.

Professor J. Lee

③ 305-581A NONLINEAR DYNAMICS AND CHAOS. 3(3-1-5) (Pre-
requisite: 305-319 or 305-315) Approximate solutions to nonlinear
dynamical systems: Lindstedt's, multiple-scale and averaging
techniques; centre manifold, normal form theorem; applications.
Transcitational, saddle-node, pitchfork, Hopf, period-doubling and
homoclinic bifurcations; fractal dimensions, Lyapunov exponents
and chaos. Applications to two-well potential oscillator, van der
Pol, Lorenz, fluid elastic systems.

Professor Paidoussis

GRADUATE 600-LEVEL COURSES

Generally, undergraduate students are not permitted to enrol in
graduate 600-level courses. However, in exceptional circumstanc-
es, the Faculty of Graduate Studies and Research does grant this
permission upon the request of the Department on behalf of the
student. A list of such courses is described in detail in the Faculty
of Graduate Studies and Research Calendar.

4.7 Department of Mining and Metallurgical
Engineering

Chair
George P. Demopoulos; Dipl. Eng.(NTU Athens), M.Sc.,
Ph.D.(McG.), Eng.

Emeritus Professors
William M. Williams; B.Sc., M.Sc.(Brist.), Ph.D.(Tor.), Eng. (Henry
Birks Emeritus Professor of Metallurgy)

Professors
George P. Demopoulos; Dipl. Eng.(NTU Athens), M.Sc.,
Ph.D.(McG.), Eng.
Robin A.L. Drew; B.Tech.(Bradford), Ph.D.(Newcastle)
James A. Finch; B.Sc.(Birm.), M.Eng., Ph.D.(McG.), Eng.
(Industry Professor of Mineral Processing)
John E. Gruzleski; B.Sc., M.Sc.(Qu.), Ph.D.(Tor.), Eng. (Gerald G.
Hatch Professor of Mining and Metallurgy)
Rod L. Guthrie; B.Sc., Ph.D.(Lond.), D.I.C., A.R.S.M., Eng.
(William C. MacDonald Professor of Mining and Metallurgy)
Farmanraz (Fern) P. Hassani; B.Sc., Ph.D.(Notit.), C.Eng.(I.U.K.
Reg.) (George Boyd Webster Professor of Mining Engineering)
(Henry Birks Professor of Metallurgy)

Associate Professors
Phil A. Distin; B.Sc., Ph.D.(Lond.), D.I.C.
Ralph Harris; B.Sc.(Qu), M.Eng., Ph.D.(McG.)
Mainul Hasan; B.Eng.(Dhaka), M.Sc.(Dhahran), Ph.D.(McG.)
André Laplante; B.A.Sc., M.A.Sc.(Montr.), Ph.D.(Tor.), Eng.
Hani S. Mitr; B.Sc.(Cairo), M.Eng., Ph.D.(McMaster), Eng.
(Director, Mining Engineering Program)
Jerzy Szpunar; B.Sc., M.Sc., Ph.D., D.Sc.(Kracow)
Steve Yue; B.Sc., Ph.D.(Leeds)

Assistant Professor
Janusz A. Kozinski; B.A., M.Eng., D.Sc.(Kracow)

Faculty Lecturer
John Mossop; B.Eng.(McG.), Eng.

Adjunct Professors
William Caley; Wilfred Comeau, Eng.; Roussou Dimitrakopoulos;
Bryn Harris; Ahmad Hemami; Hani Keira, Eng.; Yves Lizotte, Eng.;
Bibhu Mohanty; Malcolm J. Scoble, P.Eng.; Jozef Stachulak;
Gus Van Weert; Albert E. Wraith

Mining CO-OP Program Coordinator
Michel Vachon

The Department of Mining and Metallurgical Engineering offers
programs leading to the Bachelor of Engineering degree in Mining
Engineering or Metallurgical Engineering. The curriculum is dy-
namic and evolves along with new technology in both the mining
and metallurgical industries. In addition to regular courses and lab-
oratories, the curriculum includes seminars, colloquia, and student
projects reinforced by field trips to industrial operations.

The equipment operated by the Department is the best availa-
ble. On the metallurgical side there is a full range of laboratory
facilities for mineral processing, hydrometallurgy and high temper-
ature extractive process metallurgy as well as excellent materials
characterization and processing facilities. In mining engineering
the Department has rock engineering laboratories to test the
mechanical properties of both rock and backfill materials and
computer-aided mine design facilities. The Department houses
laboratories for two McGill Research Centres: the McGill Metals
Processing Centre (MMPC) and the Canadian Centre for Auto-
rution and Robotics in Mining (CCARM), which focus on R & D and
high technology applications for the minerals, metals and materi-
als industries at large.

Metallurgical Engineering (CO-OP). The Metallurgical Engi-
nering degree is a cooperative program leading to a B.Eng. and
includes formal industrial work periods. It is built around a strong
background of mathematics, basic sciences, computer skills and
applications, and specific engineering and design courses to pro-
vide up-to-date training in metals/materials engineering. Students
follow core courses covering a complete range of the industry,
from metal extraction to processing, fabrication and applications.
The program conforms with requirements of the Canadian Engi-
néeering Accreditation Board (CEAB) and is designed to offer stu-
dents the best training for employment in Canada's large and vital
metallurgical and manufacturing industries. The basic courses are
supplemented by complementary courses which provide a good
choice of specialties for the graduating engineer. The course struc-
ture is reinforced with laboratory exercises. Graduates in Metallur-
gical Engineering find employment in a wide range of industries
which include the mineral/metal producing and processing sec-
tors, as well as the aerospace and manufacturing industries. Stu-
dents in the CO-OP program benefit from the practical learning
experience arising from work-term employment in meaningful en-
gineering jobs. Students also benefit from the non-tangible learn-
ing experience arising from the increased responsibilities required
to obtain and successfully complete the work terms.

Mining Engineering (CO-OP). McGill, which has the oldest min-
ing engineering program in Canada, has always been noted for the
excellence of its courses and for the training it provides in mining
technology, mineral economics and mining practice. Graduates in
mining engineering are in demand not only in Canada but through-

McGill University, Undergraduate Programs 1999-2000
out the world. Technical developments have been rapid in recent years. These offer a challenge to the imaginative student with a strong engineering interest. The Department offers a cooperative program leading to the B.Eng. degree in Mining Engineering. The CO-OP program is offered in collaboration with the Department of Mineral Engineering at École Polytechnique in Montreal, and includes formal industrial work periods. Students registered at McGill are required to take a series of technical mining courses from École Polytechnique in the latter part of the program. These courses are designated as such in the listings below.

**Scholarships.** The Department offers Entrance Scholarships each year, valued at $2,500; these scholarships are renewable. A substantial number of other scholarships and bursaries are awarded by the Department as well as by the Canadian Mineral Industry Education Foundation.

**CURRICULUM FOR THE B.ENG. DEGREE IN METALLURGICAL ENGINEERING – CO-OP PROGRAM**

Students registered prior to September 1997 will follow the old program. For details consult with Professor Smith.

### REQUIRED COURSES

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>180-233B Selected Topics in Physical Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>189-260A,B Intermediate Calculus</td>
<td>3</td>
</tr>
<tr>
<td>189-261A,B Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>189-265A,B Advanced Calculus</td>
<td>3</td>
</tr>
<tr>
<td>302-205A,B Statics</td>
<td>3</td>
</tr>
<tr>
<td>303-207A,B Solid Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>303-208A,B Computers in Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

### Departmental Courses

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDITS</th>
</tr>
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<tbody>
<tr>
<td>306-202A Skills for Communicating as an Engineer</td>
<td>2</td>
</tr>
<tr>
<td>306-209B Mathematical Applications</td>
<td>3</td>
</tr>
<tr>
<td>306-212B Engineering Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>306-221A,B Engineering Professional Practice</td>
<td>1</td>
</tr>
<tr>
<td>306-250A Introduction to Extraction Metallurgy</td>
<td>3</td>
</tr>
<tr>
<td>306-260A,B Materials Science and Engineering</td>
<td>3</td>
</tr>
<tr>
<td>306-280T Industrial Training I</td>
<td>2</td>
</tr>
<tr>
<td>306-310A,B Engineering Economy</td>
<td>3</td>
</tr>
<tr>
<td>306-311T Modelling and Automatic Control</td>
<td>3</td>
</tr>
<tr>
<td>306-317A Materials Characterization</td>
<td>3</td>
</tr>
<tr>
<td>306-341B Introduction to Mineral Processing</td>
<td>3</td>
</tr>
<tr>
<td>306-342A Electrotechnology for Mining, Metallurgical and Materials Engineers</td>
<td>3</td>
</tr>
<tr>
<td>306-350B,C Extractive Metallurgical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>306-352A Hydrochemical Processing</td>
<td>3</td>
</tr>
<tr>
<td>306-354C Process Engineering Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>306-355C Heat, Mass and Fluid Flow</td>
<td>3</td>
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<tr>
<td>306-360A Phase Transformations in Solids</td>
<td>3</td>
</tr>
<tr>
<td>306-361A Liquid State Processing of Materials</td>
<td>3</td>
</tr>
<tr>
<td>306-362B Engineering Materials</td>
<td>3</td>
</tr>
<tr>
<td>306-380B Industrial Training II</td>
<td>2</td>
</tr>
<tr>
<td>306-410A,B Research Project</td>
<td>3</td>
</tr>
<tr>
<td>306-412C Corrosion and Degradation</td>
<td>3</td>
</tr>
<tr>
<td>306-442A Modelling in Metal Processing</td>
<td>3</td>
</tr>
<tr>
<td>306-450B Process Design</td>
<td>3</td>
</tr>
<tr>
<td>306-455A,B Advanced Process Engineering</td>
<td>3</td>
</tr>
<tr>
<td>306-463B Deformation Processing of Materials</td>
<td>3</td>
</tr>
<tr>
<td>306-465A Ceramic Engineering</td>
<td>3</td>
</tr>
<tr>
<td>306-480T Industrial Training III</td>
<td>2</td>
</tr>
<tr>
<td>306-481A Industrial Training IV</td>
<td>2</td>
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</table>

### COMPLEMENTARY COURSES

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>302-481A Polymer Engineering</td>
<td>3</td>
</tr>
<tr>
<td>306-351B Non-Ferrous Extractive Metallurgy</td>
<td>3</td>
</tr>
<tr>
<td>306-367B Electronic Properties of Materials</td>
<td>3</td>
</tr>
<tr>
<td>306-451A Environmental Controls</td>
<td>3</td>
</tr>
<tr>
<td>306-456B Steelmaking and Steel Processing</td>
<td>3</td>
</tr>
<tr>
<td>306-457B Light Metals Extraction</td>
<td>3</td>
</tr>
<tr>
<td>306-515A Advanced Metallurgical and Materials Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>306-544A Mineral Processing Systems I</td>
<td>3</td>
</tr>
<tr>
<td>306-545B Mineral Processing Systems II</td>
<td>3</td>
</tr>
<tr>
<td>306-551B Electrochemical Processing</td>
<td>3</td>
</tr>
<tr>
<td>306-555A Thermal Remediation of Wastes</td>
<td>3</td>
</tr>
<tr>
<td>306-561A Materials Design and Selection</td>
<td>3</td>
</tr>
<tr>
<td>306-563A Hot Deformation of Metals</td>
<td>3</td>
</tr>
<tr>
<td>306-564B X-ray Diffraction Analysis of Materials</td>
<td>3</td>
</tr>
<tr>
<td>306-566A Texture, Structure and Properties of Polycrystalline Materials</td>
<td>3</td>
</tr>
<tr>
<td>306-567B Aluminum Casting Alloys</td>
<td>3</td>
</tr>
<tr>
<td>306-569B Electron Beam Analysis of Materials</td>
<td>3</td>
</tr>
</tbody>
</table>

### Social Sciences and Humanities Courses

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>189-265A,B Advanced Calculus</td>
<td>3</td>
</tr>
<tr>
<td>189-261A,B Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>189-260A,B Intermediate Calculus</td>
<td>3</td>
</tr>
<tr>
<td>186-225A Properties of Minerals</td>
<td>1</td>
</tr>
<tr>
<td>303-205A,B Statics</td>
<td>3</td>
</tr>
<tr>
<td>303-207A,B Solid Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>305-290A Graphics</td>
<td>3</td>
</tr>
<tr>
<td>308-208A,B Computers in Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

### TOTAL CREDITS

116

Advanced credit is given for 189-260 Intermediate Calculus upon successful completion of a placement test (see section 2.3 on page 219).

A fee of $500 is assessed by the University for each Industrial Training course.

**CURRICULUM FOR THE B.ENG. DEGREE IN MINING ENGINEERING – CO-OP PROGRAM**

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDITS</th>
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</thead>
<tbody>
<tr>
<td>186-221A General Geology</td>
<td>3</td>
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<tr>
<td>186-225A Properties of Minerals</td>
<td>1</td>
</tr>
<tr>
<td>189-260A,B Intermediate Calculus</td>
<td>3</td>
</tr>
<tr>
<td>189-261A,B Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>189-265A,B Advanced Calculus</td>
<td>3</td>
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<tr>
<td>303-205A,B Statics</td>
<td>3</td>
</tr>
<tr>
<td>303-207A,B Solid Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>305-290A Graphics</td>
<td>3</td>
</tr>
<tr>
<td>308-208A,B Computers in Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

### Departmental Mining Courses

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CREDITS</th>
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</thead>
<tbody>
<tr>
<td>306-200A Mining Technology</td>
<td>3</td>
</tr>
<tr>
<td>306-202A Skills for Communicating as an Engineer</td>
<td>2</td>
</tr>
<tr>
<td>306-203C Mine Surveying</td>
<td>2</td>
</tr>
<tr>
<td>306-209B Mathematical Applications</td>
<td>3</td>
</tr>
<tr>
<td>306-221A,B Engineering Professional Practice</td>
<td>1</td>
</tr>
<tr>
<td>306-260A,B Materials Science and Engineering</td>
<td>3</td>
</tr>
<tr>
<td>306-290T Industrial Work Period I</td>
<td>2</td>
</tr>
<tr>
<td>306-291T Industrial Work Period II</td>
<td>2</td>
</tr>
<tr>
<td>306-310A,B Engineering Economy</td>
<td>3</td>
</tr>
<tr>
<td>306-322B Rock Fragmentation</td>
<td>3</td>
</tr>
<tr>
<td>306-323B Rock and Soil Mass Characterization</td>
<td>3</td>
</tr>
<tr>
<td>306-324B Electrotechnology for Mining, Metallurgical and Materials Engineers</td>
<td>3</td>
</tr>
<tr>
<td>306-325A Mineral Industry Economics</td>
<td>3</td>
</tr>
<tr>
<td>306-333B Materials Handling</td>
<td>3</td>
</tr>
<tr>
<td>306-340A Applied Fluid Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>306-341B Introduction to Mineral Processing</td>
<td>3</td>
</tr>
<tr>
<td>306-392B Industrial Work Period III</td>
<td>2</td>
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<tr>
<td>306-419C or T Surface Mining</td>
<td>3</td>
</tr>
<tr>
<td>306-420B Feasibility Study</td>
<td>3</td>
</tr>
<tr>
<td>306-426C or T Development and Services</td>
<td>3</td>
</tr>
<tr>
<td>306-484A,B,T Mining Project</td>
<td>3</td>
</tr>
<tr>
<td>306-494A,B,T Industrial Work Period IV</td>
<td>2</td>
</tr>
</tbody>
</table>

### TOTAL CREDITS

58
École Polytechnique Mining Courses

309-320A CAO et informatique pour les mines 3
309-321B Mécanique des roches et contrôle des terrains 3
309-326A Recherche opérationnelle minière I 3
309-328C or T Environnement minier 3
309-329A Géologie minière 2
309-330A Mécanique des matériaux meubles 3
309-421C or T Exploitation en souterrain 3
309-422A Ventilation minière 3

COMPLEMENTARY COURSES

Technical Courses 6
Two courses selected from those listed below or, 6 credits of any other approved technical course(s).

306-302B Extraction of Energy Resources 3
306-442B Modelling in Mineral Processing 3
306-520B Stability of Rock Slopes 3
306-521C or T Stability of Underground Openings 3
306-524B Mineral Resource Economics 3
306-526A,B 3 Mineral Economics
306-528B 3 Mining Automation
306-545B 3 Mineral Processing Systems II
309-327A,B 3 Hydrgéologie appliquée

Social Sciences and Humanities Courses 6
See section 3.3 on page 220.

TOTAL 119

Advanced credit is given for 189-260 Intermediate Calculus upon successful completion of a placement test (see section 2.3 on page 219).

A fee of $250 is assessed by the University for each Industrial Work Course.

Student Advising

Students entering the Mining or Metallurgical Engineering programs must plan their schedule of studies in consultation with one of the departmental advisors: Professor A.R. Laplante (Metallurgy) or Mr. J. Mossop (Mining).

COURSES OFFERED BY THE DEPARTMENT

● Denotes courses not offered in 1999-2000
⊙ Complementary Courses

Courses offered by the Department have been numbered to conform with the following classification system. The first three digits (i.e. 306) represent the departmental code. The next digit is the level of instruction. The last two digits are classified as follows:

00 to 19 3 Common foundation courses
20 to 39 3 Mining courses
40 to 49 3 Mineral processing courses
50 to 59 3 Extractive and process metallurgy courses
60 to 69 3 Materials engineering courses
80 to 99 3 Co-op work terms

DEPARTMENTAL METALLURGY COURSES

Courses associated with the CO-OP program in Mining Engineering are listed separately following this section.

306-202A SKILLS FOR COMMUNICATING AS AN ENGINEER. 2(1-2-3)
Basic forms of engineering communication: memoranda, executive summaries, letters, proposals, evaluations, oral presentations and presentation graphics, email, groupware, workflow, internet, graphics and presentation tools. Adaptation into engineering. Short assignments and oral presentations.

306-209B MATHEMATICAL APPLICATIONS. 3(3-2-4)

Professor Hasan

306-212B ENGINEERING THERMODYNAMICS. 3(3-1-5)

Professor Kozinski

306-221A,B ENGINEERING PROFESSIONAL PRACTICE. 1(1-0-2)
Professional practice and ethics, professional liability, occupational health and safety, environmental responsibility. University Code of Student Rights and Responsibilities.

Staff

306-250A INTRODUCTION TO EXTRACTION METALLURGY. 3(2-3-4)
Raw materials, processes and products of metallurgical operations. Mineral processing: comminution including size classification, separation of minerals with emphasis on flotation, waste disposal, extractive metallurgy: roasting, smelting, refining, hydrometallurgy, environmental protection.

Staff

306-260A,MATERIALS SCIENCE AND ENGINEERING. 3(2-2-5)
Structure properties and fabrication of metals, polymers, ceramics, composites; engineering properties: tensile, fracture, creep, oxidation, corrosion, friction, wear; fabrication and joining methods; principles of materials selection.

Professors Drew and Jonas


Professor Gruzleski

306-308A SOCIAL & ECONOMIC IMPACTS OF TECHNOLOGY. 3(3-0-6)
(Enrolment encouraged by students outside the Faculty of Engineering.) Critical examination of the socio-economic costs and benefits of technology, case studies of old engineering works and new technologies. The integration of applied ethics and engineering practice, analysis of basic concepts of technology assessment, the inter-connected processes of risk assessment, management, and communication.

Professor Finch

306-310A,B ENGINEERING ECONOMY. 3(3-1-5)
Introduction to the basic concepts required for the economic assessment of engineering projects. Topics include: accounting methods, marginal analysis, cash flow and time value of money, tax management, and benefits of technology, case studies of old engineering works and new investment opportunities.

Professors Bilodeau and Laplante

306-311T MODELLING AND AUTOMATIC CONTROL. 3(3-2-4)
(Prerequisite: 308-208A,B) Mass and energy conservation laws. Dynamic versus steady state models, dynamic behaviour of first and higher order metallurgical systems, linear and nonlinear models, interacting and noninteracting systems. Laplace domain dynamics and transfer functions, Feedback control, control valves and controllers, transducers. Feedback-feedforward control, introduction to cascade, adaptive and statistical control strategies. Digital computer control, instruments and interfaces.

Professor Hasan

306-317A MATERIALS CHARACTERIZATION. 3(2-3-4)
(Prerequisite: 306-260A,B) Bulk, surface and microanalytical techniques for materials characterization. Bulk analysis: spectrophotometry using UV, visible, flame and atomic absorption, x-ray diffraction and x-ray fluorescence. Surface and microanalysis: infrared spectroscopy, scanning and transmission electron microscopy, Auger electron and x-ray photoelectron spectroscopy.

Professors Szpunar, Kozinski and Yue

306-341B INTRODUCTION TO MINERAL PROCESSING. 3(2-3-4)
(Prerequisite: 306-250A) Theory and practice of unit operations including: size reduction-crushing and grinding; size separation-screening and classification; mineral separation-floatation, magnetic and gravity separation. Equipment and circuit design and selection. Mass balancing. Laboratory procedures: grindability,
liberation, magnetic and gravity separation, flotation, and solid-liquid separation.  

Professor Finch

306-350B EXTRACTIVE METALLURGICAL ENGINEERING. 3(2-3-4)  

Professor Harris

306-351B NON-FERROUS EXTRACTIVE METALLURGY. 3(2-3-4)  
(Prerequisite: 306-350B) Extractive metallurgy of the common non-ferrous metals - copper, nickel, lead, zinc and aluminum. The production of these metals is analyzed in terms of the unit operations and the chemistry of the major commercial processes applied. The metallurgy of less-common metals is also briefly described.  

Professor Distin

306-352A HYDROCHEMICAL PROCESSING. 3(3-2-4)  
(Prerequisites: 180-233B, 306-212B, 306-250A) Corequisite: 306-355A) Analysis and description of dissolution (leaching), solute separation (solvent extraction, ion exchange, carbon adsorption) and deposition operations (precipitation, crystallization, electrolysis) in addition to reaction media as these apply to: (i) the hydrometallurgical extraction of metals from primary/secondary sources; (ii) the treatment of effluents and (iii) the production of inorganic materials.  

Professor Distin

306-354C PROCESS ENGINEERING LABORATORY. 2(0-3-3)  
(Prerequisite: 306-355A) A series of laboratory exercises which cover various transfer phenomena encountered in metallurgical and materials processing including mass transfer in aqueous and high temperature systems, laminar and turbulent flow characteristics, particle and bubble motion in liquids, mixing and settling.  

Professors Distin, Harris and Guthrie

306-355C HEAT, MASS AND FLUID FLOW. 3(3-3-3)  

Professor Guthrie

306-360A PHASE TRANSFORMATIONS IN SOLIDS. 3(2-3-4)  
(Prerequisites: 306-212B and 306-260A,B, 180-233B) Free energy (equilibrium) and kinetic (non-equilibrium) considerations, phase diagrams and TT diagram, solid state diffusion, diffusional (nucleation and growth) and shear (martensitic) transformations.  

Professor Yue

306-361A LIQUID STATE PROCESSING OF MATERIALS. 3(2-3-4)  
(Prerequisites: 306-260A,B, 306-360A) Liquid-solid phase transformation in material processing. Topics covered include: casting techniques, nucleation and grain refining, freezing of pure materials, alloy freezing, solute redistribution, segregation, constitutional undercooling, solidification microstructures, ingot structures, gases in liquid metals, liquid metal cleansing, modification of phase morphology.  

Professor Yue

306-362B ENGINEERING MATERIALS. 3(2-3-4)  

Professor Szpunar

306-367B ELECTRONIC PROPERTIES OF MATERIALS. 3(3-3-3)  

Professor Szpunar

306-380B INDUSTRIAL TRAINING II. 2 Four-month work period in industry. Technical report required upon completion.  

Staff

306-410A,B RESEARCH PROJECT. 3(0-6-3)  
(Prerequisite: Recommendation of Instructor.) A research project will be carried out, usually in groups, under the guidance of a staff member. A technical report will be prepared at the end and formal presentation will be made on the research topic.  

Professor Szpunar and Staff

306-412C CORROSION AND DEGRADATION. 3(2-3-4)  

Professor Distin

306-442A MODELLING IN MINERAL PROCESSING. 3(2-3-4)  
(Prerequisite: 306-341B) Basic kinetic modelling; perfect mixers, plug-flow, zero and first-order kinetics, residence time distributions. Grinding: breakage and selection functions. Overview of the modelling of flotation and gravity separation. Introduction to control: economic incentives, basic PI control, applications to grinding and flotation circuits.  

Professor Laplante

306-450B PROCESS DESIGN. 3(3-0-6)  
(Prerequisites: 306-350B, 306-355A) Design of new metallurgical plants, processes and products based on knowledge acquired in previous core courses. Material and heat balances, material economics, design and optimization.  

Professor Mucciardi

306-451A ENVIRONMENTAL CONTROLS. 3(3-2-4)  
(Prerequisite: 306-352A) A survey of the mineral/metallurgical industries from the standpoint of environmental impact and control. Characterization of gaseous, aqueous and solid wastes. Their effects on the ecosystem and government regulations. Methods of control: Particulate collection and detoxification of gaseous streams; Aqueous effluent treatment techniques; Disposal of solid wastes and their stability/containment.  

Professors Demopoulos, Finch and Kozinski

306-455A,B ADVANCED PROCESS ENGINEERING. 3(3-1-5)  

Professor Mucciardi

306-456B STEELMAKING & STEEL PROCESSING. 3(2-2-5)  
(Prerequisites: 306-455A, 306-360A) The production and refining of liquid iron in the iron blast furnace, the production and refining of liquid steel, secondary refining operations, continuous casting and thermomechanical processing (hot rolling). Specialty steels and newly emerging technologies (e.g. thin slab casting, direct ironmaking) are also discussed in terms of process/environment and productivity. “Downstream” topics will include cold rolling, batch and continuous annealing, and coating operations.  

Professors Guthrie and Jonas

306-457B LIGHT METALS EXTRACTION. 3(2-0-7)  
(Prerequisites: 306-350B, 306-352A) Physicochemical, kinetic and economic
aspects of light metals extraction, refining and finishing for market- ing. Alumina production, aluminum electrolysis, carbon technol- ogy, alloying and casting, magnesium smelting and electrolysis, strontium, lithium, sodium extraction.

Professor Harris

306-463A DEFORMATION PROCESSING OF METALS. 3(3-3-3) (Prerequisite: 306-362A) Basic plasticity theory (yield criteria, plastic stress/strain relationships, etc.); friction and lubrication; analysis of simple forming operations, e.g. rolling of flat products. Workability; concept and measurement; effect of process variables, material properties and microstructure. Effect of hot and cold processing on microstructure and properties technology and equipment; computer-aided design of deformation processing. Professor Jonas


306-480T INDUSTRIAL TRAINING III. (2) Four-month work period in industry. Technical report and seminar required upon completion. Professor Gruzleski

306-481A INDUSTRIAL TRAINING IV. (2) Four-month work period in industry. Technical report and seminar required upon completion. Professor Gruzleski

© 306-515A ADVANCED METALLURGICAL & MATERIALS THERMODYNAMICS. 3(2-2-5) (Prerequisite: 306-212B) Computational thermodynamics including phase diagram estimation. Gibbs energy minimization, solution modelling are considered in view of the Fa- cility of Chemical Thermodynamics (F*A*C*T) computer database. Students undertake projects developed in consultation with the in- structor and prepare verbal and written reports.

Metallurgical Staff

© 306-544A MINERAL PROCESSING SYSTEMS I. 3(2-3-4) (Prereq- uisite: 306-341B) The course covers three main topics: principles of separation, including data presentation, properties of recovery/ yield plots, technical and economic efficiency and identification of limits to separation; column flotation, hydrometallurgy of collection and froth zones, mixing, scale-up and design, measurements and control; surface and electrochemistry, including absorption, sur- face charge, coagulation, electron transfer reactions, electrochem- istry in plant practice. Professor Finch


© 306-551B ELECTROCHEMICAL PROCESSING. 3(3-2-4) (Prereq- uisite: 306-352B) Characterization of aqueous, fused salt and solid electrolytes; laws of electrolysis; ion transport mechanisms; inter- facial phenomena (electrolyte-electrolyte, electrode-electrolyte); reversible cells and potentials; electrode kinetics, overpotential and potential-current laws; industrial applications; electrolytic win- ning and refining, electropolishing, surface treatment and coating, electrodiffusion and electrochemical sensors. Professor Demopoulos


Professor Kozinski

© 306-561A MATERIALS DESIGN AND SELECTION. 3(0-4-5) (Prerequisite: 306-362A or equivalent) Advanced topics in materials design problems. Discussion and laboratory work, supplemented by detailed technical reports. Special attention is given to selec- tion, design and failure problems in various materials systems. Professors Drew, Gruzleski and Yue


Professor Yue

© 306-564B X-RAY DIFFRACTION ANALYSIS OF MATERIALS. 3(2-3-4) (Prerequisite: 306-317A) The techniques of X-ray and neutron diffraction are discussed as applied to the minerals and materials production industries. Special emphasis is placed upon automated X-ray powder diffractometry as employed for determin- ing the structure and composition of materials. The application of X-ray techniques to studies of crystal structure, crystal orientation, residual stress, short-range order in liquid metals, phase diagram determination, order-disorder transformation and chemical analy- sis are presented. Professor Szpunar

© 306-566A TEXTURE, STRUCTURE & PROPERTIES OF POLYCRYSTALLINE MATERIALS. 3(2-3-4) (Prerequisite: 306-317A) Concepts and quantitative methods for the description of the structure of minerals and materials are discussed. Special emphasis is placed on experimental techniques of texture measurement. Procedures are demonstrated for the control of deformation and recrystalliza- tion textures in order to obtain the properties required of industrial products. Finally, the correlation between texture and the anisotro- py of elastic, plastic and magnetic properties of engineering mate- rials is described and analyzed. Professor Szpunar

© 306-567B ALUMINUM CASTING ALLOYS. 3(3-0-6) (Prerequisite: 306-361B or equivalent) The family of aluminum foundry alloys; al- loy systems, intermetallic phases and their formation, heat treat- ment processes, mechanical and physical properties of aluminum casting alloys, foundry properties, eutectic modification, porosity forma- tion, gassing and degassing, refinement of hypereutectic alloys, grain refinement, filtration; non destructive control of micro- structure. Professor Gruzleski

© 306-569B ELECTRON BEAM ANALYSIS OF MATERIALS. 3(2-3-4) (Prerequisite: 306-317A) Emphasis on operation of scanning and transmission electron microscopes. Topics covered are elec- tron/specimen interactions, hardware description; image contrast description; qualitative and quantitative (ZAF) X-ray analysis; electron diffraction pattern analysis. Professor Yue

DEPARTMENTAL MINING COURSES

306-200A MINING TECHNOLOGY. 3(3-3-3) Economic importance of the mining industry. Definition of a mining venture, and responsi- bilities of the mining engineer. Relevant legislation, regulations, and professional organizations. Criteria for exploiting an ore de- posit. Surface and underground mining methods: preliminary se- lection procedure. Mining methods and mining equipment. Ethics and professionalism in the practice of engineering. Mr. Mossop

306-203C MINE SURVEYING. 2 (Prerequisite: 306-200 or permis- sion of instructor) A two-week field school with laboratories and assignments. The role of the mine surveyor. Techniques and in- strumentation for measurement of levels, angles and distances. Shaft, raise, drift and stope surveying techniques. Graphical pres- entation of survey data and computer applications. Monitoring techniques for mining excavations with deformation and displace- ment measurements. Dr. MomayeZ and Mr. Vachon
306-290T Industrial Work Period I. 2 (Prerequisites: 306-200 or 306-203) A four-month work period in the mineral industry, to expose the student to an industrial environment. Candidates will receive basic industrial training. A complete report must be submitted at the end of the term.

306-291T Industrial Work Period II. 2 (Prerequisite: 306-290) A four-month industrial work period in a mining company, research laboratory or government agency. The student will receive formal industrial training in a technical position. A complete report must be submitted at the end of the term.

306-320B Extraction of Energy Resources. 3(3-0-6) The extraction of energy resources, i.e., coal, gas, oil and tar sands. After a brief geological review, different extraction techniques for these substances will be discussed. Emphasis on problems such as northern mining and offshore oil extraction with reference to Canadian operations. Transportation and marketing.


306-323B Rock and Soil Mass Characterization. 3(3-3-3) (Prerequisites: 186-221 and 306-200) Characteristics of soil and rock masses and the stability of mine workings. Mechanical properties of rocks and soils related to physical/chemical properties. Characterization of rock mass discontinuities. Laboratory and in-situ techniques to define mechanical properties of soils, rocks and discontinuities. Permeability and groundwater flow principles. In-situ stresses and their measurement. Rock mass quality and classification systems.

306-324B Electrotechnology for Mining, Metallurgical & Materials Engineers. 3(3-3-3) (Prerequisites: 189-261 and 189-265) AC theory including vector and complex number representation of sinusoidal currents, voltages and impedances. Effect of frequency on LCR circuit outputs. Logic circuits including two-state logic and logic components, logic ports and toggles, Boolean algebra, and complex circuits. Microprocessors including organization, logic, programming, and microcomputers. Data acquisition including sensors, noise, A/D and D/A converters, and programming. Operational amplifiers. Applications to systems control.

306-325A Mineral Industry Economics. 3(3-1-5) (Prerequisite: 306-310) Geographical distribution of mineral resources. Production, consumption and prices of minerals. Market structure of selected minerals. Economic evaluation aspects: grade-tonnage considerations; capital and operating cost estimation; assessment of market conditions; estimation of revenue; taxation; sensitivity and risk analyses; economic optimization of mine development and extraction.


306-392B Industrial Work Period III. 2 (Prerequisite: 75 credits including 306-291) A four-month industrial work period in a mining company, research laboratory or government agency. Based on the experience gained during the first two work periods, the student may be asked to undertake more challenging technical tasks. A complete report must be submitted at the end of the term.


306-420B Feasibility Study. 3(1-2-6) (Prerequisites: 306-419, 306-426 and 309-421) This course consists of a case study exercise in the application of the specialist skills which the student has developed in the mining engineering program. The objective is to combine these skills in carrying out a professional appraisal of the technical feasibility and economic viability of developing a mineral deposit. Students are required to prepare a professional level report and present seminars on particular aspects of the feasibility analysis.

306-426C or T Development and Services. 3(3-3-3) (Prerequisite: 306-324 and 306-333) Selection and design of the facilities required to start production at both surface and underground mines, based on design criteria dictated by mining plans, geography, geology and government regulations. Scheduling of development and construction. Staffing and health and safety considerations during development, construction and operations.

306-448A,B,T Mining Project. 3(0-0-9) (Corequisites: 306-419, 306-426, 306-429 and 309-421) A mining research project to be completed during one semester. The project must be approved by an academic advisor. A comprehensive report and a seminar presentation are required for the project.


306-520B Stability of Rock Slopes. 3(3-0-6) (Prerequisite: permission of instructor.) The properties of rock masses and of structural discontinuities. Influence of geological structure on stability. Linear, non-linear, and wedge failures. Site investigations. Methods of slope stabilization.

306-521C or T Stability of Underground Openings. 3(3-3-3) (Prerequisite: permission of instructor.) The properties of rock masses and stability classification systems. The influence and properties of geological structural features. Stability related to the design of underground openings and mining systems. Site investigations. Methods of stabilization.

306-524B Mineral Resource Economics. 3(3-0-6) (Prerequisite: 306-310 or equivalent, or permission of instructor.) Analysis of significant factors affecting mineral supply, including oil and gas. Role of governments, concept of economic rent and determinants of a mineral policy. Objectives, strategies and concerns of mining and oil and gas companies. International resource environment, commodity associations, mineral investment and trade patterns.

306-526A,B Mineral Economics. 3(3-1-5) (Prerequisite: 306-310 or equivalent) Mineral project evaluation techniques and applications. Topics covered include grade-tonnage relationships, capital and operating cost estimation techniques, assessment of mineral market conditions, taxation, discounted cash flow analysis, risk analysis, and optimization of project specifications with re-
spect to capacity and cutoff grade. (This course is given only once per academic year.)

Professor Bilodeau

306-528B MINING AUTOMATION. 3(3-3-3) (Prerequisite: 306-426) System analysis and design in the frequency domain. Review of optimization methods. Mining system modelling applied to rock cutting, materials transport, and bunkerage, pitch, yaw and roll steering of mining machines. Control and robotics: digitization, discrete systems, sensors, actuators and real time algorithms. Data communication in mines. Simulation exercises. Dr. Momayez

COURSES OFFERED BY ÉCOLE POLYTECHNIQUE

309-320A CAO ET INFORMATIQUE POUR LES MINES. 3(2-3-4) (Prerequisite: 306-200 and 308-208) Présentation de techniques informatiques et de logiciels permettant d’appliquer l’informatique dans le cadre des diverses opérations reliées à l’exploitation des mines. Utilisation de logiciels de support: chiffrier électronique, traitement de texte, éditeur graphique, utilitaires de DOS. Utilisation de graphisme, de traceurs à plumes, de tablettes numérantes, d’interfaces pour capteurs analogique/numérique et numérique/analogique. Notions de géométrie descriptive appliquées à des problèmes miniers. Professor Aubertin

309-321B MÉCANIQUE DES ROCHES ET CONTRÔLE DES TERRAINS. 3(3-3-3) (Prerequisite: 306-323) Pressions de terrains au pourtour des excavations: solutions analytiques et numériques. Stabilité des excavations souterraines et à ciel ouvert: analyse des instabilités structurelles par projection stéréographique méridienne, analyse des instabilités causées par les excès de contraintes. Soutènement. Surveillance. Études de cas. Professor Aubertin


309-328C OR T ENVIRONNEMENT MINIER. 3(3-3-3) (Prerequisite: 306-200 and 306-291) Effets du milieu d’exploitation sur le travail d’homme (hygiène du travail): législation; contraintes thermiques, problèmes de bruit, de contaminants gazeux et de poussières; techniques de mesures. Effets de l’exploitation d’une mine sur le milieu (environnement et écologie); législation; études d’impact; effets miniers: origine, nature et traitement des effluents: entreposage des résidus; restauration des sites. Professors Aubertin and Simon

309-329A GÉOLOGIE MINIÈRE. 3(2-2-2) (Prerequisite: 186-221, 306-200 and 306-209) Méthodes de cartographie minière, de sondages et d’échantillonnage. Notion de teneur de coupure, calcul des réserves par les méthodes conventionnelles. Évaluation des réserves par les méthodes géostatistiques. Professor Marcotte

4.8 School of Urban Planning

Director and Professor

Jeanne M. Wolfe; B.Sc.(Lond.); M.Sc.(W.Ont.); M.A.(McG.)

Professors

Ronald G. Rice; B.A.Sc.(Tor.); S.M.(MIT); Dipl.U.A.R.P.(Tor.); Ph.D.(Tor.); P.Eng.

Jane M. Glenn; B.A.; LL.B.(Qu.); D. en Droit(Stras.)

Associate Professor

David F. Brown; B.A.(Bishop's); M.U.P.(McG.); Ph.D.(Sheffield)

Assistant Professor

Raphaël Fischer; B.Eng.(Eindhoven); M.Sc.; M.C.P(MIT); Ph.D.(U.C. Berkeley)

Gordon O. Ewing; M.A.(Glass.); M.A.; Ph.D.(McG)

Polio Polèse; B.A.(CUNY); M.A.; Ph.D.(Penn)

Instructor

Pierre Gauthier; B.Arch.(Montr.); M.Arch.(Laval)

Guest Lecturers

Cameron Charlebois, Luc Danielsen, Marc Denhez, David Farley, Andrew Hoffmann, Peter Jacobs, Brenda Lee, Damaris Rose, Lloyd Sankey, Martin Wexler

Modern urban planning developed into a profession in the early decades of the twentieth century, largely as a response to the appalling sanitary, social and economic conditions of rapidly developing industrial cities. Initially the disciplines of architecture, civil engineering and public health provided the nucleus of concerned professionals; beautification schemes and infrastructure works marked the early stages of public intervention in the nineteenth century. Architects, engineers and public health specialists were joined by economists, sociologists, lawyers and geographers as the complexities of the city’s problems came to be more fully understood and public pressure mounted for their solution. Contemporary urban and regional planning techniques for survey, analysis, design and implementation developed from an interdisciplinary synthesis of these various fields.

Today, urban planning can be described as the collective management of urban development. It is concerned with the welfare of communities, control of the use of land, design of the built environment, including transportation and communication networks, and protection and enhancement of the natural environment. It is at once a technical and a political process which brings together actors from the public, private and community spheres. Planners participate in that process in a variety of ways, as designers and analysts, advocates and mediators.

McGill University was the first institution in Canada to offer a full-time planning program. An inter-disciplinary program was established in 1947, in which students combined a master’s degree in Urban Planning with one in a related field. An autonomous pro-
With professional experience in the selected subject matter.

The course of planning varies from semester to semester. The course matter, geographic area, scale of intervention and institutional location are applicable in diverse professional planning contexts. The subject matter exposes students to issues and techniques that are specific to the course.

303-433B URBAN PLANNING I.

Professor Wolfe

1. The program was established in 1972. It became the School of Urban Planning in 1976.

Students come to the School from diverse backgrounds, the physical sciences, the traditional professions, such as architecture and engineering, and the social sciences. Alumni of the School work as planners and designers at various levels of government, in non-profit organizations and with private consulting firms. Their expertise ranges from historic preservation to traffic management, from housing development to computer imaging. They devote their efforts in increasing numbers to environmental planning and sustainable development.

The School is a partner in the Montreal Interuniversity Group "Urbanization and Development", a consortium recognized by CIDA as a Centre of Excellence, which is devoted to the study of urban problems and the formulation of policies in developing regions. Faculty and students collaborate actively with members of other McGill departments, notably Architecture, Geography, Civil Engineering and Law, and with colleagues at other institutions in Canada and abroad.

The objective of the School is to produce qualified professional urban planners for the public and the private sectors. Training is provided at the post-graduate level; the degree offered is the Master of Urban Planning (M.U.P.). Upon completion of the two-year program of studies, graduates are expected to have acquired basic planning skills, a broad understanding of urban issues, and specialized knowledge in a field of their own choice. (The School also accepts a limited number of Ad-Hoc Ph.D. students.)

The program of study offered by the School is fully recognized by the Ordre des Urbanistes du Québec (O.U.Q.) and the Canadian Institute of Planners (C.I.P.). Graduates can become full members of these professional organizations after meeting their internship requirements.

For details of the M.U.P. admission requirements and curriculum, consult the Faculty of Graduate Studies Calendar.

5 Minor Programs and Choice of Electives or Complementary Courses

Students of the Faculty have a considerable variety of complementary course choices, which fall into the categories of technical and complementary studies. Students should refer to their respective departments for information concerning complementary course selections. Departments also publish in this Calendar and in separate documents, information regarding the choice of courses. Students should also consult their course advisers. Some general information applicable to all students of the Faculty is given below. This mainly covers the areas of materials engineering, management, biotechnology, economics, mathematics, arts, environmental engineering, computer science and chemistry.

5.1 Arts Minor

Engineering students may obtain a Minor in Arts as part of their B.Eng. degree by satisfying the 24-credit requirement described below. In general, complementary studies courses given in the Faculty of Arts and listed under: (i) "3 credits of studies of the Impact of Technology on Society" and (ii) "the remaining credits to be elective social science and humanities courses" (see section 3.3), may be used to satisfy some of these requirements. In no case will more than 9 credits taken from these complementary studies courses be used. Students should also consult their course advisers. Some general information applicable to all students of the Faculty is given below. This mainly covers the areas of materials engineering, management, biotechnology, economics, mathematics, arts, environmental engineering, computer science and chemistry.

Requirements

1. The program must consist of 24 credits as follows:
   a) at least two areas of concentration from within the Faculty of Arts must be chosen, with the minimum number of credits in any one area being 6,
   b) at least 12 credits must be at the 300 or above level.

2. All courses in the Minor program must be passed with a grade of C or better.

490-604A LAND USE PLANNING LAW. (3) A comparative study of private and public control of land use and development, involving master plans, zoning bylaws, subdivision control, urban re-development, expropriation, and regional planning.

Professor J.M. Glenn
3. The selection of courses for the Minor is to be done in consultation with the Minor Advisor, Ms. Judy Pharo, ENGMD 378.

For further information, please contact Prof. B. Haskel, Political Science, or Ms. J. Pharo, Faculty of Engineering, ENGMD 378.

5.2 Biotechnology Minor

The Faculties of Engineering and of Science offer a Minor in Biotechnology for students interested in taking additional courses in this area. For Engineering students, the Minor has been designed specifically for students within the Chemical Engineering Department, however other Engineering students are invited to contact the Minor program supervisor, Professor Bennett, or Professor B. Voilesky, Chemical Engineering (514) 398-4276, for further information. Students should identify an interest in the Minor to their academic advisor and the supervisor of the program during the U1 year, and at the time of registration for the U2 year. With the agreement of the academic advisor, students should submit their course list to the program supervisor who will certify that the proposed program conforms to the requirements for the Minor. The Biotechnology Minor Program is administered for the Faculties of Engineering and of Science by Prof. H. Bennett, Sheldon Biotechnology Centre (Lyman-Duff Building), phone 398-3998. A full description of the Minor program appears under the Biotechnology heading on page 361 of the Science section.

A Chemical Engineering student may complete the Biotechnology Minor by taking 177-200A, 177-201B, 177-202B, 528-211A, 202-505B, plus one course from the list of additional courses not including 306-310. The Department of Chemical Engineering permits students in the Minor program to complete 202-505B as one of their technical complementary requirements. The total course credit required for the Chemical Engineering student is 15 credits beyond the 110-credit B.Eng. program.

5.3 Chemistry/Chemical Engineering Minor

The Departments of Chemistry and Chemical Engineering offer a Minor Program in Chemistry, of particular interest to Chemical Engineering students and a Minor in Chemical Engineering, of interest to Chemistry students (described in the Science section). The Minor in Chemistry consists of 25 credits as follows:

1. Required courses, 10 credits: 180-212, 233 and 234 (or CEGEP equivalent)

2. At least 15 credits from the following list, two of which must be laboratory courses (* indicates lab). Note that 180-212 is a prerequisite for most of the courses listed below. If students take 180-222* instead of 180-234, they will receive credit for one of the two laboratories that are required but they must have a total of 25 Chemistry credits for the Minor.

Inorganic Chemistry
180-281A Inorganic Chemistry I
180-371A,B Inorganic Chemistry Laboratory*
180-381A Chemistry of Transition Elements
180-591B Advanced Coordination Chemistry

Analytical Chemistry
180-257D Introductory Analytical Chemistry*
or 180-277D Classical Methods of Analysis*
180-307A Environmental Analysis
180-367A Instrumental Analysis I
180-377B Instrumental Analysis II

Organic Chemistry
180-302A Introductory Organic Chemistry III
180-352B Structural Organic Chemistry
180-362A,B Advanced Organic Laboratory*
180-382B Organic Chemistry of Natural Products
180-402B Advanced Bio-organic Chemistry

Physical Chemistry
180-345A Molecular Properties & Structure I
180-355B Molecular Properties & Structure II

180-363A,B Physical Chemistry Laboratory*
180-393A,B Physical Chemistry Laboratory*
180-455A Introductory Polymer Chemistry

Please consult the program coordinators for more information: Prof. D. Berk (Chemical Engineering) and Prof. M. Andrews (Chemistry). A passing grade for courses within the Minor is a C.

5.4 Computer Science Courses and Minor Program

The School of Computer Science offers an extensive range of courses for Engineering students interested in computers. The course explicitly for Engineering students, 308-208 Computers in Engineering, and other courses in the core of the various Engineering programs are listed in section 6.2 on page 263. Descriptions of other Computer Science courses can be found on page 368 in the Faculty of Science section.

Engineering students may obtain a Minor in Computer Science as part of their B.Eng. degree by satisfying the 24-credit requirement described below. In general, complementary courses within Engineering Departmental programs may be used to satisfy some of these requirements, but the Minor in Computer Science will require at least 12 extra credits from Computer Science (308-) courses beyond those needed for the B.Eng. degree. Students should consult their departments about the use of complementaries, and credits that can be double counted.

Students should see the receptionist in 318 McConnell to pick up the appropriate forms, and to make an appointment to see the Minor Advisor for approval of their course selection. Forms must be approved before the end of the Add/Drop period of the student's final term.

Requirements

The program must consist of 24 credits, from courses passed with a grade of C or better, as follows:

Required Courses (9 credits)
308-203 Introduction to Computing II
or 308-250 Introduction to Computer Science
308-302 Programming Languages and Paradigms
308-350 Numerical Analysis (or Numerical)
or 305-409 Methods in Mechanical Engineering

Complementary Courses (15 credits)
Three credits, chosen from:
308-273 Introduction to Computer Systems
304-221 Introduction to Computer Engineering I

Three credits, chosen from any Computer Science course numbered 308-305 or higher.
Nine credits, chosen from:
(a) any Computer Science course numbered 308-305 or higher.
(b) any complementary course making considerable use of computing and approved by Computer Science for the Minor.

Notes
A. Courses 308-202 Introduction to Computing I, and 308-208 Computers in Engineering (compulsory for some Engineering students) do not form part of the Minor.
B. 308-202 is a prerequisite for 308-203. Students with a substantial high level language programming course may forego this prerequisite. Some additional make-up effort may be needed at the start of the course.

Courses in Other Departments

The following is a list of courses, offered by other departments, that will normally be approved for inclusion in the Minor program under (b) in the Complementary Courses list. This list is not necessarily complete.

Department of Mathematics
189-327B Matrix Numerical Analysis
189-328A,B Computability and Mathematical Linguistics
189-407B Dynamic Programming
189-417A Mathematical Programming
Faculty of Engineering

302-453A Process Control
302-455A Process Design
302-571B Small Computer Application in Chemical Engineering
303-208A Civil Engineering Systems Analysis
303-460A Matrix Structural Analysis
304-323A,B Digital System Design
304-425A Computer Organization and Architecture
304-426A,B Microprocessor Systems
304-512A Digital Signal Processing
304-521B Data Communications
304-529A Image Processing and Communications
304-531B Real-Time Systems
304-532A Computer Graphics
304-533B Numerical Methods in Electrical Engineering
304-546A Introduction to VLSI Systems
305-472A Project Management
305-521A (3) Stability of Underground Openings
305-527A (3) Renovation & Preservation of Infrastructure
305-540B Modelling and Decision
305-543B Mechanics of Robotic Systems II
305-572A Mechanics of Robotic Systems I
305-573A Mechanics of Robotic Systems II
305-576A Computer Graphics and Geometric Modelling
306-311A Computer Applications in Mineral and Materials Engineering

Required Courses

In addition, there are other courses that may be approved for inclusion under category (b). Students should consult with their advisers about the possibility of taking specific courses.

The following categories are a guideline to the content of the available courses:

Programming and Programming Languages
308-203 or 308-250, 308-273, 308-302, 308-425, 308-426, 308-524.

Software Design

Hardware Design

Real-Time Processes

Operations Research

Numerical Analysis
189-327, 189-578, 189-579, 304-543, 304-350 (or 305-409), 308-540.

5.5 Construction Engineering and Management Minor
Students in the Faculty of Engineering may obtain a Minor in Construction Engineering and Management by completing 24 to 25 credits chosen from the required and complementary courses listed below. By a careful selection of complementary courses, a Civil Engineering student may obtain this Minor by completing as few as 9 additional credits. Students in other departments would typically require 12 to 15 additional credits to complete the Minor. For further information, contact Professor L. Chouinard at (514) 398-6446, Room 484, Macdonald Engineering Building.

Prerequisites:
303-208A Civil Engineering Systems Analysis
or an equivalent course in Operations Research
303-324A (3) Construction Project Management
305-472A (3) Project Management

Requirements:
The 24 to 25 credits listed below must be completed with a grade of C or higher in order to fulfill the requirements of the Minor.

1. Management and Law: 15 credits, as follows:
280-211 (3) Introduction to Financial Accounting
280-341 (3) Finance I
279-294 (3) Intro to Labour-Management Relations
300-220A (3) Law for Architects and Engineers
and one of:
303-324A (3) Construction Project Management
305-472A (3) Project Management

2. Either 3 or 4 credits, as follows:

a) 4 credits -
Any two of the following relating to Building Structures:
301-446A (2) Mechanical Services in Buildings
301-447A (2) Electrical Services
301-450B (2) Specifications and Building Costs
301-451A (2) Building Regulations and Safety
303-492A (2) Structures

or:
b) 3 credits -
One of the following relating to Heavy Construction:
306-322B (3) Rock Fragmentation
306-333B (3) Materials Handling

3. Other Construction-Related Complementary Courses: 6 credits
Any two of the following:
270-462 (3) Management of New Enterprises
274-445 (3) Real Estate Finance
303-446A (3) Construction Engineering
303-527A (3) Renovation & Preservation of Infrastructure
303-586A (3) Earthwork Engineering
304-281B (3) Electric Power
306-520A (3) Stability of Rock Slopes
306-521A (3) Stability of Underground Openings
309-321B (3) Mecanique des roches et controle des pressions de terrains
336-411A (3) Off-Road Power Machinery

Total requirement: 24 or 25 credits

5.6 Economics Minor
The Minor consists of 18 credits in courses given in the Economics Department. It consists of required courses and complementary courses. In addition, it is presumed that all Engineering students will have a sufficient background in statistics. Engineering Economy, 306-310, does not form part of this minor. For more information see the Department of Economics, Leacock Room 443.

Required Courses (9 credits)
154-209A,B** Macroeconomic Analysis and Applications

Complementary Courses (9 credits) from:
154-225A Economics of the Environment
154-302D Money and Banking
154-303D Canadian Economic Policy

** These courses are at a variety of levels. Some are required courses in the student's ordinary program; some are courses that may be taken as technical complementary. Students should consult with their advisers about the possibility of taking specific courses.
154-305A Industrial Organization
154-306D Labour Economics and Institutions
154-308B Public Policies Toward Business
154-313D Economic Development
154-316A,B The Underground Economy
154-321A The Quebec Economy
154-326A Ecological Economics
154-330D Macroeconomic Theory
154-331A Economic Development: Russia and the USSR
154-332A Comparative Economic Systems
154-333B Topics in Comparative Economic Systems
154-335A The Japanese Economy
154-337A,B Introductory Econometrics I
154-344A The International Economy, 1830 - 1914
154-345B The International Economy Since 1914
154-347B Economics of Climate Change
154-404A,B Transportation
154-405A,B Natural Resource Economics
154-408D Public Sector Economics
154-423D International Trade and Finance
154-447A Economics of Information and Uncertainty
154-467D Econometrics - Honours
154-546A Game Theory
154-568B Urban and Regional Economics

Mining Engineering students will be permitted to include Mineral Economics (306-526A,B) among these 18 credits.

* Students may, with consent of instructor, take 154-250D Introduction to Economic Theory - Honours, in place of 154-230D.

** This requirement is waived for students who choose 154-330D from the list of complementaries. Students may not take both 154-209A,B and 154-330D.

5.7 Environmental Engineering Minor

The Environmental Engineering Minor is offered for students of Engineering and the Department of Agricultural and Biosystems Engineering wishing to pursue studies in this area. The Minor program consists of 27 credits in courses. Through a judicious choice of core and complementary courses listed below, students may minimize the number of additional credits required to obtain this Minor. The Minor typically requires a minimum of 9 to 15 additional credits. This minimum depends on the department/school in which the student is registered.

The Environmental Engineering Minor Program is administered by the Department of Civil Engineering and Applied Mechanics. Further information may be obtained from Professor S. Ghoshal, Room 475C, Macdonald Engineering Building.

General Regulations

To complete the Minor in Environmental Engineering, students must:

a) complete a minimum of 21 credits of Engineering courses (a minimum of 6 credits in this category must be chosen outside the student's principal departmental program) (see section A below),
b) complete a minimum of 6 credits of non-Engineering courses (each course must be chosen from a different department, and neither from the student's home department) (see section B below),
c) complete one of the corequisite courses listed below in addition to the 27 credits counted toward the Minor.
d) in the case of Agricultural and Biosystems, Chemical, and Civil Engineering students, select all courses for the Minor program in the student's principal program, other than those taken as part of the Humanities and impact course requirements,
e) obtain a grade of C or better in all approved courses in the Minor, and
f) satisfy the requirements of both the Minor and the student's departmental program.

Note: Not all courses listed below are offered every year. Students should consult with the department concerned about the courses which are offered in a given year.

Corequisites

(Not credited to the Minor Program)

- 302-230 Environmental Aspects of Technology
- 303-225 Environmental Engineering
- 306-308 Social and Economic Impacts of Technology
- equivalent environmental impact course

A. ENGINEERING COURSES (21 credits)

Agricultural Engineering (Macdonald Campus)

- 336-217 Hydrology and Drainage (not open to students who have passed 303-323)
- 336-322 Agro-food Waste Management
- 336-416 Engineering for Land Development
- 336-518 Pollution Control for Agriculture

Chemical Engineering

- 302-351 Separation Processes
- 302-370 Elements of Biotechnology
- 302-430 Technology Impact Assessment (not open to students who have passed 375-437)
- 302-452 Particulate Systems (offered in alternate years)
- 302-471 Industrial Water Pollution Control (not open to students who have passed 303-430)
- 302-472 Industrial Air Pollution Control

Civil Engineering and Applied Mechanics

- 303-225 Environmental Engineering (not part of the Minor for Civil Engineering Students)
- 303-323 Hydrology and Water Resources (not open to students who have passed 336-217)
- 303-421 Municipal Systems
- 303-430 Water Treatment and Pollution Control (not open to students who have passed 302-471)
- 303-451 Geoenvironmental Engineering
- 303-526 Solid Waste Management
- 303-550 Water Resources Management
- 303-553 Stream Pollution and Control
- 303-572 Advanced Hydraulics
- 303-574 Fluid Mechanics of Water Pollution
- 303-575 Fluid Mechanics of Air Pollution
- 303-577 River Engineering
- 303-585 Groundwater Hydrology

Mechanical Engineering

- 305-343 Energy Conversion
- 305-434 Turbomachinery
- 305-447 Combustion
- 305-525 Intro. to Nuclear Engineering
- 305-526 Manufacturing and the Environment
- 305-534 Air Pollution Engineering

Mining and Metallurgical Engineering

- 306-412 Corrosion and Degradation
- 306-451 Environmental Controls
- 306-555 Thermal Remediation of Wastes
- 309-327 Hydrogéologie Appliquée
- 309-328 Environnement Minier
- 309-422 Ventilation Minière

B. NON-ENGINEERING COURSES (6 credits)

Agricultural Sciences (Macdonald Campus)

- 338-510 Agricultural Micrometeorology
- 344-200 Biology of Organisms I
- 344-201 Biology of Organisms II
- 344-205 Principles of Ecology
- 349-315 Science of Inland Waters
- 350-380 Food Systems and the Environment
- 362-230 The Microbial World (not open to students who have passed 302-370)
5.9 Management Courses and Minor Program

Many engineers begin to assume management functions within a few years of graduation. They can, at this stage, take up the study of economics, behavioural science and other management subjects. Students wishing to include such studies in their undergraduate program can take suitable courses from Engineering and Management as listed below.

Engineering Economy 306-310 introduces the concept of costs into evaluations of engineering projects and architectural proposals. Several additional courses are available, subject to timetabled requirements, from the core program of the Faculty of Management.

Other courses from the Management core program have considerable overlap with Engineering courses and thus are not available to Engineering students.

Note: Course 280-211, a course in statistics, and a course in Micro-economics are prerequisite for 280-341. If included in the Minor in Management, 280-423 should be taken at the end of the program.

Engineering students may obtain a Minor in Management by completing 15 credits of courses from the following list of Faculty of Management courses with a grade of C or better. Successful completion of this Minor is noted on a student's transcript.

Required Courses (6 credits)

280-211 Introduction to Financial Accounting

280-320 Managing Human Resources

Complementary Courses (9 credits)

3 credits, one of List A:

280-213 Introduction to Managerial Accounting

280-341 Finance I

280-373 Operations Research

280-382 International Business

3 credits, one of List B:

270-462 Management of New Enterprises

280-222 Organizational Behaviour

280-352 Marketing Management I

280-360 Social Context of Business

280-423 Organizational Policy

3 credits, any available 300 or 400-level Management course (for which the prerequisites, if any, have been met).

An Engineering course deemed equivalent by the Faculty of Management may be substituted for course 280-373. There are three courses in Engineering that qualify: 303-208, 305-474 and 309-326. It should be noted that 280-373 does not count as a technical complementary course.

Other courses from the Management core program have considerable overlap with Engineering courses and thus are not available to Engineering students.

5.10 Materials Engineering Minor

Engineering students may obtain a Minor in Materials Engineering by completing 24 credits chosen from the required and complementary courses listed below. By a careful selection of complementary courses, Engineering students may obtain this Minor with a minimum of 15 additional credits. It should be noted that some departments (e.g. Mechanical Engineering) will allow their students to take courses from this list, providing they complete the program and have it approved by both their regular Engineering Advisor and the School. For program details, see “Minor in Environment” on page 458 in the MSE section.

5.8 Minor in Environment

Environmental studies involve the interactions between humans and their natural or technological environment. Environmental problems are frequently comprehensive and complex, and their satisfactory solutions require the synthesis of humanistic, scientific, and institutional knowledge. The Minor in Environment is offered and administered by the McGill School of Environment (MSE). Inquiries should be directed to Mr. Peter Barry, MSE. E-mail: envstud@felix.geog.mcgill.ca or telephone: (514) 398-4306.

Since the program comprises a total of 18 credits for the Minor, additional credits beyond those needed for the B.Eng. degree are required. Students wishing to receive the Minor should prepare a
Minor prior to graduation. For further information, please contact the coordinator, Prof. R.A.L. Drew, Room 2090, Wong Building.

**Required Courses** (15 credits)
- 306-260A,B Materials Science and Engineering
- or 302-380A Materials Science
- 306-367B Electronic Properties of Materials
- 306-465B Ceramic Engineering
- 302-481A Polymer Engineering
- 302-484B Materials Engineering

**Complementary Courses** (9 credits)
Three courses to be chosen from the following list:
- 180-455A Introductory Polymer Chemistry
- 302-381B Polymer Technology
- 302-483B Industrial Rheology
- 302-487B Chemical Processing in the Electronics Industry
- 302-530C Structure and Properties of Paper
- 302-581B Polymer Composites Engineering
- 304-545A Microelectronics Technology
- 305-530B Mechanics of Composite Materials
- 306-360A Phase Transformations in Solids
- 306-361B Liquid State Processing of Materials
- 306-362A Engineering Properties of Materials
- 306-412A Corrosion and Degradation
- 306-560A Joining Processes
- 306-561B Advanced Materials Design
- 306-563B Hot Deformation of Metals
- 306-564B X-Ray Diffraction Analysis of Materials
- 306-566A Texture, Structure and Properties of Polycrystalline Materials
- 306-569B Electron Beam Analysis of Materials

**5.11 Mathematics Minor**
The Minor in Mathematics for students in the Faculty of Engineering requires satisfactory passes in 24 credits of approved courses in Mathematics not including 189-247 (or -223), 260 (or -222), -261 (or -315 or -325), -285 (or -248 or -314), -266, -270, -319. At least 18 credits must be chosen from the Mathematics and Statistics courses approved for the Mathematics Majors or Honours program, or from Mathematics 189-249, -363, -381, -386. The remaining credits may be chosen from mathematically allied courses.

In addition to an Engineering Adviser, each student in the Minor program must have an Adviser designated by the Department of Mathematics and Statistics, normally beginning in the U2 year. The selection of courses for the Minor is to be done in conjunction with the Minor Adviser. Please consult the Department of Mathematics and Statistics for an Adviser.

**5.12 Physics Minor**
Students in Honours Electrical Engineering may obtain a Minor in Physics as part of their B.Eng. degree by satisfying the 18-credit requirement listed below:
- 198-357A Quantum Physics I
- 198-362B Statistical Mechanics
- 198-457B Quantum Physics II
and at least 9 credits chosen from the following:
- 198-332B Physics of Fluids
- 198-514B General Relativity
- 198-551A Quantum Theory
- 198-557A Nuclear Physics
- 198-558A Solid State Physics
- 198-559A Advanced Statistical Mechanics
- 198-562B Electromagnetic Theory
- 198-567B Particle Physics

Students who take 198-357A and 198-457B can omit 198-271B from their normal Electrical Engineering program. Candidates must go to the Department of Physics at registration time in their U3 year to fill out a Minor Program Form.

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**6 Courses Given by other Faculties for Engineering Students**
- Denotes courses not offered in 1999-2000
- Courses with limited enrolment

**6.1 Department of Chemistry**

**180-233B SELECTED TOPICS IN PHYSICAL CHEMISTRY.** 3(3-0-6) For Chemical Engineers only. Introduction to chemical kinetics, surface and colloid chemistry and electrochemistry. The topics to be discussed will be of particular interest to students in chemical engineering. Professors Whitehead, Galley and Brown

**180-234A,B SELECTED TOPICS IN ORGANIC CHEMISTRY.** 3(3-0-6) (Prerequisite: 180-212A, B or equivalent) For Chemical Engineers only. Modern spectroscopic techniques for structure determination. The chemistry of alkyl halides, alcohols, ethers, carbonyl compounds and amines with special attention to mechanistic aspects. Special topics. Professors Damha (A) and Farrell (B)

**6.2 School of Computer Science**

**308-202A,B INTRODUCTION TO COMPUTING 1.** (3 credits) (3 hours) (Prerequisite: a CEGEP level mathematics course.) Credit cannot be obtained for both 308-202 and 308-208. Overview of components of microcomputers, the internet design and implementation of programs using a modern highlevel language, an introduction to modular software design and debugging. Programming concepts are illustrated using a variety of applications. Professor Hendren

**308-208A,B COMPUTERS IN ENGINEERING.** (3 credits) (3 hours) (Prerequisite: differential and integral calculus. Co-requisite: linear algebra: determinants, vectors, matrix operations.) Credit cannot be held for both 308-202 and 308-208. Introduction to computer systems. Concepts and structures for high level programming. Elements of structured programming using FORTRAN 90 and “C”. Assignments in both mainframe and microcomputer environment. Numerical algorithms such as root finding, numerical integration and differential equations. Non-numerical algorithms for sorting and searching. Professor Ratzer

**308-250A INTRODUCTION TO COMPUTER SCIENCE.** (3) (3 hours) (Prerequisites: Familiarity with a high level programming language and CEGEP level Math.) An introduction to the design of computer algorithms, including basic data structures, analysis of algorithms, establishing correctness of programs and program testing. Overview of topics in computer science. Professor Panangaden

**308-302A,B PROGRAMMING LANGUAGES AND PARADIGMS.** (3) (3 hours) (Prerequisite: 308-250 or 308-203) Programming language design issues and programming paradigms. Binding and scope, parameter passing, lambda abstraction, data abstraction, type checking. Functional and logic programming. Professors Friedman and Panangaden

**6.3 Department of Earth and Planetary Sciences**

**186-221A GENERAL GEOLOGY.** 3(2-3-4) An introductory course in physical geology designed for majors in civil and mining engineering. Properties of rocks and minerals, major geological processes, together with natural hazards and their effects on engineered structures are emphasized. The laboratory is an integral part of the course which includes rock and mineral identification, basic techniques of airphoto and geological map interpretation, and structural geology. Staff

**186-225A PROPERTIES OF MINERALS.** (1) (1 hour lecture, 1 hour laboratory) (Not open to students who have taken 186-210A) Survey of the physical and chemical properties of the main mineral groups. Discussion of their relationships to the chemical composition and structure of minerals. The practical exercises emphasize the physical and chemical properties that relate to industrial uses
6.4 Faculty of Education

455-206A,B COMMUNICATION IN ENGINEERING. (3 credits) Written and oral communication in Engineering (in English): strategies for generating, developing, organizing, and presenting ideas in a technical setting; problem-solving; communicating to different audiences, editing and revising; and public speaking. Course work based on academic, technical, and professional communication in engineering. Attendance at first class is imperative. 

Staff

6.5 Department of Mathematics and Statistics

189-247B LINEAR ALGEBRA. (3 credits) (Prerequisite: 189-133 or equivalent. Intended for Honours Physics and Engineering students. Not open to students who have taken or are taking 189-236 or 189-223 or 189-251.) Matrix algebra, determinants, systems of linear equations. Abstract vector spaces, inner product spaces, Fourier series. Linear transformations and their matrix representations. Eigenvalues and eigenvectors, diagonalizable and defective matrices, positive definite and semidefinite matrices. Quadratic and Hermitian forms, generalized eigenvalue problems, simultaneous reduction of quadratic forms. Applications.

189-248A ADVANCED CALCULUS I. (3 credits) (Prerequisites: 189-133 and 222 or consent of Department. Intended for Honours Mathematics, Physics and Engineering students. Not open to students who have taken or are taking 189-314.) Partial derivatives; implicit functions; Jacobians; maximum and minimum; Lagrange multipliers. Scalar and vector fields; orthogonal curvilinear coordinates. Multiple integrals; arc length, volume and surface area. Line integrals; Green's theorem; the divergence theorem. Stokes' theorem; irrotational and solenoidal fields; applications.

189-249B ADVANCED CALCULUS II. (3 credits) (Prerequisite: 189-248. Intended for Honours Physics and Engineering students. Not open to students who have taken or are taking 189-316.) Functions of a complex variable; Cauchy-Riemann equations; Cauchy's theorem and consequences. Taylor and Laurent expansions. Residue calculus; evaluation of real integrals; integral representation of special functions; the complex inversion integral. Conformal mapping; Schwarz-Christoffel transformation; Poisson's integral formulas; applications.


189-261A,B DIFFERENTIAL EQUATIONS. 3(3-1-5) (Corequisite: 189-260) Ordinary differential equations: first order, linear second-order and higher order, linear with constant coefficients. Solution by series, by Laplace transform, and by some simple numerical methods.

189-265A,B ADVANCED CALCULUS. 3(3-1-5) (Prerequisites: 189-260 or 189-222 or 189-151B or equivalent) Implicit functions, constrained and unconstrained extremas for functions of several variables. Change of variables in multiple integrals, Jacobians, surface integrals. Scalar and vector fields, line integrals, vector operators. Green's, divergence and Stokes' theorems, applications to heat flow, electrostatics and fluid flow.


189-270A,B APPLIED LINEAR ALGEBRA. 3(3-1-5) (Prerequisite: 189-261) Review of matrix algebra, solution of linear equations, tri-