Table of Contents

1. The Faculty, page 235
   - 1.1 Location
   - 1.2 Administrative Officers
   - 1.3 Historical Note
   - 1.4 The Faculty Today
   - 1.5 Special Facilities and Related Programs
     - 1.5.1 Engineering Microcomputing Facility
     - 1.5.2 Agricultural and Biosystems Engineering
     - 1.5.3 Department of Biomedical Engineering
   - 1.6 Library Facilities
2. General Information, page 236
   - 2.1 Admission Requirements
   - 2.2 Exchange Programs
   - 2.3 Transfer Credits
   - 2.4 Advanced Credit Examinations
   - 2.5 Registration
     - 2.5.1 Registration for Continuing Education Courses
     - 2.5.2 Course Withdrawal
   - 2.6 Advising
   - 2.7 Student Activities
   - 2.8 Scholarships and Bursaries
   - 2.9 IYES: Internship Year for Engineering and Science
   - 2.10 Calculators in Faculty Tests and Examinations
3. Academic Requirements, page 238
   - 3.1 Degree Requirements
     - 3.1.1 Entrance Requirements
     - 3.1.2 Basic Science Requirements for Students Entering from Outside Quebec
     - 3.1.3 Architecture – Basic Science Requirements for Students Entering from Outside Quebec
   - 3.2 Degrees and Requirements for Professional Registration
   - 3.3 Prerequisites
   - 3.4 Complementary Studies
   - 3.5 Student Progress
     - 3.5.1 Letter Grades
     - 3.5.2 Incomplete Course Deadlines
     - 3.5.3 Satisfactory/Unsatisfactory Option
     - 3.5.4 Course Credits
     - 3.5.5 Grade Point Averages and Extra Courses
     - 3.5.6 Academic Standing Decisions
     - 3.5.7 Repeated Courses
     - 3.5.8 Reassessment and Reread of a Grade
     - 3.5.9 Examination Regulations
     - 3.5.10 Supplemental Examinations
     - 3.5.11 Deferred Examinations
4. Academic Programs, page 242
   - 4.1 Faculty Courses
   - 4.2 Architecture
   - 4.3 Chemical Engineering
   - 4.4 Civil Engineering and Applied Mechanics
   - 4.5 Electrical and Computer Engineering
   - 4.6 Mechanical Engineering
   - 4.7 Mining, Metals and Materials Engineering
   - 4.8 Urban Planning
5. Minor Programs and Choice of Electives or Complementary Courses, page 277
   - 5.1 Arts Minor
   - 5.2 Biotechnology Minor
   - 5.3 Chemistry/Chemical Engineering Minor
   - 5.4 Computer Science Courses and Minor Program
   - 5.5 Construction Engineering and Management Minor
   - 5.6 Economics Minor
   - 5.7 Environmental Engineering Minor
   - 5.8 Minor in Environment
   - 5.9 Management Courses and Minor Program
   - 5.10 Materials Engineering Minor
   - 5.11 Mathematics Minor
   - 5.12 Physics Minor
   - 5.13 Technological Entrepreneurship Minor
   - 5.14 Software Engineering Minor
6. Courses Given by other Faculties for Engineering Students, page 282

1 The Faculty

1.1 Location

Macdonald Engineering Building
817 Sherbrooke Street West
Montreal, QC H3A 2K6
Canada

Website: http://www.mcgill.ca/engineering

Faculty of Engineering Student Affairs Office:
Macdonald Engineering Building, Room 378
Telephone: (514) 398-7257

1.2 Administrative Officers

JOHN E. GRUZLESKI, B.Sc., M.Sc.(Queen's), Ph.D.(Tor.), Eng. **Dean**

JIM NICELL, B.A.Sc., M.A.Sc., Ph.D.(Windsor), P. Eng. **Associate Dean (Student Affairs)**

DAVID L. FROST, B.A.Sc.(U.B.C.), M.S., Ph.D.(Caltech), P.Eng. **Associate Dean (Academic)**

JUAN H. VERA, B.Mat.(Chile), Ing.Quim.(U.T.E.), M.S.(Berkeley), Dr.Ing.(Santa Maria), Ing. **Associate Dean (Research)**

DAVID COVO, B.Sc.(Arch.), B.Arch.(McG.), M.R.A.I.C., O.A.Q. **Director, School of Architecture**

DAVID F. BROWN, B.A.(Bishop's), M.U.P.(McG.), Ph.D.(Sheffield) **Director, School of Urban Planning**

RICHARD J. MUNZ, B.A.Sc., M.A.Sc.(Wat.), Ph.D.(McG.), Eng. **Chair, Department of Chemical Engineering**

DENIS MITCHELL, B.A.Sc., M.A.Sc., Ph.D.(Tor.), F.A.C.I., 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**

ARUN K. MISRA, B.Tech.(I.I.T., Kharagpur), Ph.D.(U.B.C.), P. Eng. **Chair, Department of Mechanical Engineering**

ROBIN A.L. DREW, B.Tech.(Bradford), Ph.D.(Newcastle) **Chair, Department of Mining, Metals and Materials Engineering**

JONATHAN ROUSHAM **Building Administrator**

STEVE YUE, B.Sc., Ph.D.(Leeds) **Secretary of Faculty**

IDA GODEFROY **Assistant to the Dean**

JUDY PHARO **Faculty 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, Metals and Materials 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 Engineering Departments. 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 undergraduate degree is offered in the School of Architecture for those who plan to work in related fields not requiring professional qualification. The curricula are structured to provide suitable preparation for those who plan to continue their education in post-graduate studies either at McGill or elsewhere. The professional degrees in Architecture and Urban Planning are offered at the Master's level and are described in the *Graduate Studies Calendar*.

The academic programs, which are described in detail in section 4 are divided into required and complementary sections. The required courses emphasize those basic principles which permit graduates to keep abreast of progress 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 work 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 2.9. In addition, CO-OP programs are offered in Mining Engineering and in Metals and Materials Engineering.

Post-graduate 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 post-graduate programs including the professional degree programs in Architecture and in Urban Planning are described in the *Graduate Studies Calendar*.

1.5 Special Facilities and Related Programs

1.5.1 Engineering Microcomputing Facility

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 computing resources on a 24-hour basis and to provide services that are not covered by individual units. 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 456 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.

1.5.3 Department of Biomedical Engineering

Lyman Duff Medical Sciences Building
3775 University Street
Montreal, QC 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 Department may be of interest to Engineering students, and may be approved as complementary courses. A partial list follows (see the *Graduate Studies Calendar*, accessible at http://www.mcgill.ca, for more details):

BMDE 501 SELECTED TOPICS IN BIOMEDICAL ENGINEERING. (3) (3-0-6)

BMED 503 BIOMEDICAL INSTRUMENTATION. (3) (2-1-6)

BMED 519 BIOMEDICAL SIGNALS AND SYSTEMS. (3) (2-0-8)

1.6 Library Facilities

The University has numerous libraries. Specifically serving Engineering, Architecture and Urban Planning is the Schulich Library of Science and Engineering. 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, Edward Rosenthall Mathematics and Statistics Library, and the Howard Ross Management Library. Further information is available on the Web, http://www.library.mcgill.ca.

2 General Information

2.1 Admission Requirements

The Faculty of Engineering offers programs leading to the degrees of B.Eng. and B.Sc.(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 section 2 of the Application Procedures, Admission Requirements chapter.

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. Applicants must have completed at least one year of study and have maintained an average of 3.00 or better. Further information may be obtained from the Faculty of Engineering Student Affairs Office, or the Exchange Officer, Admissions, Recuitment and Registrar's Office.

2.3 Transfer Credits

In certain cases, credit may be granted for courses passed with a grade of C or better at other universities, up to a maximum of 45 credits for Engineering and 42 credits for Architecture. For further information, please see section 6.7 of the General Information and Regulations section.

2.4 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 MATH 260 Intermediate Calculus upon successful completion of the Advanced Credit Examination. The MATH 260 Intermediate Calculus examination covers material that has a similarity to the syllabus of the CEGEP Calculus III course.

In all engineering programs, students who are successful in the MATH 260 Intermediate Calculus examination will automatically have the number of credits required for the completion of their program reduced by three.

2.5 Registration

Students who are currently registered and intend to return to the same degree program in the following academic session are required to register following procedures outlined in this Calendar, General University Information and Regulations section 3. **It is mandatory for all returning students to see a Departmental Academic Advisor in their Department 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.**

Information regarding course registration is sent to new students at the time of admission. **All new students must see a Departmental Academic Advisor during the advising period.**

Non-Engineering students should obtain permission from the Associate Dean of their Faculty, and the Faculty Student Advisor in the Faculty of Engineering Student Affairs Office, to register for Engineering courses listed in section 4.

2.5.1 Registration for Continuing Education Courses

Students wishing to take a language course(s) via the Centre of Continuing Education for credit must register through the Student Affairs Office. A complete Course Authorization Form will be required. Students must refer to the *Centre of Continuing Education Calendar* and Timetable for course information and deadlines. For further information, contact the Student Affairs Office.

2.5.2 Course Withdrawal

Students may withdraw from a course 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.

2.6 Advising

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

General Information	(514) 398-7257
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
Metals and Materials Engineering	(514) 398-4755 ext. 4365
Mining Engineering	(514) 398-4755 ext. 0573
Urban Planning	(514) 398-4075

2.7 Student Activities

The campus offers a wide variety of extra-curricular activities for students. All are encouraged to participate. Many of these are organized within the Faculty under the auspices of the Engineering Undergraduate Society (EUS), or the Architectural Student Association (ASA). 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 ASA, as appropriate.

2.8 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 on the Web at http://www.mcgill.ca or from the Admissions, Recuitment and Registrar's Office. Specific information concerning these awards may be obtained from the Faculty Student Advisor, Faculty of Engineering Student Affairs Office.

2.9 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 while at the same time earning a salary within the average range of those for entry-level professional positions. Other benefits include:

- improved chance of obtaining a job upon graduation and at a higher starting salary;
- the opportunity to test a choice of career and assess the pertinence of post-graduate study before making a long-term commitment;
- the 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.

Employment through the IYES Program typically begins in January or May and continues for 8, 12 or 16 months, including a 4-month probationary training period. Employers choose the most suitable students for their organization through the application, interview and ranking process. While employed by the participating companies, students work on assignments related to their field of study. Students switch to the Internship Program from the regular program when they accept an Internship placement. Successful completion of an 8 to 16-month internship will qualify the student to graduate with the Internship Program designation, which will be noted on the student's permanent record.

STUDENT ELIGIBILITY

All students participating in this program must:

- have a good academic record (satisfactory standing),
- be registered full time in their program,
- have between 15 and 45 credits remaining to complete their undergraduate studies in the following areas of Engineering or Science:

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

- remain a degree candidate while on internship,
- return to complete studies at McGill (internship students will receive an automatic extension for the completion of their studies). Students are not allowed to complete their undergraduate degree during the internship period.

In addition, it is recommended that the student be able to demonstrate strong leadership and communication skills.

COST

- There is no application fee.
- Every student hired through the Program will be assessed a fee 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.

Further information can be obtained from the Internet http://www.mecc.mcgill.ca or by sending an email to info@mecc.mcgill.ca

2.10 Calculators in Faculty Tests and Examinations

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 Faculty requires 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 McConnell 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.

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.

CHEM 110	(4 credits)	General Chemistry 1
CHEM 120	(4 credits)	General Chemistry 2
MATH 140	(3 credits)	Calculus 1
or MATH 139	(3 credits)	Calculus
or MATH 150	(4 credits)	Calculus A
MATH 141	(4 credits)	Calculus 2
or MATH 151	(4 credits)	Calculus B
MATH 133	(3 credits)	Vectors, Matrices & Geometry
PHYS 131	(4 credits)	Mechanics and Waves
PHYS 142	(4 credits)	Electromagnetism & Optics
xxx-xxx	(3 credits)	Humanities/Social Sciences course

Calculus courses MATH 150/MATH 151 are designed for students who have completed a course in high school calculus. Students who complete the Calculus sequence MATH 150/ MATH 151 will receive exemption with credit from MATH 260 (Intermediate Calculus), in the regular Engineering program.

In the event that the student has some prior calculus, but is not sufficiently confident to proceed with MATH 150/MATH 151, the appropriate sequence is MATH 140/MATH 141.

If a student has no previous calculus exposure, MATH 150/ MATH 151 may be replaced with MATH 139/MATH 141.

Students who are uncertain as to which calculus course sequence is appropriate for them should contact Ms. Pharo, Faculty Student Advisor in the Faculty of Engineering Student Affairs Office (514) 398-7256.

The Humanities/Social Science course may be selected from a list outlined in *Welcome to McGill*. 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 CHEM 110, CHEM 120, MATH 140, MATH 141, MATH 133, PHYS 131 and PHYS 142, in the event that they have studied similar material previously. Details on the advanced placement examinations are provided in *Welcome to McGill*.

Students entering with advanced standing credits (Advanced Placements, Advanced Levels, International Baccalaureate examinations, McGill Placement Tests) are required to meet with the Faculty Student Advisor, Faculty of Engineering Student Affairs Office, to finalize their program of studies. (This must be done prior to meeting with the Departmental Advisor.) An information session will be held prior to the advising sessions to process these advanced credits. Please refer to the *Welcome to McGill* section "Advising Engineering" for more information.

3.1.3 Architecture – Basic Science Requirements for Students Entering from Outside Quebec (8-semester program)

Generally, students admitted to Architecture from outside Quebec are required to complete the following courses:

CHEM 110	(4 credits)	General Chemistry 1
CHEM 120	(4 credits)	General Chemistry 2
MATH 139	(4 credits)	Calculus
or MATH 140	(3 credits)	Calculus 1
MATH 141	(4 credits)	Calculus 2
MATH 133	(3 credits)	Vectors, Matrices & Geometry
PHYS 131	(4 credits)	Mechanics and Waves
PHYS 142	(4 credits)	Electromagnetism & Optics

Students may write McGill Placement Tests to obtain credit for CHEM 110, CHEM 120, MATH 140, MATH 141, MATH 133, PHYS 131 and PHYS 142, in the event that they have studied similar material previously. Details on the advanced placement examinations are provided in *Welcome to McGill*.

3.2 Degrees and Requirements for Professional Registration

Non-Professional:

Bachelor of Science (Architecture)

The first professional degree in architecture is the Master of Architecture I. The description of the M.Arch. I program can be found in the *Graduate Studies Calendar*.

Professional:

Bachelor of Engineering
Bachelor of Engineering (Honours)
Bachelor of Software Engineering

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 engineering professional organizations. All students are encouraged to seek professional registration after graduation. To become a Professional Engineer, a graduate must pass an examination on legal aspects as well as on the principles of professional practice, and acquire two to four years of engineering experience, depending on the province. Only persons duly registered may use the title of “engineer” and perform the professional activities reserved for engineers by the provincial laws and regulations.

Graduates of the Bachelor of Software Engineering program should be eligible for accreditation (once accreditation standards for Software Engineers have been adopted).

In Quebec, the professional engineering body is the Ordre des ingénieurs du Québec (OIQ). In order to better prepare new graduates for the practice of their profession, McGill organizes seminars in cooperation with the Ordre on various aspects of the

profession. The OIQ also has a student section. As soon as students have accumulated 60 credits in a B.Eng. Program, they can join the Student Section of the OIQ. Registration is free.

For more information, visit the websites of the Ordre des ingénieurs du Québec (http://www.oiq.qc.ca) and of the Canadian Council of Professional Engineers (http://www.ccpe.ca).

3.3 Prerequisites

Prerequisites must be completed prior to course registration, if applicable. If a student has registered for a course and did not satisfy the prerequisite, the course may be dropped from his/her record by the Faculty. Written notification will be forwarded to the student and he/she will be permitted to revise his/her course selection.

Those students who have received advance credits/exemptions or passed a placement exam, and are blocked from registration into a course due to a prerequisite block, must complete a Course Authorization Form and submit it to the Faculty of Engineering Student Affairs Office. A Departmental advisor must sign and make a notation on the Course Authorization Form indicating that the prerequisite has been satisfied.

Further information may be obtained from the Faculty of Engineering Student Affairs Office.

3.4 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

(ii) One 3-credit course (6 credits in Electrical and Computer Engineering, of which a minimum of 3 credits must be from category A described below) in the humanities and social sciences, administrative studies and law.

The three credits under (i) are to be chosen from the following list of courses which relate to the impact of technology on society.

CHEE 230	Environmental Aspects of Technology
CHEE 430	Technology Impact Assessment
CIVE 469	Infrastructure & Society
ECON 225	Economics of the Environment
ENVR 201	Society and Environment
GEOG 200	Geographical Perspectives: World Environmental Problems
GEOG 203	Introduction to Environmental Studies
GEOG 205	Global Change: Past, Present and Future
GEOG 302	Environmental Management 1
MIME 308	Social Impact of Technology
PHIL 343	Biomedical Ethics
SOCI 235	Technology and Society
SOCI 312	Industrial Sociology

The course(s) under (ii) are to be chosen from the following: Electrical and Computer Engineering students must select at least one 3-credit course from Category A (Humanities and Social Sciences).

A. Humanities and Social Sciences

Any course at the 200 level or above from the departments of:

- Anthropology
- Economics (any 200 or 300 level course excluding ECON 208, ECON 217, ECON 227, ECON 259 and ECON 337)
- History
- Philosophy (excluding PHIL 210)
- Political Science
- Psychology (excluding PSYC 204, PSYC 305 and PSYC 435 but including PSYC 100)
- Religious Studies
- School of Social Work
- Sociology (excluding SOCI 350)

or ARCH 350 The Material Culture of Canada
or ENVR 203 Knowledge, Ethics and Environment
or ENVR 400 Environmental Thought
or MATH 338 History and Philosophy of Mathematics

B. Administrative Studies and Law

Faculty of Engineering

FACC 220	Law for Architects and Engineers

Faculty of Management

INDR 294	Introduction to Labour-Management Relations
MGCR 222	Organizational Behaviour
MGCR 320	Managing Human Resources
MGCR 352	Marketing Management 1
MGCR 360	Social Context of Business
MRKT 360	Marketing of Technology
ORGB 321	Leadership

C. Language Courses

Any language course which is deemed by the academic advisor to have a sufficient cultural component or, in the case of a student who was not already proficient in a specific language, program credit will be given for the second of two successfully completed, academically approved 3-credit language courses.

3.5 Student Progress

The B.Eng. programs may be completed in seven semesters. The B.Sc.(Arch.) program may be completed in six or eight semesters, depending upon point of entry.

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. 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.

3.5.1 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	J	Unexcused Absence
B+, B, B-	Good	K	Incomplete
C+, C	Satisfactory	KF	Incomplete Failed
D	Conditional Pass	L	Deferred
F	Failed	T	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.

3.5.2 Incomplete Course Deadlines

Those students with a K grade (incomplete), MUST complete the course within three (3) months, after which the student will be given a grade of KF (incomplete/failed). The deadline for Fall term courses is March 31st (January 15th for Winter graduation); for Winter term courses it is August 15th (May 15th for Spring graduation) and for Summer term courses it is December 1st (October 1st for Fall graduation).

If the student is unable to complete the course within the given deadlines, a request for an extension must be forwarded to the Associate Dean (Student Affairs). If an extension has already been permitted, the Faculty will make the necessary corrections.

3.5.3 Satisfactory/Unsatisfactory Option

The Satisfactory/Unsatisfactory Option (S/U) may be used for elective courses only.

Students **must** specify courses as S/U at the time of registration. The option **will not** be added manually to a student's record after the Drop/Add deadline or once a mark has been submitted by

the Faculty. Once a mark has been submitted, this option will not be reversed.

1. "Elective" refers to that category of the complementary studies component of the program involving a Social Science/Humanities course, or a course dealing with the impact of technology on society; 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 the Engineering or Architecture programs.
2. A C grade is considered a pass under the University Satisfactory/Unsatisfactory option. (Students should note that the Faculty of Engineering accepts a D grade as a pass when courses eligible for the S/U option are taken in the conventional manner.)
3. Only students in satisfactory standing will be permitted to take a course under the Satisfactory/Unsatisfactory option. Only one course (3 credits) per term, to a maximum of 10% of a student's credits taken at McGill may be taken this way. Grades will be reported in the normal fashion by the instructor and the grades of C and above will be converted to Satisfactory (S) and grades of D and F will be converted to Unsatisfactory (U).
4. The courses taken under this option will be excluded from the GPA, but will be included in the number of credits.

NOTE: To be considered for scholarships/renewal of awards, students must complete at least 27 credits in the regular academic session exclusive of courses completed under this option.

3.5.4 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 three-credit course consisting of three lecture hours per week, no other contact hours and six hours of personal study per week.

3.5.5 Grade Point Averages and Extra Courses

The Faculty calculates a semestrial grade point average (SGPA). 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.

3.5.6 Academic Standing Decisions

In the Faculty of Engineering, a decision on the student's academic standing is based on the CGPA (Cumulative Grade Point Average) according to the criteria listed below.

- Satisfactory standing - CGPA equal to 2.00 or greater.
- Probationary standing - CGPA less than or equal to 1.99 or equal to or greater than 1.20.
- Unsatisfactory standing - CGPA less than 1.20 (if this is the student's first semester, the student is normally readmitted to Probationary Standing by Faculty decision).

Note: The Faculty makes academic standing decisions after the completion of each semester (Fall, Winter, Summer) based on academic results to-date. Thus, if a student has been granted permission to defer one or more examinations, the standing decision will be made regardless of such deferrals.

Please see below for further information about academic standing decisions.

Satisfactory Standing

Students in satisfactory standing may proceed, with the following conditions:

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.

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.

Students in poor academic standing are strongly urged to contact the Student Affairs Office to discuss their situation. Office staff are available to help guide students and to provide useful advice to help students achieve their goals. Helpful workshops are provided by Student Services, e.g., study skills, stress management, test anxiety. Students who are experiencing difficulties are encouraged to explore these avenues.

Probationary Standing

Students placed on Probationary Standing may proceed with their studies under the following conditions.

Students must reduce their credit 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 a semestrial GPA (SGPA) of 2.50 or better in order to continue.

A student whose SGPA is 2.50 or better, but whose CGPA is less than 2.00, may continue on with his/her studies but will remain on Probationary Standing.

Failure to achieve either the SGPA or CGPA requirements noted above will result in the student being placed on "Unsatisfactory Standing" (see below). Students will remain on probationary standing until they achieve a CGPA equal to or exceeding 2.00, at which time their standing will be changed to "satisfactory".

Students placed on Probationary Standing who need to reduce their credit load but are unable to drop course(s) must complete a Course Authorization Form and submit it to the Student Affairs Office. The course(s) will then be deleted manually from the student's record.

Unsatisfactory Standing

Students who have been placed on Unsatisfactory Standing will be asked to withdraw from the Faculty of Engineering for a minimum of one semester. Courses for which the student is currently registered will be deleted automatically from the student's record by the Faculty.

After a minimum of one semester away, the student can apply for readmission. A request for readmission must be made in writing in a letter addressed to the Associate Dean, Student Affairs in the Student Affairs Office. If readmitted, the student will be placed back on Probationary Standing. Students will remain on probationary standing until they achieve a CGPA greater or equal to 2.00, at which time their standing will be changed to "satisfactory".

While on probation during that semester and subsequent semesters, the student must reduce his/her credit load to a maximum of 13 credits per semester, and must meet or exceed the minimum SGPA specified by the department or a CGPA greater or equal to 2.00. The minimum SGPA requirement for each department is as follows:

- Department of Chemical Engineering:
  SGPA greater than or equal to 2.50
- Department of Civil Engineering and Applied Mechanics:
  SGPA greater than or equal to 2.50
- Department of Electrical and Computer Engineering:
  SGPA greater than or equal to 3.00
- Department of Mechanical Engineering:
  SGPA greater than or equal to 2.50
- Department of Mining, Metals and Materials Engineering:
  SGPA greater than or equal to 2.50
- School of Architecture:
  SGPA greater than or equal to 2.50

Students who fail to achieve the minimum SGPA required by their department will be required to permanently withdraw from the pro-

gram with no chance of readmission. In addition, students who have returned to satisfactory standing, but whose CGPA falls below 2.00 in a subsequent semester, will be required to permanently withdraw from the program with no chance of readmission.

3.5.7 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 only in the Fall or Winter, the department responsible may, in appropriate cases, arrange "reading courses" during the other semester or during the Summer months. Such courses taken during a Fall or Winter 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.

3.5.8 Reassessment and Reread 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 discussion with the instructor, a student decides to request a formal reread of a final exam, the student must apply in writing, complete the Reread form and submit it to the Faculty of Engineering Student Affairs Office.

The following conditions apply:

– requests for rereads in more than one course per term will not be accepted, unless permission is given by the Faculty of Engineering;
– grades may be either raised or lowered as the result of a reread;
– rereads in courses not in the Faculty of Engineering are subject to the deadlines, rules and regulations of the relevant faculty;
– any request to have term work re-evaluated must be made directly to the instructor concerned.

The deadlines to make an application for a formal reread of a final exam are:
the last working day of March for fall courses,
the last working day of July for winter courses, and
the last working day of November for summer courses.

A $35 fee for each reread will be assessed directly to the student's McGill account if the result remains the same or is lowered. If the grade is increased, no charge is made.

For further information, students may consult the Faculty of Engineering Student Affairs Office.

3.5.9 Examination Regulations

For information regarding examination regulations and procedures in the Faculty of Engineering, please refer to the Engineering web site, http://www.mcgill.ca/engineering.

3.5.10 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 the Faculties of Arts and Science (typically Humanities and Social Science courses and pre-engineering courses).

The following conditions apply:

– students must be in satisfactory or probationary standing; those with an unsatisfactory standing are not permitted to write supplementals;
– students are permitted to write a supplemental for courses in which they have received a mark of D, F, J or U;
– students must write the supplemental exam at the time of the next supplemental examination period;
– special permission of the Associate Dean (Student Affairs), Engineering, is required if a student wishes to write supplemental exams totaling more than seven (7) credits.
– only one supplemental examination is allowed in a course;
– the supplemental result may or may not include the same proportion of class work as did the original grade. The instructor will announce the arrangements to be used for the course by the end of the course change period;
– the supplemental result will not erase the grade originally obtained; both the original mark and the supplemental result will be calculated in the CGPA;
– additional credit will not be given for a supplemental exam where the original grade for the course was a D and the student already received credit for the course.

The supplemental examination period for Fall courses is during the months of April and May, and for Winter courses and courses spanning Fall/Winter during the last week of August. It is the student's responsibility to find out the date and time of the supplemental exam. Supplemental exam applications are available from the Faculty of Engineering Student Affairs Office. Alternately, students may print out the Supplemental Examination Request Form from the Faculty web site and return it by mail or submit it to the Student Affairs Office.

The deadline for submission of applications is March 1st for Fall courses and July 15th for Winter courses and courses spanning Fall/Winter courses.

There is a $35 non-refundable fee per each supplemental exam, which is charged directly to the student's McGill student account.

Students should consult the Faculty of Engineering Student Affairs Office for more information.

3.5.11 Deferred Examinations

Students who have missed a final examination due to illness or family affliction, **must** submit the following documentation to the Faculty of Engineering Student Affairs Office, Room 378 Macdonald Building:

- an original medical certificate or other documentation that covers the date of the missed examination, and the nature and duration of the illness;
- a completed Deferral Request Form;
- a detailed letter justifying the request for a deferral.

Students **must** also attest that they have completed all course work up-to-date, which will be verified with the instructor(s). The Student Affairs Office **must** be informed of the reasons for absences from final examination **no later than one week** after the date of the final examination that was missed.

A student's signature on the Deferral Request form will allow the Faculty to verify the authenticity of the medical certificate and the nature of the illness, or any other documentation provided. If the form is not signed, it will result in the assignment of a J grade in the course.

If a student becomes ill during a formal examination, he/she must inform the invigilator as soon as possible. If necessary, the student will be escorted to the Health Services. As stated above, the student must return to the Faculty of Engineering Student Affairs Office with medical certification **within one week of the exam.** IMPORTANT: If a student completes the exam in routine fashion, the grade received CANNOT be changed.

Students are advised that deferrals are granted ONLY for compelling reasons. If the request for deferral is denied by the Associate Dean (Student Affairs) the student will receive a "J" grade (absent) in the course. For the purpose of calculating GPAs and CGPAs, the grade of "J" is treated as an "F" (failed, 0%). Students will be contacted regarding the approval of a deferral initially via email approximately two weeks after the end of examination period. A formal letter will be mailed at a later date.

Students granted a deferral will be given an "L" grade which will be replaced by a "J" should the students miss the next deferred or regular examination in the course, whichever occurs first. Students are to ONLY write the final examination but NOT re-do or re-submit course material. If they wish to resubmit assignments and/or rewrite quizzes, class tests and/or midterms, they must appeal to the Associate Dean, Student Affairs.

If a deferral is granted, the maximum number of courses that a student may register for will be limited to ensure that no more than 18 credits of coursework are to be satisfied in a single semester or no more than 6 exams are to be written, whichever is greater. This will provide a student with sufficient time during the semester and the exam period to properly prepare for deferred examinations.

For *Engineering* and *Management* courses, students granted a deferral MUST write the final exam the NEXT time it is offered. Students should be aware that a deferred examination might not be available until the next time the course is given (one year or longer).

For *Arts* and *Science* courses, students MUST write the supplemental examination offered during either May (for Fall courses) or August (for Winter courses). Consult the Calendar of Dates for the dates set for supplemental exams, and the supplemental examination schedule posted on the Web for the exact date and time of a specific exam. Please note deferrals are not permitted for summer courses. Students may be permitted to withdraw from a course without refund instead.

For Continuing Education courses, students granted a deferral should contact the Centre for Continuing Education directly for more information.

Further information on Deferred Examinations can be found in section 5.2.2 of the General University Information chapter.

4 Academic Programs

The curricula and courses described in the following pages have been approved for the 2002-03 session, but the Faculty reserves the right to introduce changes as may be deemed necessary or desirable.

4.1 Faculty Courses

The following two courses are administered by the Faculty of Engineering.

FACC 220 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; expropriation; responsibility for negligence; servitudes/easements, privileges/liens, hypothecs/ 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.

FACC 480 TECHNOLOGICAL ENTREPRENEURSHIP PROJECT. (3) (0-4-5) (Prerequisite: at least 6 credits from the Minor in Technological Entrepreneurship) (Open to Minor in MTE students only) Students will work with an existing "knowledge-based" or technology-based company and will define, plan and complete an in-depth study of a particular aspect of technological entrepreneurship that interests them. This project will be under the supervision of the instructor of the course and an employee of the company concerned.

4.2 School of Architecture

Macdonald-Harrington Building, Room 201
815 Sherbrooke Street West
Montreal, QC H3A 2K6

Telephone: (514) 398-6700
Fax: (514) 398-7372
http://www.mcgill.ca/arch

Director — David Covo

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.
Vikram Bhatt; N.Dip.Arch.(Ahmedabad), M.Arch.(McG.), M.R.A.I.C.
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)*
Adrian Sheppard; B.Arch.(McG.), M.Arch.(Yale), F.R.A.I.C., O.A.Q., A.A.P.P.Q.
Radoslav Zuk; B.Arch.(McG.), M.Arch.(M.I.T.), D.Sc. (Ukr.Acad.Art), F.R.A.I.C., F.R.S.A., F.A.R.C., O.A.Q., O.A.A.

Associate Professors
Annmarie Adams; B.A.(McG.), M.Arch., Ph.D.(Berkeley), M.R.A.I.C. *(William Dawson Scholar)*
Martin Bressani; B.Sc.(Arch.), B.Arch.(McG.), M.Sc.Arch., Diplomes des études approfondies, Docteur de l'Université de Paris-Sorbonne(Paris IV)
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.Q., I.A.A.
Robert Mellin; B.Arch., M.Sc.(Arch.)(Penn.State), M.Arch.(McG.), M.Sc., Ph.D.(U.Penn.), M.R.A.I.C., N.A.A.
Pieter Sijpkes; B.Sc.(Arch.), B.Arch.(McG.)

Course Lecturers
Manon Asselin, Jean D'Aragon, David Theodore, Roland Ulfig

Adjunct Professors
Cécile Baird, Ewa Bieniecka, Lawrence Bird, Julia Bourke, Michael Carroll, Randy Cohen, Nathalie David, Howard Davies, Georges Drolet, Gordon Edwards, François Émond, Martin Fiset, Julia Gersovitz, Mark Ginocchio, Robert Hamilton, Nora Hanessian, Dan Hanganu, Phyllis Lambert, Annie Lebel, Seymour Levine, Anna Mainella, Harry Mayerovitch, Serge Melanson, Rosanne Moss, Carl Mulvey, Joanna Nash, Louis Pelletier, Mark Poddubiuk, Richard Russell, Robert Stanley, Sheila Theophanides, Fred Weiser, Samson Yip, Jozef Zorko

Research Associates
Jim Donaldson, Rafik Salama

Associate Members
Irena Murray, 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 2001, they were:

Gavin Affleck, Bruce Allen, Cathy Ann Barr, Barry Bell, Denis Bilodeau, Michel Broz, Ella Chmielewska, Paul Coolican, Anne Cormier, Richard De La Riva, Rene Daoust, Alexandra Dubois, Rodolphe El-Khoury, Imma Franco, Ben Gianni, Mitchell Hall, Jean-Paul Herby, Sheila Kennedy, Marie-Claude Leblond, Ellen Leibovich, Eric Marosi, Gilles Marty, Patrick Quinn, Stephen Parcell, Pierina Saia, Barry Sampson, John A. Schweitzer, Carol Sheffer, Mohamed Talaat.

ARCHITECTURAL CERTIFICATION IN CANADA

In Canada, all provincial associations recommend a degree from an accredited professional degree program as a prerequisite for licensure. The Canadian Architectural Certification Board (CACB), which is the sole agency authorized to accredit Canadian professional degree programs in architecture, recognizes two types of accredited degrees: the Bachelor of Architecture and the Master of Architecture. A program may be granted a five-year, three-year, or two-year term of accreditation, depending on its degree of conformance with established educational standards.

Masters degree programs may consist of a pre-professional undergraduate degree and a professional graduate degree, which,

when earned sequentially, comprise an accredited professional education. However, the pre-professional degree is not, by itself, recognized as an accredited degree.

Since all provincial associations in Canada recommend any applicant for licensure to have graduated from a CACB-accredited program, obtaining such a degree is an essential aspect of preparing for the professional practice of architecture. While graduation from a CACB-accredited program does not assure registration, the accrediting process is intended to verify that each accredited program substantially meets those standards that, as a whole, comprise an appropriate education for an architect.

PROGRAMS OF STUDY

McGill's professional program in architecture is structured as a four and a half year, or nine semester, course of study divided into two parts.

The first part, for students entering with the Diploma of Collegial Studies in Pure and Applied Science or the equivalent, is a six-semester design program leading to a non-professional degree, Bachelor of Science (Architecture). [Most students from outside Quebec are admitted to an eight-semester B.Sc.(Arch.) program and enter a first year which includes courses outlined in section 3.1.3.]

The second part, for students with the B.Sc.(Arch.) degree, is a one and a half year, or three-semester, program leading to the professional Master of Architecture I degree. The professional M.Arch.I is accredited by the Canadian Architectural Certification Board (CACB), and is recognized as accredited by the National Council of Architectural Registration Boards (NCARB) in the USA.

Students in the B.Sc.(Arch.) program who intend to proceed to the professional degree must satisfy certain minimum requirements including:

1. completion of the B.Sc.(Arch.) degree, including the series of required and complementary courses stipulated for professional studies, with a minimum CGPA of 3.00;
2. completion of the sequence of six design studios, with a minimum average GPA of 2.70;
3. completion of six months relevant work experience.

Further information on the professional M.Arch.I program is available on the web at http://www.mcgill.ca/arch.

Student Exchanges

A limited number of qualified students may participate in an exchange with Schools of Architecture at other universities which have agreements with the McGill School of Architecture, for a maximum of one semester in the second year of the B.Sc.(Arch.) program. These include: Facultad de Arquitectura, Universidad de Los Andes, Bogotá, Colombia; Istituto Universitario di Architettura di Venezia, Venice, Italy; Fakultät für Raumplanung und Architektur, Technische Universität Wien, Vienna, Austria; The Technion - Israel Institute of Technology, Haifa, Israel; Institut Supérieur d'Architecture, Saint-Luc Bruxelles, Brussels, Belgium; École d'architecture de Grenoble, Grenoble, France; École d'architecture Clermont-Ferrand, Clermont-Ferrand, France.

ANCILLARY ACADEMIC FACILITIES

Laboratories and Workshops

Architectural Workshops – David Speller, Technician.

Communications Laboratory, including Photo Lab – Professor Ricardo Castro.

Computers in Architecture Laboratory and the Apple Design and Modeling Centre – Professors Robert Mellin and Richard Russell.

Building Science Resource Centre – Dr. Avi Friedman.

Library

Blackader-Lauterman Library of Architecture and Art, located in the Redpath Library – Marilyn Berger.

Collections

Visual Resources Collection, including slides, film, video and other materials – Dr. Annmarie Adams.

Canadian Architecture Collection, housed in the Blackader-Lauterman Library – Irena Murray.

Orson Wheeler Architectural Model Collection – Professor Pieter Sijpkes.

Materials Resource Centre – Dr. Avi Friedman.

CURRICULUM FOR THE B.Sc.(Arch.) DEGREE

[Program revisions are under consideration for September 2002. Go to http://www.mcgill.ca (Course Calendars) in July for details.]

REQUIRED COURSES		COURSE CREDIT	
Non-Departmental Subjects			
CIVE 205	Statics	3	
CIVE 229	Surveying for Architects	2	
CIVE 283	Strength of Materials	4	
CIVE 385*	Structural Steel and Timber Design	3	
CIVE 388*	Foundations & Concrete Design	3	
CIVE 492*	Structures	2	
FACC 220	Law for Architects and Engineers	3	
MIME 310	Engineering Economy	3	**23**

* Candidates intending not to proceed to the M.Arch.I degree may substitute other courses of equal total weight for any of these.

Architectural Subjects			
ARCH 201	Communication, Behaviour & Architecture	6	
ARCH 202	Arch. Graphics and Design Elements	6	
ARCH 217	Freehand Drawing 1	1	
ARCH 218	Freehand Drawing 2	1	
ARCH 240	Organization of Materials in Building	3	
ARCH 250	Architectural History 1	3	
ARCH 251	Architectural History 2	3	
ARCH 303	Design and Construction 1	6	
ARCH 304	Design and Construction 2	6	
ARCH 321	Freehand Drawing 3	1	
ARCH 322	Freehand Drawing 4	1	
ARCH 324	Sketching School 1	1	
ARCH 375	Landscape	2	
ARCH 405	Design and Construction 3	6	
ARCH 406	Design and Construction 4	6	
ARCH 447	Electrical Services	2	
ARCH 451	Building Regulations & Safety	2	**56**
COMPLEMENTARY COURSES			**12**

Students must complete 12 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.

A. History	B. Theory	C. Environmental Design	D. Technics
ARCH 372	ARCH 352	ARCH 350	ARCH 318
ARCH 379	ARCH 363	ARCH 378	ARCH 319
ARCH 388	ARCH 383	ARCH 379	ARCH 364
ARCH 522	ARCH 524	ARCH 520	ARCH 377
ARCH 523	ARCH 525	ARCH 521	ARCH 461
ARCH 528	ARCH 529	ARCH 527	ARCH 471
ARCH 531		OCC1 442	ARCH 526
ARCH 532			
ARCH 533			

OUTSIDE ELECTIVES:	**6**
6 credits must be completed outside the School of Architecture, subject to approval by the Student Advisor.	
TOTAL CREDITS, B.Sc.(Arch.):	**97**

Architectural Complementaries

ARCH 252	(3)	Intro. to Architectural History 1
ARCH 253	(3)	Intro. to Architectural History 2
ARCH 318	(3)	Design Sketching
ARCH 319	(3)	The Camera and Perception
ARCH 350	(3)	The Material Culture of Canada

ARCH 352	(3)	Art and Theory of House Design
ARCH 364	(2)	Architectural Modeling
ARCH 372	(2)	History of Architecture in Canada
ARCH 377	(2)	Energy, Environment and Buildings
ARCH 378	(3)	Site Usage
ARCH 379	(4)	Summer Course Abroad
ARCH 383	(2)	Geometry, Architecture and Environment
ARCH 388	(2)	Introduction to Historic Preservation
ARCH 461	(1)	Freehand Drawing & Sketching
ARCH 471	(2)	Computer-Aided Building Design
ARCH 490	(2)	Selected Topics in Design
ARCH 520	(3)	Montreal: Urban Morphology
ARCH 521	(3)	Structure of Cities
ARCH 522	(3)	History of Domestic Arch. in Quebec
ARCH 523	(3)	Significant Texts and Buildings
ARCH 524	(3)	Seminar on Architectural Criticism
ARCH 525	(3)	Seminar on Analysis and Theory
ARCH 526	(3)	Philosophy of Structure
ARCH 527	(3)	Civic Design
ARCH 528	(3)	History of Housing
ARCH 529	(3)	Housing Theory
ARCH 531	(3)	Arch. Intentions from Vitruvius to the Renaissance
ARCH 532	(3)	Origins of Modern Architecture
ARCH 533	(3)	New Approaches to Architectural History
ARCH 540	(3)	Selected Topics in Architecture 1
ARCH 541	(3)	Selected Topics in Architecture 2
OCC1 442	(2)	Enabling Environments

COURSES OFFERED BY THE SCHOOL

For the Term (Fall and/or Winter), days, and times when courses will be offered, please refer to the 2002-2003 Class Schedule on the Web, http://www.mcgill.ca/students/. Class locations and names of instructors are also provided.

Students preparing to register are advised to consult the Class Schedule website for the most up-to-date list of courses available. New courses may have been added or courses rescheduled after this Calendar went to press.

The schedule of courses to be offered in Summer 2003 will be available on the website in January.

A limited number of courses are open to students not registered in the School of Architecture. These courses are divided into two sections. Section 01 is reserved for students in Architecture; Section 02 is reserved, on a limited enrolment basis, for students not registered in the School of Architecture. Please refer to individual course descriptions.

ARCH has replaced 301 as the prefix for Architecture courses.

The course credit weight is given in parentheses after the title.

● Denotes courses not offered in 2002-03.

★ Denotes courses taught only in alternate years.

▭ Denotes courses with limited enrolment.

ARCH 201 COMMUNICATION, BEHAVIOUR AND ARCHITECTURE. (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.

ARCH 202 ARCHITECTURAL GRAPHICS AND ELEMENTS OF DESIGN. (6) (2-10-6) (Prerequisite: ARCH 201) 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.

ARCH 217 FREEHAND DRAWING 1. (1) (0-3-0) Drawing in pencil and charcoal.

ARCH 218 FREEHAND DRAWING 2. (1) (0-3-0) (Prerequisite: ARCH 217) A continuation of course ARCH 217.

ARCH 240 ORGANIZATION OF MATERIALS IN BUILDINGS. (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.

ARCH 250 ARCHITECTURAL HISTORY 1. (3) (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.

ARCH 251 ARCHITECTURAL HISTORY 2. (3) (2-0-4) (Prerequisite: ARCH 250) 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.

▭ **ARCH 252 INTRODUCTION TO ARCHITECTURAL HISTORY 1.** (3) (3-0-6) (Open only to students outside the School of Architecture) 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.

▭ **ARCH 253 INTRODUCTION TO ARCHITECTURAL HISTORY 2.** (3) (3-0-6) (Open only to students outside the School of Architecture) 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.

ARCH 303 DESIGN AND CONSTRUCTION 1. (6) (2-10-6) (Prerequisite: ARCH 202) 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.

ARCH 304 DESIGN AND CONSTRUCTION 2. (6) (2-10-6) (Prerequisite: ARCH 303) 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.

● ▭ **ARCH 318 DESIGN SKETCHING.** (3) (2-4-3) (Prerequisite: ARCH 202) (Departmental permission required)

▭ **ARCH 319 THE CAMERA AND PERCEPTION.** (3) (2-4-3) (Prerequisite: ARCH 202) (Departmental permission required) An intensive study of man and the urban environment. Through the use of still photography, the relationship of time, motion, space, place and light are explored in order to gain insights into the urban environment. Topics include: "photographic seeing", light, survey of masters, history of photography, camera and darkroom techniques, tonal control, composition, etc.

ARCH 321 FREEHAND DRAWING 3. (1) (0-3-0) (Prerequisite: ARCH 218) A continuation of course ARCH 218.

ARCH 322 FREEHAND DRAWING 4. (1) (0-3-0) (Prerequisite: ARCH 321) A continuation of course ARCH 321.

ARCH 324 SKETCHING SCHOOL 1. (1) (0-0-3) (Prerequisite: ARCH 218) 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 I in the B.Sc.(Arch.) program.

ARCH 350 THE MATERIAL CULTURE OF CANADA. (3) (2-1-6) (Section 01: Architecture students) (Section 02: Canadian Studies) (Section 03: others) 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.

▭ **ARCH 352 ART AND THEORY OF HOUSE DESIGN.** (3) (2-2-5) (Prerequisite: ARCH 202 or permission of instructor) (Section 01:

Architecture students) (Section 02: others) An examination of the art and theory of the design of houses by architects who developed the form to perfection. Lectures and field trips will focus on the work of selected house architects from antiquity to the present.

▭ **ARCH 364 ARCHITECTURAL MODELLING.** (3) (2-1-6) (Prerequisite: ARCH 202 and ARCH 471) 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.

▭ ★ **ARCH 372 HISTORY OF ARCHITECTURE IN CANADA.** (2) (2-0-4) (Prerequisite: ARCH 202) (Given alternate years, alternating with ARCH 388) French, British and American influences in the Maritime Provinces, Quebec and Ontario.

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

ARCH 377 ENERGY, ENVIRONMENT AND BUILDINGS. (2) (2-0-4) (Prerequisite: ARCH 202 or permission of instructor) (Section 01: Architecture students) (Section 02: others; limited enrolment.) 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.

ARCH 378 SITE USAGE. (3) (2-0-7) (Prerequisite: ARCH 202 or permission of instructor) (Section 01: Architecture students) (Section 02: others; limited enrolment.) 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.

▭ **ARCH 379 SUMMER COURSE ABROAD.** (3) (0-0-9) (Prerequisite: ARCH 202 or permission of instructor) (Departmental permission required) Study of a distinct urban environment and its key buildings; graphic recording and analysis of physical configuration, constructional peculiarities and present use. Excursions to neighbouring sites of special architectural interest.

ARCH 383 GEOMETRY/ARCHITECTURE/ENVIRONMENT. (2) (2-0-4) (Prerequisite: ARCH 202 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.

● ★ **ARCH 388 INTRODUCTION TO HISTORIC PRESERVATION.** (2) (2-2-2) (Prerequisite: ARCH 303) (Given alternate years, alternating with ARCH 372)

ARCH 405 DESIGN AND CONSTRUCTION 3. (6) (2-10-6) (Prerequisite: ARCH 304) 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.

ARCH 406 DESIGN AND CONSTRUCTION 4. (6) (2-10-6) (Prerequisite: ARCH 405) 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.

● **ARCH 410 DESIGN AND CONSTRUCTION 5.** (6)

ARCH 447 ELECTRICAL SERVICES. (2) (2-2-2) (Prerequisite: ARCH 304) (Section 01: Architecture students) (Section 02: others; limited enrolment.) Production, measurement and control of light; design of lighting systems; electrical distribution in residential and commercial buildings; Canadian Electrical Code.

ARCH 451 BUILDING REGULATIONS AND SAFETY. (2) (2-2-2) (Prerequisite: ARCH 405) (Section 01: Architecture students) (Section 02: others; limited enrolment.) The study of building codes with specific emphasis 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.

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

▭ **ARCH 471 COMPUTER-AIDED BUILDING DESIGN.** (2) (2-2-2) (Prerequisite: ARCH 202 or equivalent) An introduction to selected applications of interactive computing 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.

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

ARCH 520 MONTREAL: URBAN MORPHOLOGY. (3) (2-1-6) (Prerequisite: ARCH 251) (Section 01: Architecture students) (Section 02: others; limited enrolment.) Historical, geographical, demographical, and regional evolution of the metropolis of Montreal. Topics include: important quartiers, the Montreal urban grid, industrialization, reform movements, geographical diversity, urban culture, local building techniques and materials. Basic concepts of urban morphology and their relationships to the contemporary urban context will be explored.

● **ARCH 521 STRUCTURE OF CITIES.** (3) (2-0-7) (Prerequisite: ARCH 202 or permission of instructor) (Section 01: Architecture students) (Section 02: others; limited enrolment.)

● ▭ **ARCH 522 HISTORY OF DOMESTIC ARCHITECTURE IN QUEBEC.** (3) (2-0-7) (Prerequisite: ARCH 251) (Departmental permission required)

▭ ★ **ARCH 523 SIGNIFICANT TEXTS AND BUILDINGS.** (3) (2-0-7) (Prerequisite: ARCH 251) (Alternating with ARCH 524) (Departmental permission required) 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.

● ▭ ★ **ARCH 524 SEMINAR ON ARCHITECTURAL CRITICISM.** (3) (2-0-7) (Prerequisite: ARCH 251) (Alternating with ARCH 523) (Departmental permission required)

● ▭ **ARCH 525 SEMINAR ON ANALYSIS AND THEORY.** (3) (2-0-7) (Prerequisite: ARCH 202 or permission of instructor) (Departmental permission required)

ARCH 526 PHILOSOPHY OF STRUCTURE. (3) (2-0-7) (Prerequisite: ARCH 202 or permission of Instructor) (Not open to students who have taken ARCH 374) (Section 01: Architecture students) (Section 02: others; imited enrolment.) 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.

ARCH 527 CIVIC DESIGN. (3) (2-0-7) (Prerequisite: ARCH 378) (Section 01: Architecture students) (Section 02: others; limited enrolment.) The elements of form in buildings and their siting design in the urban setting.

ARCH 528 HISTORY OF HOUSING. (3) (2-0-7) (Prerequisite: ARCH 251 or permission of instructor) (Section 01: Architecture students) (Section 02: others) Indigenous housing both transient and permanent, from the standpoint of individual structure and pattern of settlements. The principal historic examples of houses including housing in the age of industrial revolution and contemporary housing.

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

ARCH 531 ARCHITECTURAL INTENTIONS VITRUVIUS - RENAISSANCE. (3) (2-0-7) (Prerequisite: ARCH 251) (Section 01: Architecture students) (Section 02: others; limited enrolment.) 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.

ARCH 532 ORIGINS OF MODERN ARCHITECTURE. (3) (2-0-7) (Prerequisite: ARCH 251) (Section 01: Architecture students) (Section 02: others; limited enrolment.) 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.

● ▭ **ARCH 533 NEW APPROACHES TO ARCHITECTURAL HISTORY.** (3) (2-0-7) (Prerequisite: ARCH 251 or permission of instructor) (Departmental permission required)

ARCH 540 SELECTED TOPICS IN ARCHITECTURE 1. (3) (2-0-7) A course to allow the introduction of new topics in Architecture as needs arise, by regular and visiting staff.

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

ARCH 550 URBAN PLANNING 1. (3) (2-0-7) (Prerequisite: B.Sc.(Arch.) or permission of instructor) (Not normally open to Urban Planning students) (Section 01: Architecture students) (Section 02: others; limited enrolment.) Theory and practice. An examination of different basic approaches to urban planning with special reference to Quebec.

ARCH 551 URBAN PLANNING 2. (3) (2-1-6) (Prerequisite: ARCH 550) (Section 01: Architecture students) (Section 02: others; limited enrolment.) Urban design and project development, theory and practice. Detailed analysis of selected examples of the development process and of current techniques in urban design. Includes case studies from Quebec and elsewhere.

ARCH 554 MECHANICAL SERVICES. (2) (2-0-4) (Prerequisite: ARCH 405 or permission of instructor) (Section 01: Architecture students) (Section 02: others; limited enrolment.) 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.

ARCH 555 ENVIRONMENTAL ACOUSTICS. (2) (2-0-4) (Prerequisite: ARCH 405 or permission of instructor) (Section 01: Architecture students) (Section 02: others; limited enrolment.) 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.

▭ **OCC1 442 ENVIRONMENTS FOR THE DISABLED.** (2) (1-2-3) (Prerequisite: ARCH 303 for Architecture students; OCC1 326 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.

4.3 Department of Chemical Engineering

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Sasha Omanovic; B.Sc., Ph.D. (Zagreb)

PAPRICAN Adjunct Professor
George J. Kubes; B.Eng., M.Eng.(Prague), Ph.D.(Bratislava)

Adjunct Professors
Andrejs Beils, Claude Belanger, Pierre Bisaillon, Richard Campeau, Peter Csakany, Mario Davidovsky, France Dubuc, Andrés Garcia-Rejon, Gil Garnier, Serge Guiot, Bing Huang, David J. McKeagan, Carlos Miguez, Arun S. Mujumdar, Patrice Nadeau, Raman Nayar, Norman Peters, Marc Renaud, Bassam Sarkis, John Sarlis, Armen Tasan, Roger C. Urquhart, Leszek A. Utracki, Paula Wood-Adams.

The central purpose of engineering is to pursue solutions to technological problems in order to satisfy the needs and desires of society. Chemical engineers are trained to solve the kinds of problems that are typically found in the "chemical process industries", which include the chemical manufacturing, plastics, water treatment, pulp and paper, 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, economic and environmental concerns. For this reason, practitioners of chemical engineering often deal with these questions when they are working in management, pollution abatement, product development, marketing 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 understanding of the process industries. Those with an interest in the fourth major science, biology, will find several courses in the chemical engineering curriculum which integrate aspects of the biological 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 subjects. Some students elect to complete a minor in biotechnology, management, materials engineering, computer science, environmental engineering or chemistry.

The solution to many environmental problems requires an understanding of technological principles. A chemical engineering degree provides an ideal background. In addition to relevant material learned in the core program, a selection of environmental complementary courses and minor programs is available. The involvement of many chemical engineering staff members in environmental research provides the opportunity for undergraduate students to carry out research projects in this area.

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 curriculum 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 departmental programs in three calendar years. Students who have passed Chemistry 202 or 302 at the CEGEP level may be exempt from course CHEM 212 or CHEM 234, respectively (Introductory Organic Chemistry 1 and Selected Topics in Organic Chemistry), the corresponding courses are transferred from required courses to electives. 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 MATH 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.

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 discuss 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 passing grade in other complementary courses and in any elective courses taken.

CURRICULUM FOR THE B.ENG. DEGREE IN CHEMICAL ENGINEERING

REQUIRED COURSES		COURSE CREDIT	
Non-Departmental Courses			
CHEM 212	Introductory Organic Chemistry 1	4	
CHEM 233	Sel. Topics in Phys. Chemistry	3	
CHEM 234	Sel. Topics in Org. Chemistry	3	
COMP 208	Computers in Engineering	3	
MATH 260	Intermediate Calculus	3	
MATH 261	Differential Equations	3	
MATH 265	Advanced Calculus	3	
MIME 221	Engineering Professional Practice	1	
MIME 310	Engineering Economy	3	**26**
Chemical Engineering Courses			
CHEE 200	Intro. to Chemical Eng.	4	
CHEE 204	Chemical Manuf. Processes	3	
CHEE 220	Chem. Eng.Thermodynamics	3	
CHEE 291	Instr. Measurements Lab.	4	
CHEE 314	Fluid Mechanics	4	
CHEE 315	Heat and Mass Transfer	4	
CHEE 340	Process Modelling	3	
CHEE 351	Separation Processes	3	
CHEE 360	Technical Paper 1	1	
CHEE 370	Elements of Biotechnology	3	
CHEE 380	Materials Science	3	
CHEE 392	Project Laboratory 1	4	
CHEE 393	Project Laboratory 2	5	
CHEE 423	Chemical Reaction Engineering	4	
CHEE 453	Process Design	4	
CHEE 455	Process Control	4	
CHEE 456	Design Project 1	1	
CHEE 457	Design Project 2	5	
CHEE 462	Technical Paper 2	1	
CHEE 474	Biochemical Engineering	3	
CHEE 484	Materials Engineering	3	**69**
COMPLEMENTARY COURSES			
Courses to be selected from those approved by the Department (see list of technical complementaries below)			**9**
See section 3.4. The Chemical Engineering program requires 6 credits selected from categories (i) and (ii) of section 3.4.			**6**
TOTAL			**110**

If advanced credit is obtained for MATH 260 Intermediate Calculus (see section 2.4), 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		**Credits**	
CHEE 200	Intro. to Chemical Eng.	4	
CHEE 291	Instr. Meas. Lab.	4	
CHEM 212	Organic Chemistry 1	4	
MATH 260	Intermediate Calculus	3	
MIME 221	Engineering Professional Practice	1	**16**
Semester 2			
CHEE 204	Chemical Manuf. Processes	3	
CHEE 220	Chem. Eng. Thermodynamics	3	
CHEM 234	Organic Chemistry 2	3	
COMP 208	Computers in Engineering	3	
MATH 261	Differential Equations	3	**15**

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

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

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.

The Technical Complementary courses currently approved by the Department are as follows::

BIOT 505	Selected Topics in Biotechnology (Biotechnology Minor students only)
CHEE 363	Projects in Chemical Engineering 1
CHEE 438	Eng. Princ. of Pulp & Paper Processes
CHEE 452	Particulate Systems
CHEE 458	Computer Applications
CHEE 464	Projects in Chemical Engineering 2
CHEE 471	Industrial Water Pollution Control (or CIVE 430)
CHEE 472	Industrial Air Pollution Control (or MECH 534)
CHEE 481	Polymer Engineering
CHEE 487	Chemical Processing in the Electronics Industry
CHEE 494	Research Project and Seminar
CHEE 495	Research Project and Seminar
CHEE 571	Small Computer Applications in Chemical Engineering
CHEE 581	Polymer Composites Engineering

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

Courses CHEE 370 and CHEE 474 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: CHEE 471 and CHEE 472. As some water pollution control problems are solved by microbial processes, course CHEE 474 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 CHEE 452 is also relevant. Additional courses in this area are listed under section 5.7.

A Minor in Biotechnology is also offered in the Faculties of Engineering and of Science with emphasis on Molecular Biology and Chemical Engineering Processes. A full description of the Minor program appears in section 5.2.

Note that many of the technical complementaries are offered only in alternate years. Students should, therefore, plan their complementaries as far ahead as possible. With the approval of the instructor and academic advisor, students may also take graduate (CHEE 500- level) courses as technical complementaries.

ELECTIVE COURSES

Students who have obtained exemptions for courses, i.e. for CEGEP courses equivalent to CHEM 212 or CHEM 234, or who take more than the minimum requirements for the degree, may choose university-level courses in any field. Approval of an elective course requires only that no timetable conflicts are created and that it not be a repetition of material already covered in the curriculum or already mastered by the student.

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 example, recent events have included student-professor banquets and Christmas parties, dances, speakers, broomball games and joint meetings with the Montreal Section of the CSChE. The latter gives students a chance to mix with practising chemical engineers.

COURSES OFFERED BY THE DEPARTMENT

For the Term (Fall and/or Winter), days, and times when courses will be offered, please refer to the 2002-2003 Class Schedule on the Web, http://www.mcgill.ca/students/. Class locations and names of instructors are also provided.

Students preparing to register are advised to consult the Class Schedule website for the most up-to-date list of courses available. New courses may have been added or courses rescheduled after this Calendar went to press.

The schedule of courses to be offered in Summer 2003 will be available on the website in January.

CHEE has replaced 302 as the prefix for Chemical Engineering courses.

The course credit weight is given in parentheses after the title.

● Denotes courses not offered in 2002-03.

▭ Denotes courses with limited enrolment.

CHEE 200 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.

CHEE 204 CHEMICAL MANUFACTURING PROCESSES. (3) (2-3-4) (Prerequisite: CHEE 200) Material and energy balances in chemical processes. Problem solving in the design of separation processes (evaporation, crystillization), reactor design, process control, and environmental applications. reactor design and environmental

CHEE 220 CHEMICAL ENGINEERING THERMODYNAMICS. (3) (3-1-8) (Prerequisite: CHEE 200) 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.

▭ **CHEE 230 ENVRONMENTAL 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.

CHEE 291 INSTRUMENTAL MEASUREMENT LAB. (4) (2-5-5) Elements of statistical analysis associated with instrumental measurements. Principles of operation and calibration of selected measuring instruments. Principles of modern data acquisition and processing. Introduction to instrument system selection in chemical engineering.

CHEE 314 FLUID MECHANICS. (4) (3-3-6) (Prerequisite: CHEE 204. Corequisite: MATH 265.) 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.

CHEE 315 HEAT AND MASS TRANSFER. (4) (3-2-7) (Prerequisite: CHEE 314) Transport of heat and mass by diffusion and convection; transport of heat by radiation; diffusion; convective mass transfer; drying; absorption; mathematical formulation of prob-

lems and equipment design for heat and mass transfer; laboratory exercises.

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

CHEE 351 SEPARATION PROCESSES. (3) (3-0-6) (Prerequisites: CHEE 204, CHEE 220. Corequisites: CHEE 315.) Concepts underlying separation processes. Equilibrium-based processes with staging and continuous contacting, distillation, evaporation, liquid-liquid extraction, leaching. Introduction to membrane based separations.

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

CHEE 363 PROJECTS CHEMICAL ENGINEERING 1. (2) (1-0-5) (Prerequisite: CHEE 200 (A D grade is acceptable for prerequisite purposes only)) 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.

CHEE 370 ELEMENTS OF BIOTECHNOLOGY. (3) (3-0-6) (Prerequisite: CHEM 234) Enzyme kinetics; proteins, carbohydrates and other biochemicals; industrially significant microbes; introduction to genetic engineering, cell structure and metabolism; laboratory exercises.

CHEE 380 MATERIALS SCIENCE. (3) (3-1-5) (Prerequisite: CHEE 220) 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.

CHEE 392 PROJECT LABORATORY 1. (4) (3-3-6) (Prerequisite: CHEE 291) 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.

CHEE 393 PROJECT LABORATORY 2. (5) (2-10-4) (Prerequisite: CHEE 392) Student groups execute and report on experimental projects.

CHEE 423 CHEMICAL REACTION ENGINEERING. (4) (3-1-8) (Prerequisites: CHEM 233; CHEE 315) Review of fundamental concepts in chemical reaction thermodynamics and kinetics. Mass and energy balances for homogenous ideal reactors. Batch, semi-batch and continuous operation. Minimization of by-product and pollution production. Heterogenous reactions, effect of heat and mass transfer on the global rate. Laboratory exercises.

● ▭ **CHEE 430 TECHNOLOGY IMPACT ASSESSMENT.** (3) (3-1-5) (Restricted to final year students by permission of instructor)

CHEE 438 ENERGY PRINCIPLES IN PULP AND PAPER PROCESSES. (3) (3-0-6) (Corequisite: CHEE 423) Characterization of wood, pulp and paper. Flowsheets of basic pulping processes. Applications of thermodynamics, fluid mechanics, heat and mass transfer, and reaction engineering principles in the pulp and paper processes.

CHEE 452 PARTICULATE SYSTEMS. (3) (3-0-6) (Prerequisites: CHEE 200, CHEE 314) (A D grade is acceptable for prerequisite purposes only.) Study of operations involving multiphase systems with one of the phases finely sub-divided as bubbles, drops or particles. Applications in environmental engineering, grinding, agglomeration, settling, fluidization.

CHEE 453 PROCESS DESIGN. (4) (4-1-7) (Prerequisites: CHEE 315; MIME 310. Corequisite: CHEE 351) Analysis of design alternatives. Structure of process design systems, degrees of freedom, information flow. Computer-aided process and plant design programs, physical properties, specifications, recycle convergence, optimization, applications, economics. Safety, environmental control in plant design.

CHEE 455 PROCESS CONTROL. (4) (3-1-8) (Prerequisites: CHEE 315; CHEE 351; CHEE 423) 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.

CHEE 456 DESIGN PROJECT 1. (1) (1-0-2) (Prerequisite: CHEE 393. Corequisite: CHEE 453. Must be taken in the semester preceding CHEE 547.) Introduction to a process design and economic evaluation project, including environmental and safety aspects, for a major industrial operation. Students work in small groups under an experienced plant design supervisor.

CHEE 457 DESIGN PROJECT 2. (5) (1-2-12) (Prerequisite: CHEE 456. Must be taken in the semester following CHEE 456.) A process plant design and economic evaluation, including environmental and safety aspects, for a major industrial operation. Students work in small groups, under an experienced plant design supervisor. Plant visit.

CHEE 458 COMPUTER APPLICATIONS. (3) (2-3-4) (Prerequisites: COMP 208 and CHEE 393) 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.

CHEE 462 TECHNICAL PAPER 2. (1) (0-0-3) (Prerequisite: CHEE 360) A technical paper prepared according to instructions issued by the Department.

CHEE 464 PROJECTS CHEMICAL ENGINEERING 2. (2) (1-0-5) (Prerequisite: CHEE 363) 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.

CHEE 471 INDUSTRIAL WATER POLLUTION CONTROL. (3) (3-0-6) (Prerequisite: CHEE 314 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.

CHEE 472 INDUSTRIAL AIR POLLUTION CONTROL. (3) (2-0-7) (Prerequisite: CHEE 314 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.

CHEE 474 BIOCHEMICAL ENGINEERING. (3) (3-0-6) (Prerequisites: CHEE 370, CHEE 423) Bioreactor design for biotechnology and environmental applications; microbial growth kinetics; application of transport phenomena and selected chemical engineering unit operations. Bioreactor instrumentation and performance optimization. Air and media sterilization processes. Selected operations of downstream processing and product recovery.

CHEE 481 POLYMER ENGINEERING. (3) (3-0-6) (Prerequisite: CHEM 212) 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, viscoelasticity and rheology, processing techniques; extrusion, molding, etc.

CHEE 484 MATERIALS ENGINEERING. (3) (3-0-6) (Prerequisites: CHEE 315, CHEE 380) 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.

CHEE 487 CHEMICAL PROCESSING: ELECTRONICS INDUSTRY. (3) (3-0-6) (Prerequisite: CHEM 233) 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.

CHEE 494 RESEARCH PROJECT AND SEMINAR. (3) (1-6-2) (Prerequisite: CHEE 393) Independent study and experimental work on a topic chosen by consultation between the student and Departmental Staff.

CHEE 494D1 RESEARCH PROJECT AND SEMINAR. (1.5) (Students must also register for CHEE 494D2) (No credit will be given for this course unless both CHEE 494D1 and CHEE 494D2 are successfully completed in consecutive terms) (CHEE 494D1 and CHEE 494D2 together are equivalent to CHEE 494) See CHEE 494 for course description.

CHEE 494D2 RESEARCH PROJECT AND SEMINAR. (1.5) (Prerequisite: CHEE 494D1) (No credit will be given for this course unless both CHEE 494D1 and CHEE 494D2 are successfully completed in consecutive terms) (CHEE 494D1 and CHEE 494D2 together are equivalent to CHEE 494) See CHEE 494 for course description.

CHEE 495 RESEARCH PROJECT AND SEMINAR. (4) (1-9-2) (Prerequisite: CHEE 393) Independent study and experimental work on a topic chosen by consultation between the student and the Departmental staff.

CHEE 495D1 RESEARCH PROJECT AND SEMINAR. (2) (Students must also register for CHEE 495D2) (No credit will be given for this course unless both CHEE 495D1 and CHEE 495D2 are successfully completed in consecutive terms) (CHEE 495D1 and CHEE 495D2 together are equivalent to CHEE 495) See CHEE 495 for course description.

CHEE 495D2 RESEARCH PROJECT AND SEMINAR. (2) (Prerequisite: CHEE 495D1) (No credit will be given for this course unless both CHEE 495D1 and CHEE 495D2 are successfully completed in consecutive terms) (CHEE 495D1 and CHEE 495D2 together are equivalent to CHEE 495) See CHEE 495 for course description.

CHEE 496 ENVIRONMENTAL RESEARCH PROJECT. (3) (1-6-2) (Prerequisite: CHEE 393 or permission of instructor.) Independent study and experimental work on an environmental topic chosen by consultation between the student and Departmental staff.

CHEE 496D1 ENVIRONMENTAL RESEARCH PROJECT. (1.5) (Students must also register for CHEE 496D2) (No credit will be given for this course unless both CHEE 496D1 and CHEE 496D2 are successfully completed in consecutive terms) (CHEE 496D1 and CHEE 496D2 together are equivalent to CHEE 496) See CHEE 496 for course description.

CHEE 496D2 ENVIRONMENTAL RESEARCH PROJECT. (1.5) (Prerequisite: CHEE 496D1) (No credit will be given for this course unless both CHEE 496D1 and CHEE 496D2 are successfully completed in consecutive terms) (CHEE 496D1 and CHEE 496D2 together are equivalent to CHEE 496) See CHEE 496 for course description.

CHEE 571 SMALL COMPUTER APPLICATIONS: CHEMICAL ENGINEERING. (3) (2-0-7) (Prerequisite: CHEE 458 or permission of the instructor.) (Undergraduate program: complementary course) 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.

● **CHEE 581 POLYMER COMPOSITES ENGINEERING.** (3) (3-0-6) (Prerequisite: CHEE 481 or permission of instructor)

CHEE 591 ENVIRONMENTAL BIOREMEDIATION. (3) (3-0-6) (Undergraduate program: complementary course) 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.

4.4 Department of Civil Engineering and Applied Mechanics

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Richard G. Redwood; B.Sc.(Eng.)(Bristol), M.A.Sc.(Tor.), Ph.D.(Bristol), F.C.S.C.E., F.I.Struct.Eng., Eng.
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.
M. Saeed Mirza; B.Eng.(Karachi), M.Eng., Ph.D.(McG.), F.A.C.I., F.E.I.C., F.C.S.C.E., Hon. F.I.E.P., Eng.
Denis Mitchell; B.A.Sc., M.A.Sc., Ph.D.(Tor.), F.A.C.I., F.C.A.E., F.C.S.C.E., Eng. *(William Scott Professor of Civil Engineering)*
Van-Thanh-Van Nguyen; B.M.E.(Vietnam), M.C.E.(A.I.T.), D.A.Sc.(Montr.), Eng.
A. Patrick S. Selvadurai; M.S.(Stan.), Ph.D., D.Sc.(Nottingham), F.E.I.C., F.I.M.A., F.C.S.C.E., P.Eng.
Suresh C. Shrivastava; B.Sc.(Eng.) (Vikram), M.C.E.(Del.), Sc.D.(Col.), Eng.

Associate Professors
Luc E. Chouinard; B.Ing., M.Ing.(Montr.), B.C.L.(McG.), Sc.D.(M.I.T.), Eng.
Ronald Gehr; B.Sc.(Eng.)(Rand), M.A.Sc.,Ph.D.(Tor.), P.Eng.
Ghyslaine McClure; B.Ing.(Montr.), S.M.C.E.(M.I.T.), Ph.D.(Montr.), Eng.
James Nicell; B.A.Sc., M.A.Sc., Ph.D.(Windsor), P.Eng. *(William Dawson Scholar)*

Assistant Professors
Susan J. Gaskin; B.Sc.(Queen's), Ph.D. (Canterbury)
Subhasis Ghoshal; B.C.E. (India), M.S.(Missouri), Ph.D. (Carnegie Mellon)
Murtaza Haider; B.Sc.(Peshawar), M.A.Sc., Ph.D.(Tor.) *(joint appt. with School of Urban Planning)*
Colin Rogers; B.A.Sc.(Waterloo), M.A.Sc., Ph.D.(Sydney), P.Eng.
Yixin Shao; B.S., M.S.(Tongji), Ph.D.(Northwestern)

Adjunct Professors
Sofia Barbarutsi, Jordan Belovski, Claude Carette, Serge Guiot, John Hadjinicolaou, Jalal Hawari, Paul Henshaw, Catherine Hirou, Graham Holder, Robert D. Japp, Kenneth MacKenzie, Charles Manatakos, John C. Osler, Vincent Patterson, Martin Samson, Sandro Scola, David Stringer, William Taylor, Jan Vrana, Ronald Zaloum

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, 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 the 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 combining 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 and Geoenvironmental Engineering, Water Resources and Hydraulic 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 *Welcome to McGill* for the prescribed courses for the first two semesters. All students must meet with their advisor each semester 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 advisor. 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 advisor.

CURRICULUM FOR THE B.ENG. DEGREE IN CIVIL ENGINEERING

REQUIRED COURSES		COURSE CREDIT	
Non-departmental courses			
COMP 208	Computers in Engineering	3	
EDEC 206	Communication in Engineering	3	
EPSC 221	General Geology	3	
MATH 260	Intermediate Calculus	3	
MATH 261	Differential Equations	3	
MATH 265	Advanced Calculus	3	
MECH 261	Measurement Laboratory	2	
MECH 290	Graphics	3	
MIME 221	Engineering Professional Practice	1	
MIME 310	Engineering Economy	3	**27**
Departmental courses			
CIVE 202	Construction Materials	4	
CIVE 205	Statics	3	
CIVE 206	Dynamics	3	
CIVE 207	Solid Mechanics	4	
CIVE 208	Civil Eng Systems Analysis	3	
CIVE 210	Surveying	2	
CIVE 225	Environmental Engineering	4	
CIVE 290	Thermodynamics & Heat Transfer	3	
CIVE 302	Probabilistic Systems	3	
CIVE 311	Geotechnical Mechanics	4	
CIVE 317	Structural Engineering 1	3	
CIVE 318	Structural Engineering 2	3	
CIVE 319	Transportation Engineering	3	
CIVE 320	Numerical Methods	4	
CIVE 323	Hydrology & Water Resources	3	
CIVE 324	Construction Project Management	3	
CIVE 327	Fluid Mechanics and Hydraulics	4	
CIVE 418	Design Project	3	
CIVE 432	Technical Paper	1	**60**
COMPLEMENTARY COURSES			
A minimum of six credits to be selected from list (a) and the remaining nine credits to be slected from lists (a) or (b) or from other suitable undergraduate or 500-level courses.			**15**
(a) Design Technical Complementaries			
CIVE 416	(3) Geotechnical Engineering		
CIVE 421	(3) Municipal Systems		
CIVE 428	(3) Water Resources & Hydraulic Engineering		
CIVE 462	(3) Design of Steel Structures		
CIVE 463	(3) Design of Concrete Structures		
(b) General Technical Complementaries			
CIVE 430	(3) Water Treatment & Pollut Control		
CIVE 433	(3) Urban Planning		
CIVE 440	(3) Traffic Engineering		
CIVE 446	(3) Construction Engineering		
CIVE 451	(3) Geoenvironmental Engineering		
CIVE 460	(3) Matrix Structural Analysis		
CIVE 470	(3) Research Project		
CIVE 512	(3) Advanced Civil Engrg Materials		
CIVE 514	(3) Structural Mechanics		
CIVE 526	(3) Solid Waste Management		
CIVE 527	(3) Renov & Preserv of Infrastructure		
CIVE 540	(3) Urban Transportation Planning		
CIVE 541	(3) Rail Engineering		
CIVE 550	(3) Water Resources Management		
CIVE 553	(3) Stream Pollution and Control		
CIVE 555	(3) Environmental Data Analysis		
CIVE 570	(3) Waves and Costal Engineering		
CIVE 572	(3) Computational Hydraulics		
CIVE 573	(3) Hydraulic Structures		
CIVE 574	(3) Fluid Mech of Water Pollution		
CIVE 576	(3) Hydrodynamics		
CIVE 577	(3) River Engineering		
CIVE 579	(3) Water Power Engineering		
CIVE 585	(3) Groundwater Hydrology		
CIVE 586	(3) Earthwork Engineering		
CIVE 587	(3) Pavement Design		
Two courses (6 credits) to be selected in consultation with academic advisor as prescribed by section 3.4.			**6**
TOTAL CREDITS			**108**
If advanced credit given for MATH 260, Intermediate Calculus (see section 2.4)			
TOTAL CREDITS			**105**

COURSES OFFERED BY THE DEPARTMENT

For the Term (Fall and/or Winter), days, and times when courses will be offered, please refer to the 2002-2003 Class Schedule on the Web, http://www.mcgill.ca/students/. Class locations and names of instructors are also provided.

Students preparing to register are advised to consult the Class Schedule website for the most up-to-date list of courses available. New courses may have been added or courses rescheduled after this Calendar went to press.

The schedule of courses to be offered in Summer 2003 will be available on the website in January.

CIVE has replaced 303 as the prefix for Civil and Applied Mechanics Engineering courses.

The course credit weight is given in parentheses after the title.

● Denotes courses not offered in 2002-03.

▭ Denotes courses with limited enrolment.

CIVE 202 CONSTRUCTION MATERIALS. (4) (4-2-6) (Prerequisite: CIVE 290) 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.

CIVE 203 SOLID MECHANICS LABORATORY. (1)

CIVE 205 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.

CIVE 206 DYNAMICS. (3) (3-2-4) (Prerequisite: CIVE 205. Corequisites: MATH 260 and MATH 261) Kinematics and kinetics of particles, systems, and rigid bodies; mass-acceleration, work-energy, impulse-momentum. Moving coordinate systems. Lagrange's equations. Vibrations and waves.

CIVE 207 SOLID MECHANICS. (4) (3-2-7) (Prerequisites: CIVE 205 (a D grade is acceptable for prerequisite purposes), MECH 290 (under special circumstances, the Department may permit this course to be taken as a corequisite) or equivalent) (Two-hour laboratory periods, alternate weeks. Weekly tutorials) Stress-strain relationships; elastic and inelastic behaviour; performance criteria. Elementary and compound stress states, Mohr's circle. Shear strains, torsion. Bending and shear stresses in flexural members. Deflections of beams. Statically indeterminate systems under flexural and axial loads. Columns. Dynamic loading.

CIVE 208 CIVIL ENGINEERING SYSTEMS ANALYSIS. (3) (3-1-5) (Prerequisites: COMP 208 and Corequisite: MATH 265) 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 method.

CIVE 210 SURVEYING. (2) (Two weeks after winter session examination period) (Prerequisite: COMP 208) 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.

CIVE 225 ENVIRONMENTAL ENGINEERING. (4) (4-2-6) (Prerequisite: CIVE 290. Corequisite: MATH 261) 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.

● **CIVE 229 SURVEYING FOR ARCHITECTS.** (2) (2-3-1)

CIVE 281 ANALYTICAL MECHANICS. (3) (3-1-5) (Corequisites: MATH 260 and MATH 261) Kinematics of particles, dynamics of particles. Work, conservative forces, potential energy. Relative motion and general moving frames of reference. Central force fields and orbits. Dynamics of a system of particles. General motion of rigid bodies, angular momentum and kinetic energy of rigid bodies. Generalized coordinates and forces, Lagrange's equations.

CIVE 283 STRENGTH OF MATERIALS. (4) (4-1-7) (Prerequisite: CIVE 205 (a D grade is acceptable for prerequisite purposes)) 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.

CIVE 290 THERMODYNAMICS AND 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, polytrophic processes, applications of First Law; Second Law; entropy; introduction to heat transfer.

CIVE 302 PROBABILISTIC SYSTEMS. (3) (3-1-5) (Prerequisites: MATH 260 and COMP 208 (a D grade is acceptable for prerequisite purposes)) An introduction to probability and statistics with applications to Civil Engineering design. Descriptive statistics, common probability models, statistical estimation, regression and correlation, acceptance sampling.

CIVE 311 GEOTECHNICAL MECHANICS. (4) (3-3-6) (Prerequisite: CIVE 207) 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.

CIVE 317 STRUCTURAL ENGINEERING 1. (3) (3-1-5) (Prerequisites: CIVE 202 and CIVE 207) 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.

CIVE 318 STRUCTURAL ENGINEERING 2. (3) (3-1-5) (Prerequisite: CIVE 317) Durability and service life; fire resistance and protection; steel, reinforced concrete and timber; behaviour and design of components in tension, compression, bending and shear; slenderness, global and local instability; axial load and moment interaction; curvature, deflection, ductility; connections; bond and anchorage of reinforcement; simple footings.

CIVE 319 TRANSPORTATION ENGINEERING. (3) (3-1-5) (Prerequisites: CIVE 208 and COMP 208. Corequisite: CIVE 302) 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.

CIVE 320 NUMERICAL METHODS. (4) (3-3-6) (Prerequisites: COMP 208 and MATH 265) 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.

CIVE 323 HYDROLOGY AND WATER RESOURCES. (3) (3-2-4) (Prerequisite: CIVE 302) 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.

CIVE 324 CONSTRUCTION PROJECT MANAGEMENT. (3) (3-1-5) (Prerequisites: MIME 310 and CIVE 208) Construction fundamen-

tals; 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.

CIVE 327 FLUID MECHANICS AND HYDRAULICS. (4) (3-6-3) (Prerequisites: CIVE 206 and MATH 265) Fluid properties; hydrostatics; dimensional analysis and similitude, fluxes of mass, momentum and energy; Bemoulli's equation; method of control volume; streamline curvature; potential flow and boundary layers; pipe flow, hydraulic machinery and introduction to open-channel flow.

● **CIVE 382 PARTIAL DIFFERENTIAL EQUATIONS IN ENGINEERING.** (3) (3-1-5) (Prerequisites: MATH 261, MATH 265 and CIVE 281 (a D grade is acceptable for prerequisite purposes)

CIVE 385 STRUCTURAL STEEL AND TIMBER DESIGN. (3) (3-1-5) (Prerequisite: CIVE 283. Corequisite: ARCH 240) 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.

CIVE 388 FOUNDATION AND CONCRETE DESIGN. (3) (3-1-5) (Prerequisite: CIVE 283) Physical properties of concrete; behaviour and design of reinforced concrete members in compression, tension, bending, shear and combined loadings; bond and anchorage; soil properties, soil testing, footings; pile foundation; shorting; retaining walls.

CIVE 416 GEOTECHNICAL ENGINEERING. (3) (3-1.5-4.5) (Prerequisite: CIVE 311) 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.

CIVE 418 DESIGN PROJECT. (3) (1-2-6) (Prerequisite: Completion of an approved set of required and complementary courses; normally restricted to final semester.) Capstone design project.

CIVE 421 MUNICIPAL SYSTEMS. (3) (3-2-4) (Prerequisite: CIVE 327) 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.

CIVE 428 WATER RESOURCES AND HYDRAULIC ENGINEERING. (3) (3-3-3) (Prerequisite: CIVE 327) Application of continuity, energy and momentum concepts to open-channel flow; design of channels considering uniform flow and flow resistance, non-uniform flow and longitudinal profiles; design of channel controls and transitions; unsteady flow and flood routing; river ice engineering.

CIVE 430 WATER TREATMENT AND POLLUTION CONTROL. (3) (3-3-3) (Prerequisites: CIVE 225 and CIVE 327) Principles of water and sewage treatment. Water and sewage characteristics; design of conventional unit operations and processes; laboratory analyses of potable and waste waters.

CIVE 432 TECHNICAL PAPER. (1) (0-0-3) (Prerequisite: EDEC 206) 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.

CIVE 433 URBAN PLANNING. (3) (3-1-5) (Prerequisites: CIVE 421 and MIME 310. Corequisite: CIVE 319) 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.

CIVE 440 TRAFFIC ENGINEERING. (3) (3-1-5) (Prerequisite: CIVE 319 (a D grade is acceptable for prerequisite purposes)) Driver, vehicle and traffic flow characteristics; origin-destination studies, traffic studies and analysis, accident studies, queuing theory applications, gap acceptance, simulation, highway capacity, traffic regulations and control measures, intersection control.

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

CIVE 451 GEOENVIRONMENTAL ENGINEERING. (3) (3-1.5-4.5) (Prerequisites: CIVE 225 and CIVE 311) 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.

CIVE 460 MATRIX STRUCTURAL ANALYSIS. (3) (3-2-4) (Prerequisites: CIVE 206 and CIVE 317) 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.

CIVE 462 DESIGN OF STEEL STRUCTURES. (3) (3-3-3) (Prerequisite: CIVE 318) 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.

CIVE 463 DESIGN OF CONCRETE STRUCTURES. (3) (3-3-3) (Prerequisite: CIVE 318) Review of flexual behaviour and design concepts. Design of flexual members, columns, two-way slab systems, retaining walls, disturbed regions, and shear walls. Introduction to prestressed concrete design.

● **CIVE 469 INFRASTRUCTURE AND SOCIETY.** (3) (3-2-4) (Prerequisite: MIME 310)

CIVE 470 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 CIVE 418 and the project therefore can be carried out through two semesters.

CIVE 492 STRUCTURES. (2) (2-2-2) (Prerequisites: CIVE 385 and CIVE 388) 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.

● **CIVE 512 ADVANCED CIVIL ENGINEERING MATERIALS.** (3) (3-3-3) (Prerequisite: CIVE 202)

CIVE 514 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.

● **CIVE 526 SOLID WASTE MANAGEMENT.** (3) (3-2-4) (Prerequisite: CIVE 225)

CIVE 527 RENOVATION AND PRESERVATION: INFRASTRUCTURE. (3) (3-2-4) (Prerequisites: CIVE 202 and CIVE 318) 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.

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

- **CIVE 541 RAIL ENGINEERING.** (3) (3-1-5)
- **CIVE 546 SELECTED TOPICS IN CIVIL ENGINEERING 1.** (3) (3-0-6)

CIVE 550 WATER RESOURCES MANAGEMENT. (3) (3-0-6) (Prerequisite: CIVE 323 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.

CIVE 553 STREAM POLLUTION AND CONTROL. (3) (3-2-4) (Prerequisite: CIVE 225) Water quality standards. Physical and chemical pollution, 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.

CIVE 555 ENVIRONMENTAL DATA ANALYSIS. (3) (3-0-6) (Prerequisite: CIVE 302 or permission of instructor) Application of statistical principles to design of measurement systems and sampling programs. Introduction to experimental design. Graphical data analysis. Description of uncertainty. Hypothesis tests. Model parameter estimation methods: linear and nonlinear regression methods. Trend analysis. Statistical analysis of censored data. Statistics of extremes.

- **CIVE 570 WAVES AND COASTAL ENGINEERING.** (3) (3-0-6) (Prerequisite: CIVE 327)
- **CIVE 572 COMPUTATIONAL HYDRAULICS.** (3) (3-0-6) (Prerequisite: CIVE 327 or equivalent)

CIVE 573 HYDRAULIC STRUCTURES. (3) (3-0-6) (Prerequisites: CIVE 323 and CIVE 327) 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.

CIVE 574 FLUID MECHANICS OF WATER POLLUTION. (3) (Prerequisite: CIVE 327 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.

- **CIVE 576 HYDRODYNAMICS.** (3) (3-0-6) (Prerequisite: CIVE 327 or equivalent)

CIVE 577 RIVER ENGINEERING. (3) (3-0-6) (Prerequisite: CIVE 327) Fluvial geomorphology; sediment properties; river turbulence; mechanics of the entrainment, transportation and deposition of solids by fluids; threshold of movement; bed forms; suspended load, bed load and total load equations; stable channel design and regime rivers; river modeling; river engineering and river management.

- **CIVE 579 WATER POWER ENGINEERING.** (3) (3-0-6) (Prerequisites: CIVE 323 and MIME 310)
- **CIVE 585 GROUNDWATER HYDROLOGY.** (3) (3-0-6)
- **CIVE 586 EARTHWORK ENGINEERING.** (3) (3-0-6)
- **CIVE 587 PAVEMENT DESIGN.** (3) (3-0-6)

4.5 Department of Electrical and Computer Engineering

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Post-Retirement
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Jonathan Webb; B.A., Ph.D.(Cantab.)

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Bruce Pike; M.Eng., Ph.D.(McG.)
Bernard Segal; B.Sc., B.Eng., M.Eng., Ph.D.(McG.)

Adjunct Professors
Vinod Agarwal, Ray Bartnikas, Maier Blostein, Jean Luc Bouchard, Eduard Cerny, Simon Chamlian, Charalambos Charalambous, Danny Grant, Cedric Guss, Maurice Huneault, Cheng K. Jen, Michael Kaplan, Karim Khordoc, Irene Leszkowicz, Lin Lin, Miguel Marin, Donald McGillis, Douglas O'Shaughnessy, Norbert Puetz, Katarzyna Radecka, Jean Regnier, Farouk Rizk, Mohammad R. Soleymani, Richard Vickers, Lucjan Wegrowicz.

General Information on Programs

The Department of Electrical and Computer Engineering offers undergraduate degree programs in Electrical Engineering, Electrical Engineering (Honours), Computer Engineering, and Software 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 complementaries are selected from graduate courses, facilitating the transition to postgraduate studies. Students in this curriculum benefit from smaller classes and have more contact with professorial 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 3.00. 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.

The Department, jointly with the School of Computer Science, will offer a Bachelor of Software Engineering program (subject to Ministry of Education approval)*. Graduates of this program should be eligible for accreditation (once accreditation standards for Software Engineers have been adopted). This new program offers students the opportunity to focus their studies on the skills needed to design and develop complex software systems. This emerging field of engineering is a major component of the growing Information Technology (IT) sector of the economy, in which the demand for qualified personnel continues to outstrip supply. Graduates of this program will have a solid foundation for careers in the software industry. [*The School of Computer Science will also offer a B.Sc. Major program in Software Engineering (subject to Ministry of Education approval). The B.Sc. program **will not** lead to accreditation. For further information on the Major in Software, refer to the School of Computer Science entry in the Faculty of Science section, page 394.]

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 MATH 260 Intermediate Calculus by passing the Advanced Credit examination described in section 2.4.

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 or wishing to enter the Honours Program are encouraged to take the following advanced math and physics courses:

MATH 325	Ordinary Differential Eqns	instead of MATH 261
MATH 247	Linear Algebra	instead of MATH 270
MATH 248	Advanced Calculus 1	instead of MATH 265
MATH 249	Advanced Calculus 2	instead of MATH 381
PHYS 251	Mechanics	instead of CIVE 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 3.00 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)

REQUIRED COURSES		COURSE CREDIT	
Non-Departmental Courses			
COMP 202	Intro. to Computer Science 1	3	
EDEC 206	Communication in Engineering	3	
MATH 260	Intermediate Calculus	3	
MATH 247*	Linear Algebra	3	
or MATH 270	Applied Linear Algebra (3)		
MATH 248*	Advanced Calculus 1	3	
or MATH 265	Advanced Calculus (3)		
MATH 249	Advanced Calculus 2	3	
or MATH 381	Complex Variables & Transforms (3)		
MATH 325	Ordinary Differential Eqns	3	
or MATH 261	Differential Equations (3)		
MIME 221	Engineering Professional Practice	1	
MIME 310	Engineering Economy	3	
PHYS 251	Mechanics	3	
or CIVE 281	Analytical Mechanics (3)		
PHYS 271	Quantum Physics	3	**31**

** CGPA of 3.30 is required to register for MATH 247 and MATH 248.*

Departmental Courses

ECSE 200	Fundamentals of Electrical Engineering	3
ECSE 210	Circuit Analysis	3
ECSE 221	Introduction to Computer Engineering	3
ECSE 291	Electrical Measurements Lab	2
ECSE 303	Signals & Systems 1	3
ECSE 304	Signals & Systems 2	3
ECSE 305	Probability & Random Sig. 1	3
ECSE 322	Computer Engineering	3
ECSE 323	Digital System Design	5
ECSE 330	Electronic Circuits 1	3
ECSE 334	Electronic Circuits 2	5
ECSE 351	Electromagnetic Fields	3
ECSE 352	EM Waves and Optics	3
ECSE 361	Power Engineering	3
ECSE 498	Honours Thesis 1	3
ECSE 499	Honours Thesis 2	3 **51**

COMPLEMENTARY COURSES

Technical Complementaries **15**

Five technical complementary courses (15 credits), which must be Electrical Engineering Courses at the 500 level (or ECSE 427, ECSE 451). 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 1 and 2 (ECSE 498 and ECSE 499) can count as 6 of the 9 credits. The remaining courses may be any at the 500 level offered by the Department. The choice is not restricted.

Computer Systems Technology

ECSE 427	Operating Systems
ECSE 525	Computer Architecture
ECSE 532	Computer Graphics
ECSE 548	Introduction to VLSI

Control and Automation

ECSE 501	Linear Systems
ECSE 502	Control Engineering
ECSE 503	Linear Stochastic Systems 1
ECSE 504	Computer Control
ECSE 505	Nonlinear Control Systems
ECSE 507	Optimization and Optimal Control
ECSE 509	Probability and Random Sig. 2
ECSE 512	Digital Signal Processing 1
ECSE 529	Image Processing & Communication
ECSE 531	Real Time Systems

Integrated Circuits and Electronics

ECSE 522	Asynchronous Circuits and Systems
ECSE 527	Optical Engineering
ECSE 530	Logic Synthesis
ECSE 533	Physical Basis of Semiconductors
ECSE 534	Analog Microelectronics
ECSE 545	Microelectronics Technology
ECSE 548	Introduction to VLSI
ECSE 571	Optoelectronic Devices
ECSE 573	Microwave Electronics

Power Engineering

ECSE 502	Control Engineering
ECSE 549	Expert Systems in Electrical Design
ECSE 559	Flexible AC Transmission Systems
ECSE 560	Power Systems 2
ECSE 563	Power Systems Operation and Planning
ECSE 565	Power Electronics

Telecommunications

ECSE 451	EM Transmission and Radiation
ECSE 509	Probability and Random Sig. 2
ECSE 511	Intro. to Digital Comm.
ECSE 512	Digital Signal Processing 1
ECSE 521	Digital Communications 1
ECSE 523	Speech Communications
ECSE 527	Optical Engineering
ECSE 528	Telecom. Network Architecture
ECSE 571	Optoelectronic Devices
ECSE 596	Optical Waveguides

Laboratory Complementaries **4**

Two 400-level laboratory courses in Electrical Engineering.

General Complementaries **9**

Two courses (6 credits) in Social Sciences, Administrative Studies or Humanities, selected from an approved list (category ii - section 3.4) and one course (3 credits) on the impact of technology (category i - section 3.4) in consultation with an academic advisor. At least one 3-credit course must be from category A (Humanities and Social Sciences) in section 3.4.

TOTAL CREDITS **110**

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

REQUIRED COURSES		**COURSE CREDIT**
Non-Departmental Courses		
CIVE 281	Mechanics	3
or PHYS 251	Mechanics (3)	
COMP 202	Intro. to Computing 1	3
EDEC 206	Communication in Engineering	3
MATH 260	Intermediate Calculus	3
MATH 261	Differential Equations	3
or MATH 325	Ordinary Differential Eqns (3)	
MATH 265	Advanced Calculus	3
or MATH 248*	Advanced Calculus (3)	
MATH 270	Applied Linear Algebra	3
or MATH 247*	Linear Algebra (3)	
MATH 381	Complex Variables & Transforms	3
MIME 221	Engineering Professional Practice	1
MIME 310	Engineering Economy	3
PHYS 271	Quantum Physics	3 **31**

** CGPA of 3.30 is required to register for MATH 247 and MATH 248.*

Departmental Courses

ECSE 200	Fundamentals of Electrical Engineering	3
ECSE 210	Circuit Analysis	3
ECSE 221	Introduction to Computer Engineering	3
ECSE 291	Electrical Measurements Lab	2
ECSE 303	Signals & Systems 1	3
ECSE 304	Signals & Systems 2	3
ECSE 305	Probability & Random Sig. 1	3
ECSE 322	Computer Engineering	3
ECSE 323	Digital System Design	5
ECSE 330	Electronic Circuits 1	3
ECSE 334	Electronic Circuits 2	5
ECSE 351	Electromagnetic Fields	3
ECSE 352	EM Waves and Optics	3
ECSE 361	Power Engineering	3
ECSE 494	Design Project	3 **48**

COMPLEMENTARY COURSES

Technical Complementaries **18**

Six courses (18 credits) from the list of 400-level courses in Electrical Engineering that must include 9 credits (3 courses) from one of the areas of concentration listed below:

Computer Systems Technology

ECSE 424	Human Computer Interaction
ECSE 425	Computer Organization and Architecture
ECSE 427	Operating Systems

Control & Automation

ECSE 404	Control Systems
ECSE 412	Discrete Time Signal Processing
ECSE 426	Microprocessor Systems

Integrated Circuits & Electronics

ECSE 425	Computer Organization and Architecture
ECSE 431	Electronic Design
ECSE 432	Physical Basis: Transistor Devices
ECSE 435	Mixed-Signal Test Techniques

Phototonics
ECSE 423 Optical Communications 1
ECSE 430 Optical Communications 2
ECSE 432 Physical Basis: Transistor Devices

Power Engineering
ECSE 404 Control Systems
ECSE 462 Electromechanical Energy Conversion
ECSE 464 Power System Analysis 1

Telecommunications*
ECSE 411 Communications Systems 1
ECSE 414 Introduction to Telecommunication Networks
and any one of the following:
ECSE 412 Discrete Time Signal Processing
ECSE 413 Communications Systems 2
ECSE 423 Optical Communications 1
ECSE 451 EM Transmission and Radiation

Laboratory Complementaries **4**
Two 400-level laboratory courses in Electrical Engineering

General Complementaries **9**
Two courses (6 credits) in Social Sciences, Administrative Studies or Humanities, selected from an approved list (category ii - section 3.4) and one course (3 credits) on the impact of technology (category i - section 3.4) in consultation with an academic advisor. At least one 3-credit course must be from category A (Humanities and Social Sciences) in section 3.4.

TOTAL CREDITS **110**

***Enhanced ITT Concentration in Telecommunications**

The International Institute of Telecommunications (IIT) was recently established in Montreal as a center for telecommunications education. It is funded by government and industry, and provides state-of-the-art laboratory facilities and a point of contact between local telecommunications industries and universities.

This progam is open to students in the regular Electrical Engineering program only.

The benefits of the Concentration are:
– a guaranteed project lab (ECSE 494) in telecommunications, at IIT or with an IIT company; and
– permission to take ECSE 496 at IIT.

To complete the Concentration, students must take six courses as Technical Complementaries:
ECSE 411 Communications Systems 1
ECSE 414 Introduction to Telecommunication Networks
ECSE 496 Telecom. Systems and Services
and any three courses selected from the following list:
ECSE 412 Discrete Time Signal Processing
ECSE 413 Communications Systems 2
ECSE 423 Optical Communications 1
ECSE 451 EM Transmission and Radiation

In addition, students must take ECSE 491 (Communications Systems Lab) and complete ECSE 494 (Design Project) in telecommunications, at IIT or with an IIT company.

There may be an enrolment limitation in this concentration in any given semester.

CURRICULUM FOR THE B.ENG. DEGREE IN COMPUTER ENGINEERING

REQUIRED COURSES		COURSE CREDIT	
Non-Departmental Courses			
MATH 260	Intermediate Calculus	3	
MATH 261	Differential Equations	3	
or MATH 325	Ordinary Differential Eqns (3)		
MATH 265	Advanced Calculus	3	
or MATH 248*	Advanced Calculus 1 (3)		
MATH 270	Applied Linear Algebra	3	
or MATH 247*	Linear Algebra (3)		
MATH 363	Discrete Mathematics	3	
MATH 381	Complex Variables & Transforms	3	
CIVE 281	Mechanics	3	
or PHYS 251	Mechanics (3)		
MIME 221	Engineering Professional Practice	1	
MIME 310	Engineering Economy	3	
COMP 202	Intro. to Computing 1	3	
COMP 250	Intro. to Computer Science	3	
COMP 302	Programming Languages	3	
EDEC 206	Communication in Engineering	3	**37**

** CGPA of 3.30 is required to register for MATH 247 and MATH 248.*

Departmental Courses

ECSE 200	Fundamentals of Electrical Engineering	3	
ECSE 210	Circuit Analysis	3	
ECSE 221	Introduction to Computer Engineering	3	
ECSE 291	Electrical Measurements Lab	2	
ECSE 303	Signals & Systems 1	3	
ECSE 304	Signals & Systems 2	3	
ECSE 305	Probability & Random Sig. 1	3	
ECSE 321	Introduction to Software Engineering	3	
ECSE 322	Computer Engineering	3	
ECSE 323	Digital System Design	5	
ECSE 330	Electronic Circuits 1	3	
ECSE 334	Electronic Circuits 2	5	
ECSE 353	Electromagnetic Fields & Waves	3	
ECSE 425	Computer Architecture	3	
ECSE 427	Operating Systems	3	
ECSE 494	Design Project	3	**51**

COMPLEMENTARY COURSES

Technical Complementaries **9**
Three courses (9 credits) selected from the list of courses below:
ECSE 404 Control Systems
ECSE 411 Communications Systems 1
ECSE 412 Discrete-Time Signal Processing
ECSE 414 Introduction to Telecommunication Networks
ECSE 424 Human-Computer Interaction
ECSE 426 Microprocessor Systems
ECSE 428 Software Engineering Practice
ECSE 431 Electronic Design
ECSE 530 Logic Synthesis
ECSE 526 Artificial Intelligence
ECSE 531 Real-Time Systems
ECSE 532 Computer Graphics
ECSE 548 Introduction to VLSI Systems
COMP 420 File Systems
COMP 431 Algorithms & Data Structures
COMP 535 Computer Networks
COMP 575 Fundamentals of Parallel Computing

Laboratory Complementaries **4**
Two 400-level laboratory courses in Electrical Engineering

General Complementaries **9**
Two courses (6 credits) in Social Sciences, Administrative Studies or Humanities, selected from an approved list (category ii - section 3.4) and one course (3 credits) on the impact of technology (category i - section 3.4) in consultation with an academic advisor. At least one 3-credit course must be from category A (Humanities and Social Sciences) in section 3.4.

TOTAL CREDITS **110**

CURRICULUM FOR THE BACHELOR IN SOFTWARE ENGINEERING (B.S.E.)

(subject to Ministry of Education approval)

REQUIRED COURSES		COURSE CREDIT	
ECSE 221	Introduction to Computer Engineering	3	
ECSE 321	Intro to Software Engineering	3	
ECSE 322	Computer Engineering	3	
ECSE 427	Operating Systems	3	
ECSE 428	Software Engineering Practice	3	
ECSE 429	Software Validation	3	
ECSE 495	Software Eng. Design Project	3	
COMP 202	Introduction to Computing 1	3	
COMP 206	Intro Software Systems	3	
COMP 250	Intro to Computer Science	3	
COMP 251	Data Structures and Algorithms	3	
COMP 302	Programming Languages and Paradigms	3	
COMP 330	Theoretical Aspects of Computer Science	3	
COMP 360	Algorithm Design Techniques	3	
COMP 361	Systems Programming Project	3	
COMP 420	Files and Databases	3	**48**
Mathematics and Science Required Courses			
MATH 260	Intermediate Calculus	3	
MATH 261	Differential Equations	3	
MATH 270	Applied Linear Algebra	3	
PHYS 230	Dynamics of Simple Systems	3	**12**
Mathematics Complementary Course			
MATH 363	Discrete Mathematics	3	**3**
or MATH 381	Complex Variables & Transforms		
Engineering Breadth Required Courses			
ECSE 200	Fundamentals of Electrical Engineering	3	
ECSE 210	Circuit Analysis	3	
ECSE 291	Electrical Measurements Lab	2	
ECSE 303	Signals and Systems 1	3	
ECSE 305	Probability and Random Sig. 1	3	
ECSE 330	Electronic Circuits 1	3	
EDEC 206	Communication in Engineering	3	
MIME 310	Engineering Economy	3	
MIME 221	Engineering Professional Practice	1	**24**
Technical Complementaries			**14 - 16**

Students must take 14-16 credits of technical complementaries from the following list, of which at least 6 credits must be taken from list A and the remainder from list B.

Group A Technical Complementaries

COMP 350	Numerical Computing
COMP 409	Concurrent Programming
COMP 424	Topics in Artificial Intelligence 1
COMP 433	Personal Software Engineering
COMP 524	Theoretical Found. of Prog. Lang.
COMP 575	Fundamentals of Distributed Algorithms

Group B Technical Complementaries

ECSE 304	Signals and Systems 2
ECSE 323	Digital Systems Design
ECSE 404	Control Systems
ECSE 411	Communications Systems 1
ECSE 412	Discrete Time Signal Processing
ECSE 413	Communications Systems 2
ECSE 414	Introduction to Telecommunication Networks
ECSE 421	Embedded Systems
ECSE 422	Fault Tolerant Computing
ECSE 420	Parallel Computing
ECSE 424	Human-Computer Interaction
ECSE 425	Computer Organization and Architecture
ECSE 426	Microprocessor Systems
or COMP 573	Microcomputers
ECSE 504	Computer Control
ECSE 522	Asynchronous Circuits and Systems
ECSE 526	Artificial Intelligence
ECSE 529	Image Processing & Communications
ECSE 530	Logic Synthesis
ECSE 531	Real-Time Systems
ECSE 532	Computer Graphics
or COMP 557	Fundamentals of Computer Graphics
COMP 410	Mobile Computing
COMP 412	Software for e-commerce
COMP 505	High-Performance Computer Architecture
COMP 520	Compiler Design
COMP 535	Computer Networks
COMP 566	Computer Methods in Operations Research

General Complementaries **9**

Two courses (6 credits) in Social Sciences, Administrative Studies or Humanities, selected from an approved list (category ii - section 3.4) and one course (3 credits) on the impact of technology (category i - section 3.4) in consultation with an academic advisor. At least one 3-credit course must be from category A (Humanities and Social Sciences) in section 3.4.

TOTAL CREDITS **110/112**

COURSES OFFERED BY THE DEPARTMENT

For the Term (Fall and/or Winter), days, and times when courses will be offered, please refer to the 2002-2003 Class Schedule on the Web, http://www.mcgill.ca/students/. Class locations and names of instructors are also provided.

Students preparing to register are advised to consult the Class Schedule website for the most up-to-date list of courses available. New courses may have been added or courses rescheduled after this Calendar went to press.

The schedule of courses to be offered in Summer 2003 will be available on the website in January.

ECSE has replaced 304 as the prefix for Electrical and Computer Engineering courses.

The course credit weight is given in parentheses after the title.

● Denotes courses not offered in 2002-03.

▭ Denotes courses with limited enrolment.

All courses with limitations listed for section A01 have a section A02 open to other students but with Department permission required.

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.

ECSE 200 FUNDAMENTALS OF ELECTRICAL ENGINEERING. (3) (3-0-6) (Corequisites: MATH 261 or MATH 325) (Section A01: Limited to Electrical Honours, Regular, and Computer Engineering students only.) 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.

ECSE 210 CIRCUIT ANALYSIS. (3) (3-1-5) (Prerequisite: ECSE 200) (For Fall Term: Section A01: Limited to Electrical Honours and Computer Engineering students only.) (For Winter Term: Section A01: Limited to Regular Electrical Engineering students only.) 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.

ECSE 221 INTRODUCTION TO COMPUTER ENGINEERING. (3) (3-1-5) (Corequisite: COMP 202) (Section A01: Limited to Electrical Honours, Regular, and Computer Engineering students only) Data representation in digital computers. Boolean algebra. Basic combinational circuits; their analysis and synthesis. Elements of sequential circuits: latches, flip-flops, counters and memory cir-

cuits. Computer structure, central processing unit, machine language. Assemblers and assembler language.

- **ECSE 271 ELECTRIC POWER UTILIZATION.** (2)
- **ECSE 281 ELECTRIC POWER.** (3)

ECSE 291 ELECTRICAL MEASUREMENTS LABORATORY. (2) (1-4-1) (Corequisite: ECSE 210) Experiments with fundamental electric circuits are used to illustrate the principles and limitations of basic electrical and electronic instrumentation in typical measurement applications. Basic electrical laboratory practice and safety procedures are introduced. Introduction to error analysis and application to laboratory measurements.

ECSE 303 SIGNALS AND SYSTEMS 1. (3) (3-0-6) (Prerequisites: ECSE 210, MATH 270 or MATH 247. Corequisite: MATH 381 or MATH 249.) (Section A01: Limited to Electrical Honours, Regular, and Computer Engineering students only) Elementary continuous and discrete-time signals, impulse functions, basic properties of discrete and continuous linear time-invariant (LTI) systems, Fourier representation of continuous-time periodic and aperiodic signals, the Laplance transform, time and frequency analysis of continuous-time LTI systems, application of transform techniques to electric circuit analysis.

ECSE 304 SIGNALS AND SYSTEMS 2. (3) (3-0-6) (Prerequisite: ECSE 303) (Section A01: Limited to Electrical Honours, Regular, and Computer Engineering students only) Application of transforms to the analysis of LTI single-loop feedback systems, the discrete-time Fourier series, the discrete-time Fourier transform, the Z transform, time and frequency analysis of discrete-time LTI systems, sampling systems, application of continuous and discrete-time signal theory to communications LTI systems.

ECSE 305 PROBABILITY AND RANDOM SIG. 1. (3) (3-0-6) (Prerequisite: ECSE 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 independence, laws of large numbers, central limit theorem; introduction to random processes and random signal analysis.

ECSE 321 INTRODUCTION TO SOFTWARE ENGINEERING. (3) (3-1-5) (Prerequisites: COMP 202 or COMP 208) Design, development and testing of software systems. Software life cycle: requirements analysis, software architecture and design, implementation, integration, test planning, and maintenance.The course involves a group project.

ECSE 322 COMPUTER ENGINEERING. (3) (3-0-6) (Prerequisites: ECSE 200 and ECSE 221) (Not open to students who have taken ECSE 222) Data structures (arrays, lists, stcks, queues, dequeues and trees) and their machine representation and simple algorithms. Peripheral devices: printers, keyboards, magnetic type drives, magnetic disc drives. Peripheral interfacing and busses. Introduction to operating systems. System integration. Computer systems and networks.

ECSE 323 DIGITAL SYSTEM DESIGN. (5) (3-6-6) (Prerequisites: ECSE 291, ECSE 221, and EDEC 206) (Section A01: Limited to Regular Electrical Engineering students only) Minimization and synthesis of combinational logic 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.

ECSE 330 ELECTRONIC CIRCUITS 1. (3) (3-0-6) (Prerequisite: ECSE 210) (Section A01: Limited to Electrical Honours, Regular, and Computer Engineering students only) 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.

ECSE 334 ELECTRONIC CIRCUITS 2. (5) (3-6-6) (Prerequisite: ECSE 291, ECSE 303, ECSE 330 and EDEC 206) (Section A01: Limited to Electrical Honours, Regular and Computer Engineering students only) 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.

ECSE 351 ELECTROMAGNETIC FIELDS. (3) (3-1-5) (Prerequisites: ECSE 200 and MATH 265) (Section A01: Limited to Electrical Honours, Regular, and Computer Engineering students only) Maxwell's equations, electrostatics, magnetostatics and induction for power-frequency electrical engineering problems.

ECSE 352 EM WAVES AND OPTICS. (3) (3-1-5) (Prerequisite: ECSE 351) (Limited to Electrical Honours, Regular, and Computer Engineering students only) 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.

ECSE 353 ELECTROMAGNETIC FIELDS AND WAVES. (3) (3-1-5) (Prerequisites: ECSE 210 and MATH 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.

ECSE 361 POWER ENGINEERING. (3) (3-0-6) (Prerequisite: ECSE 210, ECSE 351) Characteristics and components of power systems. Generation, transmission and utilization of electric power. 3-phase ac and dc systems. Fundamentals of electromechanical energy conversion. Ampere and Faraday's law. Magnetic circuits. Systems of coupled coils. Torque and force. Rotating magnetic fields. Basic rotating machines.

ECSE 404 CONTROL SYSTEMS. (3) (3-0-6) (Prerequisite: ECSE 303) Modelling of engineering systems. State variables. State and transfer function descriptions. Observability and controllability. Stability, Realizations. Performance limitations. Open-loop, feedforward, closed-loop configurations. Performance specifications. The Nyquist criterion; stability margins, unstructured uncertainty and robust stability. Classical design. Systems with delay. Pole placement, linear quadratic design. Observers, controllers based on separation.

ECSE 411 COMMUNICATIONS SYSTEMS 1. (3) (3-0-6) (Prerequisite: ECSE 304 and ECSE 305) Communication system models; AM and FM modulation, performance of AM and FM systems in noise; sampling, PCM and DPCM techniques; FDM and TDM multiplexing systems; baseband digital transmission over bandlimitted channels, digital modulation and detection techniques; illustrative examples of subscriber loop telephone systems, cable TV systems and broadcasting systems.

ECSE 412 DISCRETE TIME SIGNAL PROCESSING. (3) (3-0-6) (Prerequisite: ECSE 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.

ECSE 413 COMMUNICATIONS SYSTEMS 2. (3) (3-0-6) (Prerequisite: ECSE 411) Introduction to radio communications; satellite communication systems; the cellular concept; fading channel models, digital modulation techniques over fading channels, diversity systems, spread spectrum techniques; fixed assignment multiple access (FDMA, TDMA, CDMA), duplexing methods (FDD, TDD); illustrative examples of terrestrial mobile systems, fixed wireless systems, LEOs, etc.; overview of standardization activities.

ECSE 414 INTRODUCTION TO TELECOMMUNICATION NETWORKS. (3) (3-0-6) (Prerequisites: ECSE 304, ECSE 305 and ECSE 322) Introduction to the physical and software architecture of modern networks; transport configurations, multiplexing, the digital hierarchy; wired and wireless access systems; circuit and packet switching systems, signaling, addressing and routing; protocol

stacks; local area networking; introduction to network engineering; examples include: ATM, ISDN, IP, Frame Relay, Ethernet.

ECSE 420 PARALLEL COMPUTING. (3) (3-0-6) (Prerequisite: ECSE 427) Overview of parallel computing architectures and topologies. Programming models for parallel computing: data flow, shared memory, message passing, systolic, and data parallel. Theory of parallel programming and analysis of fundamental algorithms on different architectures. Architecture dependent/independent parallel programming languages: Unity, Id, Linda, C*, C-Paris, CM-Fortran, and MPL.

ECSE 421 EMBEDDED SYSTEMS. (3) (3-0-6) (Prerequisite: ECSE 427) Definition, structure and properties of embedded systems. Real-time programming: interrupts, latency, context, re-entrancy, thread and process models. Microcontroller and DSP architectures, I/O systems, timing and event management. Real-time kernels and services. Techniques for development, debugging and verification. Techniques for limited resource environments. Networking for distributed systems.

ECSE 422 FAULT TOLERANT COMPUTING. (3) (3-0-6) (Prerequisite: ECSE 427) Introduction to fault-tolerant systems. Fault-tolerance techniques through hardware, software, information and time redundancy. Failure classification, failure semantics, failure masking. Exception handling: detection, recovery, masking and propagation, termination vs resumption. Reliable storage, reliable communication. Process groups, synchronous and asynchronous group membership and broadcast services. Automatic redundancy management. Case studies.

ECSE 423 OPTICAL COMMUNICATIONS 1. (3) (3-0-6) (Prerequisites: ECSE 352, Corequisite: ECSE 305) Review of electromagnetic waves; propagation of light (free-space, optical fibers, and waveguides); dispersion; optical sources (fundamentals, LEDs, semiconductor lasers); optical detectors. Throughout the course, photonic systems applications will be addressed

ECSE 424 HUMAN-COMPUTER INTERACTION. (3) (3-4-2) (Prerequisite: ECSE 322) The course highlights human-computer interaction strategies from an engineering perspective. Topics include user interfaces, novel paradigms in human-computer interaction, affordances, ecological interface design, ubiquitous computing and computer-supported cooperative work. Attention will be paid to issues of safety, usability, and performance.

ECSE 425 COMPUTER ORGANIZATION AND ARCHITECTURE. (3) (3-0-6) (Prerequisites: ECSE 322 and ECSE 323) Trends in technology. CISC vs. RISC architectures. Pipelining. Instruction level parallelism. Data and Control Hazards. Static prediction. Exceptions. Dependencies. Loop level paralleism. Dynamic scheduling, branch predicition. Branch target buffers. Superscalar and N-issue machines. VLIW. ILP techniques. Cache analysis and design. Interleaved and virtual memory. TLB translations and caches.

▭ **ECSE 426 MICROPROCESSOR SYSTEMS.** (3) (1-3-5) (Prerequisites: ECSE 323 and EDEC 206) (This course may be counted as a technical complementary or a lab complementary.) (Limited Enrolment (50)) 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.

ECSE 427 OPERATING SYSTEMS. (3) (3-3-3) (Prerequisite: ECSE 322) 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.

ECSE 428 SOFTWARE ENGINEERING PRACTICE. (3) (3-4-2) (Prerequisite: ECSE 321 or COMP 335) Software engineering practice in industry, related to the design and commissioning of large software systems. Ethical, social, economic, safety and legal issues. Metrics, project management, costing, marketing, control, standards, CASE tools and bugs. The course involves a large team project.

ECSE 429 SOFTWARE VALIDATION. (3) (3-0-6) (Prerequisite: ECSE 321) Correct and complete implementation of software requirements. Verification and validation lifecycle. Requirements analysis, model based analysis, and design analysis. Unit and system testing, performance, risk management, software reuse. Ubiquitous computing.

ECSE 430 OPTICAL COMMUNICATIONS 2. (3) (3-0-6) (Prerequisites: ECSE 304 and ECSE 423) Modulation of optical signals; optical amplifiers; devices for optical signal processing (e.g. filters, routers, and cross-connect switches); link system engineering; concepts of WDM and TDM; issues in high-performance lightwave transmission systems.

▭ **ECSE 431 ELECTRONIC DESIGN.** (3) (2-4-3) (Prerequisites: ECSE 323 and ECSE 330) (Limited enrolment - 30. Departmental permission required.) 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.

ECSE 432 PHYSICAL BASIS: TRANSISTOR DEVICES. (3) (3-0-6) (Prerequisites: ECSE 330, ECSE 351 and PHYS 271) 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.

ECSE 435 MIXED-SIGNAL TEST TECHNIQUES. (3) (3-4-2) (Prerequisities: ECSE 304, and ECSE 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 experiements will be performed using a Teradyne A567 mixed-signal production tester.

ECSE 451 EM TRANSMISSION AND RADIATION. (3) (3-0-6) (Prerequisite: ECSE 352) Microwave transmission through waveguides: impedance matching, microwave devices, filters and resonators; microwave transmission though free space; near and far field behaviour of electromagnetic radiators, simple antennas, antenna arrays, practical antenna parameters; the physics of the radio communication channel: reflection, diffraction and scattering and their macroscopic impact (multipath, fading).

ECSE 461 ELECTRIC MACHINERY. (3) (3-0-6) (Prerequisite: MECH 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.

ECSE 462 ELECTROMECHANICAL ENERGY CONVERSION. (3) (3-0-6) (Prerequisite: ECSE 361) Lumped parameter concepts of electromechanics. Energy, co-energy in the derivation of torques and forces. Examples of electric machines: - dc, synchronous and induction types. Steady-state, transient and stability analysis. Power electronic controllers.

ECSE 464 POWER SYSTEMS ANALYSIS 1. (3) (3-0-6) (Prerequisite: ECSE 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.

● **ECSE 472 SYSTEMS DESIGN.** (3) (2-2-5) (Prerequisite: At least 42 credits of Departmental courses and permission of instructor)

▭ **ECSE 485 IC FABRICATION LABORATORY.** (2) (1-3-2) (Prerequisite: ECSE 334, EDEC 206. Corequisite: ECSE 432 or ECSE 533) (Limited Enrolment - 8) 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.

▭ **ECSE 486 POWER LABORATORY.** (2) (1-3-2) (Prerequisites: EDEC 206, ECSE 361 and ECSE 334) (Limited Enrolment - 14) 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.

▭ **ECSE 487 COMPUTER ARCHITECTURE LABORATORY.** (2) (0-3-3) (Prerequisite: EDEC 206. Corequisite: ECSE 425 or ECSE 525) (Limited enrollment -50) 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.

▭ **ECSE 488 HIGH FREQUENCY LABORATORY.** (2) (1-3-2) (Prerequisites: ECSE 291 and EDEC 206. Corequisite: ECSE 451.) (Limited Enrolment - 20) High frequency measurement techniques. Vector network analyzer and spectrum analyzer. Resistors, capacitors and inductors at high frequencies. High-level signal handling of a high-frequency bandpass amplifier. Electromagnetic interference (EMI) and spectrum coordination. Cavity resonators. Standing waves in waveguides. Reciprocity of microwave networks. Scattering parameters of a microstrip network.

● **ECSE 489 TELECOMMUNICATION NETWORK LAB.** (2) (Prerequisite: EDEC 206) (Corequisite: ECSE 414)

▭ **ECSE 490 DIGITAL SIGNAL PROCESSING LAB.** (2) (0-3-3) (Prerequisites: ECSE 291 and EDEC 206. Corequisite: ECSE 412 or ECSE 512) (Limited Enrolment - 30) (Departmental approval required) 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.

▭ **ECSE 491 COMMUNICATION SYSTEMS LAB.** (2) (0-3-3) (Prerequisites: ECSE 291 and EDEC 206. Corequisite: ECSE 411 or ECSE 511) (Limited Enrolment - 30) 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.

ECSE 492 OPTICAL COMMUNICATIONS LAB. (2) (Prerequisite: ECSE 423 or ECSE 527, and EDEC 206) Hands-on experience of the physical layer of optical communications systems. Experiments involving optical fiber link characterization, laser measurements, beam divergence, coupling efficiency. Use of lasers, optical spectrum analyser, data generator, beam profiler, photodetectors, optical filters. Experiments are supported with simulation and analysis software.

▭ **ECSE 493 CONTROL AND ROBOTICS LABORATORY.** (2) (0-3-3) (Prerequisites: ECSE 291 and EDEC 206. Corequisite: ECSE 404 or ECSE 502) (Limited Enrolment - 16) 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.

▭ **ECSE 494 ELECTRICAL ENGINEERING DESIGN PROJECT.** (3) (0-5-4) (Prerequisites: EDEC 206 and at least 42 Departmental credits) (Limited Enrolment - 50) 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.

● **ECSE 495 SOFTWARE ENGINEERING DESIGN PROJECT.** (3) (0-5-4) (Prerequisites: ECSE 321 and at least 42 Departmental credits from Electrical and Computer Eng. and Computer Science)

ECSE 496 TELECOMMUNICATIONS SYSTEMS AND SERVICES. (3) (3-3-3) (Prerequisites: ECSE 411 and ECSE 414) Case studies of several end-to-end telecommunications systems used for the delivery of various service application scenarios. Issues in network and systems architecture, technology, operations management, regulation and competition. Examples from conventional telephony, internet service delivery, wireless services and cable TV distribution.

ECSE 498 HONOURS THESIS 1. (3) (0-3-6) (Prerequisite: EDEC 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.

ECSE 499 HONOURS THESIS 2. (3) (0-3-6) (Prerequisite: ECSE 498) A research project undertaken with close supervision by a staff member. A continuation of ECSE 498. The work consists of carrying out the research plan developed in ECSE 498 along with a seminar presentation at end of term.

ECSE 501 LINEAR SYSTEMS. (3) (3-0-6) (Prerequisite: ECSE 304) State equations and input-output descriptions of linear systems: basic properties and solution. Observability and controllability. Matrix Fraction Descriptions. Canonical forms. Feedback synthesis: linear quadratic control problems, pole placement, observers and compensators.

ECSE 502 CONTROL ENGINEERING. (3) (3-0-6) (Prerequisites: ECSE 303, ECSE 305) Modeling of engineering systems, simulation. Linear systems theory. Performance limitations. Stability of single-input-single-output closed-loop systems. Classical design in the frequency domain. Sampled-data implementation of continuous-time design.

● **ECSE 503 LINEAR STOCHASTIC SYSTEMS 1.** (3) (3-0-6) (Prerequisites: MATH 587 or ECSE 510)

● **ECSE 504 COMPUTER CONTROL.** (3) (3-0-6) (Prerequisites: ECSE 404 or ECSE 502 and ECSE 305)

ECSE 505 NONLINEAR CONTROL SYSTEMS. (3) (3-0-6) (Prerequisite: ECSE 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.

ECSE 507 OPTIMIZATION AND OPTIMAL CONTROL. (3) (3-0-6) (Prerequisites: MATH 265 or MATH 248 and MATH 270 or MATH 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.

ECSE 509 PROBABILITY AND RANDOM SIG. 2. (3) (3-0-6) (Prerequisites: ECSE 304 and ECSE 305) Multivariate Gaussian distributions; finite-dimensional mean-square estimation (multivariate case); principal components; introduction to random processes; weak stationarity: correlation functions, spectra, linear processing and estimation; Poisson processes and Markov chains: state processes, invariant distributions; stochastic simulation.

● **ECSE 510 RANDOM PROCESSES.** (3) (3-0-6) (Prerequisite: ECSE 509)

ECSE 511 INTRODUCTION TO DIGITAL COMMUNICATION. (3) (3-0-6) (Prerequisite: ECSE 304. Corequisite: ECSE 509) (An advanced version of ECSE 411) 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.

ECSE 512 DIGITAL SIGNAL PROCESSING 1. (3) (3-0-6) (Prerequisite: ECSE 304 and ECSE 305) Review of discrete-time transforms, sampling and quantization, frequency analysis. Structures for IIR and FIR filters, coefficient quantization, roundoff noise. The DFT, its properties, frequency analysis and filtering using DFT methods, the FFT and its implementation. Multirate processing, subsampling and interpolation, oversampling techniques.

ECSE 521 DIGITAL COMMUNICATIONS 1. (3) (3-0-6) (Prerequisite: ECSE 411 or ECSE 511. Corequisite: ECSE 509) Modulation: orthogonal and biorthogonal signalling, MPSK, QAM, modulation with memory. Detection: coherent, noncoherent and differentially coherent detection, performance issues and channel capacity, synchronization. Coding: block and convolutional codes, fast Hadamard Transform decoding, Viterbi algorithm, turbo-codes. Bandlimited channels: intersymbol interference , spectral shaping, correlative coding, data estimation and channel equalization.

ECSE 522 ASYNCHRONOUS CIRCUITS AND SYSTEMS. (3) (3-3-3) (Prerequisite: ECSE 323) Specification of asynchronous behaviors. Asynchronous logic components. Hierarchical design and verification. Concurrency issues: deadlock, livelock, starvation, safety. Timing issues. Modern design styles: handshaking, micropipelines. Asynchronous analysis models for protocols and software.

ECSE 523 SPEECH COMMUNICATIONS. (3) (3-0-6) (Prerequisite: ECSE 412 or ECSE 512) Articulatory and acoustic descriptions of speech production, speech production models, speech perception, digital processing of speech signals, vocodors using formant, linear predictive and cepstral techniques, overview of automatic speech recognition systems, speech synthesis systems and speaker verification systems.

● **ECSE 525 COMPUTER ARCHITECTURE.** (3) (3-0-6) (Prerequisites: ECSE 322 and ECSE 323)

ECSE 526 ARTIFICIAL INTELLIGENCE. (3) (3-0-6) (Prerequisite: ECSE 322) Design principles of autonomous agents, agent architectures, machine learning, neural networks, genetic algorithms, and multi-agent collaboration. The course includes a term project that consists of designing and implementing software agents that collaborate and compete in a simulated environment.

ECSE 527 OPTICAL ENGINEERING. (3) (3-0-6) (Prerequisite: ECSE 304 and ECSE 352) A structure introduction to modern optical engineering. Topics 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.

ECSE 528 TELECOMMUNICATION NETWORK ARCHITECTURE. (3) (3-0-6) (Prerequisite: ECSE 411 or ECSE 511. Corequisite: ECSE 509) Organization of large, highspeed, multiservice telecommunication networks. Connection hierarchies, protocol stacks, transmission formats. Local-area networking: Token Ring and Ethernet. Multiplexing for wide-area transport: performance modelling and analysis, traffic scheduling and shaping. Routing and flow control. Switch architecture: performance criteria, buffer management, routers versus switches and hybrids.

ECSE 529 IMAGE PROCESSING AND COMMUNICATION. (3) (3-0-6) (Prerequisite: ECSE 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.

● **ECSE 530 LOGIC SYNTHESIS.** (3) (3-2-4) (Prerequisite: ECSE 323)

ECSE 531 REAL TIME SYSTEMS. (3) (3-3-3) (Prerequisites: ECSE 322 and ECSE 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.

ECSE 532 COMPUTER GRAPHICS. (3) (3-3-3) (Prerequisite: ECSE 322) 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.

ECSE 533 PHYSICAL BASIS OF SEMICONDUCTOR DEVICES. (3) (3-0-6) (Prerequisites: ECSE 330, ECSE 351 and PHYS 271) 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.

ECSE 534 ANALOG MICROELECTRONICS. (3) (3-0-6) (Prerequisite: ECSE 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; precision reference sources; analog multipliers; oscillators; waveform generators and shaping circuits, and analog switches.

● **ECSE 535 SYNTHESIS OF DIGITAL SYSTEMS.** (3)

ECSE 536 RF MICROELECTRONICS. (3) (3-3-3) (Prerequisite: ECSE 334. Corequisite: ECSE 352) Introduction to Radio Frequency Integrated Circuits and wireless transceiver architectures. Modeling of passive/active integrated devices. Design of monolithic bipolar and CMOS LNAs, mixers, filters, broadband amplifiers, RF power amplifiers, VCOs, and frequency synthesizers. Analysis of noise and non-linearity in RFICs. Project using modern RFIC simulation/layout CAD tools.

ECSE 543 NUMERICAL METHODS IN ELECTRICAL ENGINEERING. (3) (3-0-6) (Prerequisites: ECSE 322, ECSE 334 and ECSE 352) DC resistor networks and sparse matrix methods. Nonlinear electric and magnetic circuits: curve-fitting; the Newton-Raphson method. Finite elements for electrostatics. Transient analysis of circuits: systems of Ordinary differential equations; stiff equations. Transient analysis of induced currents. Solution of algebraic eigenvalue problems. Scattering of electromagnetic waves: the boundary element method; numerical integration.

● **ECSE 545 MICROELECTRONICS TECHNOLOGY.** (3) (3-0-6) (Prerequisite: ECSE 432 or ECSE 533)

ECSE 547 FINITE ELEMENTS IN ELECTRICAL ENGINEERING. (3) (3-0-6) (Prerequisites: ECSE 322 and ECSE 352) Finite elements for electrostatics. Energy minimization. Semi-conductors. Nonlinear magnetics and Newton-Raphson. Axisymmetric problems. Capacitance, inductance, and resistance through finite elements. Resonance: cavities, waveguides. High order and curvilinear elements.

▭ **ECSE 548 INTRODUCTION TO VLSI SYSTEMS.** (3) (2-2-5) (Prerequisites: ECSE 334 and ECSE 323) (Limited Enrolment - 20) (Departmental approval required) An interdisciplinary course for electrical engineering and computer science students. A structured design methodology for managing the complexity of VLSI system design. Sufficient information on integrated devices, circuits, digital subsystems and system architecture is presented to

enable students to span the range of abstractions from device physics to VLSI digital systems.

ECSE 549 EXPERT SYSTEMS IN ELECTRICAL DESIGN. (3) (3-0-6) (Prerequisites: ECSE 323 and ECSE 361) Design processes in electrical engineering. Hierarchical design. Computer aided design. Expert system technology. Device representations, heuristics and structures, algebraic models. Design versus diagnosis, "Shallow" and "Deep" systems, second generation (multi-paradigm) systems. Shells and their uses in design systems. Knowledge acquisition systems.

- **ECSE 559 FLEXIBLE AC TRANSMISSION SYSTEMS.** (3) (3-0-6) (Prerequisite: ECSE 361 and ECSE 334)
- **ECSE 560 POWER SYSTEMS ANALYSIS 2.** (3) (3-0-6) (Prerequisite: ECSE 464)
- **ECSE 562 CONTINUUM ELECTROMECHANICS.** (3) (3-0-6) (Prerequisite: ECSE 352)

ECSE 563 POWER SYSTEMS OPERATION AND PLANNING. (3) (3-0-6) (Prerequisite: ECSE 361) Design and operation of large scale power systems: Temporal, spatial and hierarchical decomposition of tasks. Local vs. distributed control. Load-frequency control. Voltage and speed regulation. Interconnected power systems. Power flow. Security states. Optimal operation of power systems. Power system reliability.

ECSE 565 INTRODUCTION TO POWER ELECTRONICS. (3) (3-0-6) (Prerequisite: ECSE 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.

ECSE 571 OPTOELECTRONIC DEVICES. (3) (3-0-6) (Prerequisites: ECSE 304, ECSE 305, ECSE 352 and ECSE 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.

ECSE 573 MICROWAVE ELECTRONICS. (3) (3-0-6) (Prerequisite: ECSE 432 or ECSE 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.

- **ECSE 578 CRYSTALS AND CONDUCTION.** (3) (3-0-6) (Prerequisite: ECSE 432 or ECSE 533)
- **ECSE 579 PROPERTIES OF SOLIDS.** (3) (3-0-6) (Prerequisite: ECSE 533).
- **ECSE 596 OPTICAL WAVEGUIDES.** (3) (3-0-6) (Prerequisite: ECSE 352)

GRADUATE 600-LEVEL COURSES

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

4.6 Department of Mechanical Engineering

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Chair — Arun K. Misra

Emeritus Professors
William Bruce; B.A.Sc., M.A.Sc.(Toronto), Eng.
Romuald Knystautas; B.Eng., M.Eng., Ph.D.(McG.), Eng.
Michael P. Paidoussis; B.Eng.(McG.), Ph.D.(Cantab.), Eng., F.I.Mech.E., F.A.S.M.E., F.A.A.M., F.C.S.M.E., F.R.S.C., F.C.A.E. *(Thomas Workman Emeritus Professor of Mechanical Engineering)*

Post-Retirement
Glen Bach; B.Sc.(Alta.), M.Sc.(Birm.), Ph.D.(McG.)
Lucjan Kops; B.Eng., M.Eng., D.Sc., Eng. (Krakow Tech.U.), Eng., M.C.I.R.P., F.A.S.M.E., F.C.S.M.E.

Professors
Abdul M. Ahmed; B.Sc.(Dhaka), M.Eng., Ph.D.(McG.), Eng. *(Thomas Workman Professor of Mechanical Engineering)*
Jorge Angeles; B.Eng., M.Eng.(UNAM Mexico), Ph.D.(Stanford), Eng., F.A.S.M.E., F.C.S.M.E.
Bantwal R. Baliga; B.Tech.(I.I.T., Kanpur), M.Sc.(Case), Ph.D.(Minnesota)
Wagdi Habashi; B. Eng., M. Eng.(McG.), Ph.D.(Cornell), P. Eng., F.A.S.M.E.
John H.S. Lee; B.Eng.(McG.), M.Sc.(M.I.T.), Ph.D.(McG.), Eng.
Arun K. Misra; B.Tech.(I.I.T.,Kharagpur), Ph.D.(U.B.C.), P.Eng.
Stuart J. Price; B.Sc., Ph.D.(Bristol), P.Eng.

Associate Professors
Martin Buehler; M.Sc., Ph.D.(Yale)
Luca Cortelezzi; M.Sc., Ph.D.(Caltech)
David L. Frost; B.A.Sc.(U.B.C.), M.S., Ph.D.(Caltech), P.Eng.
Tim Lee; M.S.(Portland State), Ph.D.(Idaho)
Larry B. Lessard; B.Eng.(McG.), M.Sc., Ph.D.(Stanford), Eng. (Undergraduate Program Coordinator)
Dan Mateescu; M.Eng.(Poli.Univ.Buch.), Ph.D.(Rom. Acad. Sci.), Doctor Honoris Causa (Poli.Univ.Buch.), F.C.A.S.I., A.F.A.I.A.A.
Meyer Nahon; B.Sc.(Queen's), M.Sc.(Tor.), Ph.D.(McG.), Eng.
James A. Nemes; B.Sc.(Maryland), M.S., D.Sc.(GWU) *(William Dawson Scholar)* (Graduate Program Coordinator)
Martin Ostoja-Starzewski; M.Eng., Ph.D.(McG.), F.A.S.M.E.
Peter Radziszewski; B.Sc.(U.B.C.), M.Sc., Ph.D.(Laval)
Vince Thomson; B.Sc.(Windsor), Ph.D.(McMaster) (Werner Graupe Professor of Manufacturing Automation)
Paul J. Zsombor-Murray; B.Eng., M.Eng., Ph.D.(McG.), Eng. F.C.S.M.E.

Assistant Professors
Andrew J. Higgins, B.Sc.(Ill.), M.S., Ph.D.(Wash.)
R. Mongrain; B.Sc., M.Sc.(Montr.), Ph.D.(Ecole Polytechnique), Eng.
Laurent Mydlarski; B.A.Sc.(Waterloo), Ph.D.(Cornell)

Laboratory Superintendents
D. Chellan, G. Savard, G. Tewfik

Associate Members
R.E. Kearney; B.Eng., M.Eng., Ph.D.(McG.), Biomedical Engineering Unit
B.H.K. Lee; B.Eng., M.Eng., Ph.D.(McG.)
M. Tanzer; M.D., Orthopaedic Surgery

Adjunct Professors
H. Attia, R.G. Edwards, G. Guèvremont, Z. Liu, K. Mackenzie, W.D. May, A. Pavillet, M.P. Robichaud, R. Sumner, G.A. Wagner, T. Yee, D. Zorbas

Mechanical engineers are traditionally concerned with the conception, design, implementation and operation of mechanical systems. Typical fields of work are aerospace, energy, manufacturing,

machinery, and transportation. Because of the very broad nature of the discipline there is usually a high demand for mechanical engineers. A recent study indicated that 39% of all engineering openings were for graduates of mechanical engineering.

Many mechanical engineers follow other career paths. Graduate studies are useful for the specialists working in research establishments, consulting firms or in corporate research and development.

To prepare the mechanical engineer for a wide range of career possibilities, there is a heavy stress in our curriculum on the fundamental analytical disciplines. This is balanced by a sequence of experimental and design engineering courses which include practice in design, manufacture and experimentation. In these courses students learn how to apply their analytical groundwork to the solution of practical problems.

Specialist interests are satisfied by selecting appropriate complementary courses from among those offered with a specific subject concentration, such as management, industrial engineering, computer science, controls and robotics, bio-engineering, aeronautics, combustion, systems engineering, etc.

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, Mechatronics 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 extracurricular activities. Students are active in such professional societies as CASI (Canadian Aeronautics and Space Institute), SAE (Society of Automotive Engineers), and 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 CREDIT	
Non-Departmental Subjects			
CIVE 207	Solid Mechanics	4	
COMP 208	Computers in Engineering	3	
ECSE 461	Electric Machinery	3	
EDEC 206	Communication in Engineering	3	
MATH 260	Intermediate Calculus	3	
MATH 261	Differential Equations	3	
MATH 265	Advanced Calculus	3	
MATH 266	Linear Algebra and BVP	4	
MIME 221	Engineering Professional Practice	1	
MIME 260	Materials Science and Engineering	3	
MIME 310	Engineering Economy	3	**33**
Departmental Courses			
MECH 201	Introduction to Mechanical Engineering	2	
MECH 210	Mechanics 1	4	
MECH 220	Mechanics 2	3	
MECH 240	Thermodynamics 1	3	
MECH 260	Machine Tool Laboratory	2	
MECH 262	Statistics and Measurement Laboratory	3	
MECH 291	Graphics	3	
MECH 292	Design 1	3	
MECH 314	Dynamics of Mechanisms	3	
MECH 315	Dynamics of Vibrations	3	
MECH 321	Mechanics of Deformable Solids	3	
MECH 331	Fluid Mechanics 1	3	
MECH 341	Thermodynamics 2	3	
MECH 346	Heat Transfer	3	
MECH 362	Mechanical Laboratory	2	
MECH 383	Applied Electronics and Instrumentation	3	
MECH 393	Design 2	3	
MECH 409	Numerical Methods in Mechanical Engineering	3	
MECH 412	Dynamics of Systems	3	
MECH 430	Fluid Mechanics 2	3	
MECH 463D1	Mechanical Engineering Project	3	
MECH 463D2	Mechanical Engineering Project	3	**64**
COMPLEMENTARY COURSES			**15**

2 courses (6 credits) at the 300 level or higher to be selected from Mechanical Engineering. For students who entered in September 2000 or later, one of these two courses must be chosen from the following list:

MECH 343	Energy Conversion
MECH 413	Control Systems
MECH 432	Aircraft Structures
MECH 471	Industrial Engineering
MECH 472	Case Studies in Project Mgmt
MECH 495	Design 3
MECH 496	Design 4
MECH 497	Value Engineering
MECH 524	Computer Integrated Manufacturing
MECH 526	Manufacturing and the Environment
MECH 528	Product Design
MECH 532	Aircraft Performance, Stability and Control
MECH 541	Kinematic Synthesis
MECH 543	Design with Composite Materials
MECH 554	Microprocessors for Mechanical Systems
MECH 557	Mechatronic Design
MECH 565	Fluid Flow & Heat Transfer Equipment
MECH 572	Introduction to Robotics
MECH 573	Mechanics of Robotic Systems
MECH 577	Optimum Design

1 course (3 credits) at the 300-level or higher 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 3.4).

TOTAL CREDITS **112**

If advanced credit is given for MATH 260 Intermediate Calculus (see section 2.4), 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 *Welcome to McGill*. After registering, students must consult with their academic advisor.

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

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

REQUIRED COURSES		COURSE CREDIT	
Non-Departmental Subjects			
CIVE 207	Solid Mechanics	4	
EDEC 206	Communication in Engineering	3	
COMP 208	Computers in Engineering	3	
MATH 260	Intermediate Calculus	3	
MATH 261	Differential Equations	3	
MATH 265	Advanced Calculus	3	
MATH 266	Linear Algebra and BVP	4	
MIME 221	Engineering Professional Practice	1	
MIME 310	Engineering Economy	3	**27**

Departmental Courses

MECH 201	Introduction to Mechanical Engineering	2	
MECH 210	Mechanics 1	4	
MECH 220	Mechanics 2	3	
MECH 240	Thermodynamics 1	3	
MECH 260	Machine Tool Laboratory	2	
MECH 262	Statistics and Measurement Laboratory	3	
MECH 291	Graphics	3	
MECH 292	Design 1	3	
MECH 321	Mechanics of Deformable Solids	3	
MECH 331	Fluid Mechanics 1	3	
MECH 341	Thermodynamics 2	3	
MECH 346	Heat Transfer	3	
MECH 362	Mechanical Laboratory	2	
MECH 383	Applied Electronics and Instrumentation	3	
MECH 403D1	Honours Thesis 1	3	
MECH 403D2	Honours Thesis 1	3	
MECH 404	Honours Thesis 2	3	
MECH 409	Numerical Methods in Mechanical Engineering	3	
MECH 419	Advanced Mechanics of Systems	3	
MECH 430	Fluid Mechanics 2	3	
MECH 452	Mathematical Methods in Engineering	3	
MECH 494	Honours Design Project	3	
And any two of three below:		**6**	**70**

MECH 545 (3) Advanced Stress Analysis
MECH 562 (3) Advanced Fluid Mechanics
MECH 578 (3) Advanced Thermodynamics

COMPLEMENTARY COURSES **15**

2 courses (6 credits) at the 300 level or higher to be selected from Mechanical Engineering. For students who entered in September 2000 or later, one of these two courses must be chosen from the following list:

MECH 343 Energy Conversion
MECH 413 Control Systems
MECH 432 Aircraft Structures
MECH 471 Industrial Engineering
MECH 472 Case Studies in Project Mgmt
MECH 495 Design 3
MECH 496 Design 4
MECH 497 Value Engineering
MECH 524 Computer Integrated Manufacturing
MECH 526 Manufacturing and the Environment
MECH 528 Product Design
MECH 532 Aircraft Performance, Stability and Control
MECH 541 Kinematic Synthesis
MECH 543 Design with Composite Materials
MECH 554 Microprocessors for Mechanical Systems
MECH 557 Mechatronic Design
MECH 565 Fluid Flow & Heat Transfer Equipment
MECH 572 Introduction to Robotics
MECH 573 Mechanics of Robotic Systems
MECH 577 Optimum Design

1 course (3 credits) at the 300 level or higher 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 3.4).

TOTAL CREDITS **112**

Students entering in September or January must plan their program of studies in accordance with the regulations described in *Welcome to McGill*. After registering, students must consult with their academic advisor.

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

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

MECH 343 Energy Conversion
MECH 413 Control Systems
MECH 432 Aircraft Structures
MECH 434 Turbomachinery
MECH 447 Combustion
MECH 471 Industrial Engineering
MECH 472 Case Studies in Project Mgmt
MECH 474 Selected Topics in Operations Research
MECH 495 Design 3
MECH 496 Design 4
MECH 497 Value Engineering
MECH 500 Selected Topics in Mechanical Engineering
MECH 501 Special Topics: Mechanical Engineering
MECH 522 Production Systems
MECH 524 Computer Integrated Manufacturing
MECH 526 Manufacturing and the Environment
MECH 528 Product Design
MECH 529 Discrete Manufacturing Systems
MECH 530 Mechanics of Composite Materials
MECH 531 Aeroelasticity
MECH 532 Aircraft Performance, Stability and Control
MECH 533 Subsonic Aerodynamics
MECH 534 Air Pollution Engineering
MECH 537 High Speed Aerodynamics
MECH 538 Unsteady Aerodynamics
MECH 539 Computational Aerodynamics
MECH 540 Design: Modelling and Decision
MECH 541 Kinematic Synthesis
MECH 542 Spacecraft Dynamics
MECH 543 Design with Composite Materials
MECH 545 Advanced Stress Analysis
MECH 552 Advanced Applied Mathematics
MECH 554 Microprocessors for Mechanical Systems
MECH 555 Applied Process Control
MECH 557 Mechatronic Design
MECH 561 Biomechanics of Musculoskeletal Systems
MECH 562 Advanced Fluid Mechanics
MECH 565 Fluid Flow & Heat Transfer Equipment
MECH 572 Introduction to Robotics
MECH 573 Mechanics of Robotic Systems
MECH 576 Computer Graphics and Geometrical Modelling
MECH 577 Optimum Design
MECH 578 Advanced Thermodynamics
MECH 581 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)
COMP 208 Computers in Engineering
MATH 260 Intermediate Calculus
MECH 201 Introduction to Mechanical Engineering
MECH 210 Mechanics 1
MECH 260 Machine Tool Laboratory
MIME 221 Engineering Professional Practice

Semester 2 (Winter)
EDEC 206 Communication in Engineering
MATH 261 Differential Equations
MATH 265 Advanced Calculus
MECH 220 Mechanics 2
MECH 262 Statistics & Measurement Laboratory
MECH 291 Graphics

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:

MECH 532 Aircraft Performance, Stability and Control
MECH 533 Subsonic Aerodynamics

and at least one of the following:
MECH 432 Aircraft Structures
MECH 434 Turbomachinery

The remaining two courses may be chosen from the above or from the following courses:
MECH 531 Aeroelasticity
MECH 537 High Speed Aerodynamics
MECH 538 Unsteady Aerodynamics
MECH 539 Computational Aerodynamics

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

Students should also discuss the matter with their advisor 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:
MECH 495 Design 3
MECH 496 Design 4

Plus any four below:
MECH 497 Value Engineering
MECH 540 Design: Modelling and Decision
MECH 541 Kinematic Synthesis
MECH 543 Design with Composite Materials
MECH 557 Mechatronic Design
MECH 565 Fluid Flow & Heat Transfer Equipment
MECH 576 Computer Graphics and Geometrical Modelling
MECH 577 Optimum Design

MECHATRONICS 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:

MECH 413 Control Systems
MECH 554 Microprocessors for Mechanical Systems
MECH 557 Mechatronic Design
MECH 572 Introduction to Robotics

and two of the following:
MECH 528 Product Design
MECH 541 Kinematic Synthesis
MECH 573 Mechanics of Robotic Systems
MECH 576 Computer Graphics and Geometrical Modelling
ECSE 502 Control Engineering

COURSES OFFERED BY THE DEPARTMENT

For the Term (Fall and/or Winter), days, and times when courses will be offered, please refer to the 2002-2003 Class Schedule on the Web, http://www.mcgill.ca/students/. Class locations and names of instructors are also provided.

Students preparing to register are advised to consult the Class Schedule website for the most up-to-date list of courses available. New courses may have been added or courses rescheduled after this Calendar went to press.

The schedule of courses to be offered in Summer 2003 will be available on the website in January.

MECH has replaced 305 as the prefix for Mechanical Engineering courses.

The course credit weight is given in parentheses after the title.

● Denotes courses not offered in 2002-03.

▭ Denotes courses with limited enrolment.

MECH 201 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.

MECH 210 MECHANICS 1. (4) (4-1-7) Basic principles of Newtonian mechanics. Kinematics, relative motion, momentum, forces (gravity, friction, elastic, etc.), pseudo-forces, impulse, energy (kinetic and potential) and mechanical work. Conservation of momentum and angular momentum, central force motion, centre of mass and moment of inertia. Engineering applications including beams, trusses, frames, mechanisms.

MECH 220 MECHANICS 2. (3) (3-1-5) (Prerequisites: MECH 210 and MATH 260. Pre-/Co-requisite: MATH 261) Newtonian and Lagrangian formulations of mechanics. Solution of equations of motion for simple systems. Degrees of freedom, generalized coordinates and constraints. Energy methods. Equilibrium and stability of mechanical systems. 3-dimensional rigid-body dynamics; Euler's equations. Gyroscopic motion.

MECH 240 THERMODYNAMICS 1. (3) (3-1-5) Thermodynamic systems and properties. First law of thermodynamics: energy, work and heat. State principle, p-v-T surfaces, phase equilibrium, ideal gas model. Second law of thermodynamics, entropy, exergy analysis. Energy analysis applied to steady and transient engineering systems including heat engines, refrigerators and heat pumps, air compressors.

▭ **MECH 260 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.

MECH 261 MEASUREMENT LAB. (2) (2-3-1) (Restricted to Civil Engineering students) Basic experimental laboratory measurements, such as measurement of strain, pressure, force, position, and temperature.

MECH 262 STATISTICS AND MEASUREMENT LABORATORY. (3) (3-3-3) Introduction to probability: conditional probability, binomial and Poisson distributions, random variables, laws of large numbers. Statistical analysis associated with measurements; regression and correlation. Basic experimental laboratory techniques, including the measurement of strain, pressure, force, position, and temperature.

MECH 290 GRAPHICS 2. (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.

MECH 291 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.

MECH 292 DESIGN 1. (3) (1-3-5) (Prerequisites: MECH 260 and MECH 291. Pre-/Co-requisites: CIVE 207, EDEC 206) (Course description change awaiting University approval) Introduction to design. Problem formulation, idea generation, feasibility study, preliminary design, design analysis, design evaluation, project management, and 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.

MECH 314 DYNAMICS OF MECHANISMS. (3) (3-1-5) (Prerequisite: MECH 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.

MECH 315 DYNAMICS OF VIBRATIONS. (3) (3-1-5) (Prerequisites: MECH 220, CIVE 207 and MATH 266) Modelling of vibration of mechanical systems. Single-degree-of-freedom systems: free vibrations; effect of damping; response to harmonic, periodic and arbitrary excitation; vibration isolation. Free and forced vibrations of n degree-of-freedom and continuous systems.

MECH 321 MECHANICS OF DEFORMABLE SOLIDS. (3) (3-1-5) (Prerequisite: CIVE 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.

MECH 331 FLUID MECHANICS 1. (3) (3-1-5) (Prerequisite: MECH 210. Pre-/Co-requisites: MECH 220, MECH 240 and MATH 266) Physical properties of fluids. Kinematics and dynamics of fluid flow: stress in a continuum, 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.

MECH 341 THERMODYNAMICS 2. (3) (3-1-5) (Prerequisite: MECH 240) (Course description change awaiting University approval) Generalized thermodynamic relations. Real gas effects, gas tables, dense gas equations of state and generalized compressibility, enthalpy, and entropy charts. Vapour and gas power cycles (coal/nuclear power plants). Refrigerators and heat pumps. Psychrometry and air conditioning processes. Thermodynamics of reactive gas mixtures.

● **MECH 343 ENERGY CONVERSION.** (3) (3-0-6) (Prerequisite: MECH 240)

MECH 346 HEAT TRANSFER. (3) (3-1-5) (Prerequisites: MECH 240 or ABEN 301, MECH 331 or ABEN 305, MATH 266 or ABEN 319) Basic concepts and overview. Steady and unsteady heat conduction. Fin Theory. Convective heat transfer: governing equations; dimensionless parameters; analogy between momentum and heat transfer. Design correlations for forced, natural, and mixed convection. Heat exchangers. Radiative heat transfer: black- and gray-body radiation; shape factors; enclosure theory. Thermal engineering design project.

MECH 362 MECHANICAL LABORATORY 1. (2) (0-3-3) (Prerequisite: MECH 261 or MECH 262) (Prerequisite change awaiting University approval) Experiments will be performed in four areas: MECH 240 Thermodynamics, MECH 315 Vibrations, MECH 331 Fluid Mechanics 1, and MECH 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.

MECH 383 APPLIED ELECTRONICS AND INSTRUMENTATION. (3) (3-2-4) (Prerequisites: MECH 261 or MECH 262, and MATH 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.

MECH 393 DESIGN 2. (3) (3-3-3) (Prerequisite: MECH 292. Pre-/co-requisites: MECH 314 and MIME 260) (Prerequisite change awaiting University approval) 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.

MECH 403D1 THESIS (HONOURS). (3) (0-6-12) (Prerequisite: Candidates must have completed courses in the Mechanical Engineering Program weighted at a minimum of 60 credits.) (Students must also register for MECH 403D2) (No credit will be given for this course unless both MECH 403D1 and MECH 403D2 are successfully completed in consecutive terms) This course, together with course MECH 404 involves a research project containing an explicit component of design, 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.

MECH 403D2 THESIS (HONOURS). (3) (Prerequisite: MECH 403D1) (No credit will be given for this course unless both MECH 403D1 and MECH 403D2 are successfully completed in consecutive terms) See MECH 403D1 for course description.

MECH 403N1 THESIS (HONOURS). (3) (Students must also register for MECH 403N2) (No credit will be given for this course unless both MECH 403N1 and MECH 403N2 are successfully completed in the same calendar year) See MECH 403D1 for course description.

MECH 403N2 THESIS (HONOURS). (3) (Prerequisite: MECH 403N1) (No credit will be given for this course unless both MECH 403N1 and MECH 403N2 are successfully completed in the same calendar year) See MECH 403D1 for course description.

MECH 404 HONOURS THESIS 2. (3) (0-3-3) (Corequisite: MECH 403) This course is part of the same thesis project as course MECH 403.

MECH 409 NUMERICAL METHODS IN MECHANICAL ENGINEERING. (3) (3-1-5) (Prerequisites: MATH 261, MATH 266 and COMP 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.

MECH 412 DYNAMICS OF SYSTEMS. (3) (3-1-5) (Prerequisite: MECH 315. Pre-/Co-requisite: MECH 331) Modelling of physical systems by lumped-parameter linear elements. Unified treatment of mechanical, fluid, electrical, and thermal devices and systems. State space, formulation of state equations, time response. Frequency-response methods. Dynamic response specifications. Stability. Elementary feedback control systems. Extensive use of engineering examples and software tools.

MECH 413 CONTROL SYSTEMS. (3) (3-1-5) (Prerequisite: MECH 412) Stability of Linear Systems. Controller design based on root-locus and frequency response methods. Tuning of PID controllers. State-space representation of dynamic systems. Concepts of controllability and observability. Design of state feedback controller and state observer based on state-space and polynomial methods. Introduction to digital control.

MECH 419 ADVANCED MECHANICS OF SYSTEMS. (3) (3-1-5) (Prerequisites: MECH 220, CIVE 207, MATH 265 and MATH 266) Lagrangian and Hamiltonian dynamics. Variational methods. Discrete linear systems; classical and numerical solutions for conservative and non-conservative systems; matric function methods. Electrical-mechanical-acoustical analogies. Stability considerations and closed-loop systems. Vibration of distributed parameter systems. Energy methods. Non-linear vibrations; the phase plane, perturbation and other methods of solution.

MECH 430 FLUID MECHANICS 2. (3) (3-1-5) (Prerequisite: MECH 331) (Course description change awaiting University approval) Review of thermodynamics of gases, one dimensional isentropic flow and choking. Nozzles and wind tunnels. Normal shock waves. Flow in constant area ducts with friction and heat exchange. Compressible irrotational flow. Oblique shock waves and Prandtl-Meyer expansion. Supersonic aerofoil and wing theory.

MECH 432 AIRCRAFT STRUCTURES. (3) (3-0-6) (Prerequisites: MECH 331 and MECH 321) Plane stress and strain. Theories of failure. Plastic and viscoelastic stress-strain relations. External and internal forces in spars. Bending, deflection of beams, plastic deformation and aeroelastic distortion of wings and fuselage. Structural characteristics of wings. Torsion of wings and related

critical aeroelastic design parameters; divergence and aeroelastic twist. Energy methods. Buckling in aeronautical structures. Flutter.

MECH 434 TURBOMACHINERY. (3) (3-0-6) (Prerequisite: MECH 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 configurations. Centrifugal compressors and radial inflow turbines.

● **MECH 447 COMBUSTION.** (3) (3-0-6) (Prerequisite: MECH 240)

MECH 452 MATHEMATICAL METHODS IN ENGINEERING 1. (3) (3-1-5) (Prerequisite: Candidates must have completed courses in the Mechanical Engineering Program weighted at 60 credits (minimum)) 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.

MECH 463D1 MECHANICAL ENGINEERING PROJECT. (3) (1-3-5) (Prerequisite: MECH 393) (Students must also register for MECH 463D2) (No credit will be given for this course unless both MECH 463D1 and MECH 463D2 are successfully completed in consecutive terms) Team project work typically involving the design, fabrication, verification, and application of a mechanical device/system, or experimental facility. The project work is complemented with lectures in the Fall term on topics related to design and management of design projects. Emphasis is on the completion of a project of professional quality.

MECH 463D2 MECHANICAL ENGINEERING PROJECT. (3) (Prerequisite: MECH 463D1) (No credit will be given for this course unless both MECH 463D1 and MECH 463D2 are successfully completed in consecutive terms) See MECH 463D1 for course description.

● **MECH 471 INDUSTRIAL ENGINEERING.** (3) (3-1-5)

● **MECH 472 CASE STUDIES IN PROJECT MANAGEMENT.** (3) (3-0-6) (Prerequisite: U3 and permission of the instructor)

MECH 474 SELECTED TOPICS IN OPERATIONS RESEARCH. (3) (3-0-6) (Prerequisites: MATH 266 and COMP 208) (Course title change awaiting University approval) Introduction to the general mathematical programming problem in the context of engineering design; linear programming, queueing theory, Monte Carlo simulation. 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.

MECH 494 HONOURS DESIGN PROJECT. (3) (0-6-3) (Prerequisite: MECH 292) (Restricted to Mechanical Engineering Honours students.) An advanced design project course with emphasis on analytical solutions, performance prediction and validation, and planning for production.

MECH 495 DESIGN 3. (3) (0-6-3) (Prerequisite: MECH 463) A design project course of two terms together with MECH 496. Project approval required. Allows the completion of a project of greater complexity than Design II and Mechanical Engineering Project with emphasis on analytical solutions, stressing, planning for production. No lectures. Weekly consultations. Interim and final reports required.

MECH 496 DESIGN 4. (3) (0-6-3) (Prerequisite: MECH 495) Continuation of MECH 495. 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 2 and Mechanical Engineering Project with emphasis on analytical solutions, stressing, planning for production. No lectures. Weekly consultations. Interim and final reports required.

MECH 497 VALUE ENGINEERING. (3) (0-8-1) (Prerequisites: MECH 393 and completion of 45 credits) Value Engineering is an in-depth analysis of an industrial product or process with a view to improving its design and/or performance to increase its worth. This is a workshop type of course. Projects will be supplied by industrial firms and students will work in teams with industrial personnel.

● **MECH 500 SELECTED TOPICS IN MECHANICAL ENGINEERING.** (3) (3-0-6)

MECH 501 SPECIAL TOPICS: MECHANICAL ENGINEERING. (3) (3-0-6) A course to allow the introduction of new topics in Mechanical Engineering as needs arise, by regular and visiting staff.

MECH 522 PRODUCTION SYSTEMS. (3) (3-0-6) (Course description change awaiting University approval) Characteristics of production systems. System boundaries, input-output, feedback time-lag effects, dynamics of production systems. Design for manufacturability. 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 production modeling and industrial simulation software.

▭ **MECH 524 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 structures. Study of several types of production systems. Integration issues: inter-and intra-enterprise. Laboratory experience with manufacturing software systems.

● **MECH 525 INTRODUCTION TO NUCLEAR ENGINEERING.** (3)

▭ **MECH 526 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 technology on the environment, environmental impact assessment, regulatory process, and managing the "political" process.

● **MECH 527 COMPUTER-AIDED MECHANICAL DESIGN.** (3)

▭ **MECH 528 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 mechanics, electronics and software in products. Effect on design of product cost, maintainability, recycling, marketability.

● ▭ **MECH 529 DISCRETE MANUFACTURING SYSTEMS.** (3) (3-0-6) (Prerequisite: Permission of the instructor)

MECH 530 MECHANICS OF COMPOSITE MATERIALS. (3) (3-0-6) (Corerequisite: MECH 321 or equivalent/instructor's permission) Fiber reinforced composites. Stress, strain, and strength of composite laminates and honeycomb structures. Failure modes and failure criteria. Environmental effects. Manufacturing processes. Design of composite structures. Computer modeling of composites. Computer techniques are utilized throughout the course.

● **MECH 531 AEROELASTICITY.** (3) (3-1-5) (Prerequisites: MECH 419, MECH 319 or MECH 315 and MECH 533)

MECH 532 AIRCRAFT PERFORMANCE, STABILITY AND CONTROL. (3) (3-1-5) (Prerequisites: MECH 412, MECH 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 response for all three modes.

MECH 533 SUBSONIC AERODYNAMICS. (3) (3-1-5) (Prerequisite: MECH 331) Kinematics: equations of motion; vorticity and circulation, conformal mapping and flow round simple bodies. Two dimensional flow round aerofoils. Three dimensional flows; high and low aspect-ratio wings; airscrews. Wind tunnel interference. Similarity rules for subsonic irrotational flows.

MECH 534 AIR POLLUTION ENGINEERING. (3) (3-0-6) (Prerequisites: MECH 240, MECH 331, MECH 341 and MECH 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.).

● **MECH 536 FRICTION LUBRICATION AND WEAR.** (3)

MECH 537 HIGH-SPEED AERODYNAMICS. (3) (3-0-6) (Pre-/Co-requisite: MECH 533) Equations of compressible flows. Planar and conical shock waves. Expansion and shock wave interference; shock tubes. Method of characteristics. Supersonic nozzle design. Aerofoil theory in high subsonic, supersonic and hypersonic flows. Conical flows. Yawed, delta and polygonal wings; rolling and pitching rotations. Wing-body systems. Elements of transonic flows.

● **MECH 538 UNSTEADY AERODYNAMICS.** (3) (3-0-6) (Prerequisite: MECH 533)

MECH 539 COMPUTATIONAL AERODYNAMICS. (3) (3-0-6) (Pre-/Co-requisite: MECH 533 or equivalent) Fundamental equations. Basic flow singularities. Boundary element methods. Source, doublet and vortex panel methods for 2D and 3D incompressible and compressible flows. Method of characteristics. Euler equations for inviscid rotational flows. Finite-difference and finite-volume methods. Explicit and implicit time-integration methods. Quasi 1D solutions. Nozzle and confined aerofoil applications.

MECH 540 DESIGN: MODELLING AND 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.

● **MECH 541 KINEMATIC SYNTHESIS.** (3) (3-0-6)

MECH 542 SPACECRAFT DYNAMICS. (3) (3-0-6) (Prerequisite: MECH 220. Corequisite: MECH 412 or MECH 419) (Course description change awaiting University approval) Review of central force motion; Hohmann and other coplanar transfers, rotation of the orbital plane, patched conic method. 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.

MECH 543 DESIGN WITH COMPOSITE MATERIALS. (3) (3-3-3) (Prerequisite: MECH 530) Material systems/selection process. Cost vs performance. Laminate layup procedures. Theory and application of filament winding of composite cylinders. Regular oven and autoclave oven curing, analysis of resulting material performance. Practical design considerations and tooling. Analysis of environmental considerations. Joining techniques. Analysis of test methods. Theory of repair techniques.

MECH 545 ADVANCED STRESS ANALYSIS. (3) (3-1-5) (Prerequisites: CIVE 207 and MECH 321) Tensor Analysis: Review of continuum mechanics. Equilibrium and constitutive equations in tensor form. Finite element methods. Torsion of non-circular cross-sections; spherical problems; advanced airy stress function problems. Introduction to plates and shells. Thermal deformations and stresses. Introduction to plasticity and viscoelasticity.

MECH 552 ADVANCED APPLIED MATHEMATICS. (3) (3-1-5) (Prerequisite: MECH 452) Solutions of ordinary differential equations using integral methods; asymptotic series, Stirling's approximation. Bessel and Laguerre functions. Green's functions. Laplace, Helmholtz, diffusion, wave, telegraph partial differential equations. Variational methods. Numerical solutions to partial differential equations.

MECH 554 MICROPROCESSORS FOR MECHANICAL SYSTEMS. (3) (2-3-4) (Prerequisites: MECH 383 and COMP 208) Digital logic and circuits - asynchronous and synchronous design. Microcontroller architectures, organization and programming - assembly and high-level. Analog/ Digital/Hybrid Sensors and Actuators. Sensing and conditioning subsystems. Interfacing issues. Real time issues. Operator interfaces. Lab exercises on digital logic design, interfacing and control of peripherals with a final team project.

● **MECH 555 APPLIED PROCESS CONTROL.** (3) (3-2-4) (Prerequisite: MECH 554 or equivalent)

MECH 557 MECHATRONIC DESIGN. (3) (3-1-5) (Prerequisites: ECSE 461, MECH 383 and MECH 412) Team project course on the design, modeling, model validation, and control of complete mechatronic systems, constructed with modern sensors, actuators, real time operating systems, embedded controllers, and intelligent control.

MECH 561 BIOMECHANICS OF MUSCULOSKELETAL SYSTEMS. (3) (3-0-6) (Prerequisites: MECH 321, MECH 315 or MECH 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.

MECH 562 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.

MECH 565 FLUID FLOW AND HEAT TRANSFER EQUIPMENT. (3) (3-1-5) (Prerequisites: MECH 240, MECH 341, MECH 331 and MECH 346) Pipes and piping systems, pumps, and valves. Fans and building air distribution systems. Basic thermal design methods for fins and heat exchangers. Thermal design of shell-and-tube and compact heat exchangers.

MECH 572 INTRODUCTION TO ROBOTICS. (3) (3-0-6) (Prerequisites: MATH 266 and MECH 220 or permission of the instructor) (Not open to students who have taken MECH 573) Manipulator hardware structure, kinematics, statics, dynamics planning and control. Rigid-body, three-dimensional statics, kinematics and dynamics. Direct and inverse kinematics and dynamics. Trajectory planning subject to constraints. Manipulator control. In depth study of serial manipulators with extension to more complex robotic devices.

MECH 573 MECHANICS OF ROBOTIC SYSTEMS. (3) (3-0-6) (Prerequisite: Permission of the instructor) Numerical methods for the kinematic inversion of serial manipulators. The handling of redundancies and singularities. Kinematics and dynamics of parallel manipulators, manipulator performance evaluation and optimization, multifingered hand grasping and manipulation, robot compliant and constrained motion. Obstacle avoidance.

MECH 576 COMPUTER GRAPHICS AND GEOMETRICAL MODELLING. (3) (2-3-4) (Prerequisites: MATH 266 and MECH 290 or MECH 291) Review of pertinent linear algebra and projective geometry. Explicit, implicit 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 Engineering applications.

MECH 577 OPTIMUM DESIGN. (3) (2-3-4) The role of optimization within the design process: Design methodology and philosophy. Constrained optimization: The Kuhn-Tucker conditions. Techniques 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.

● **MECH 578 ADVANCED THERMODYNAMICS.** (3) (3-0-6)

● **MECH 581 NONLINEAR DYNAMICS AND CHAOS.** (3) (3-1-5) (Prerequisite: MECH 315 or MECH 419/MECH 319)

GRADUATE 600-LEVEL COURSES

Generally, undergraduate students are not permitted to enrol 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. A list of such courses is described in detail in the *Graduate Studies Calendar*.

4.7 Department of Mining, Metals and Materials Engineering

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Metals and Materials –
Telephone: (514) 398-1040 Fax: (514) 398-4492

Mining –
Telephone: (514) 398-2215 Fax: (514) 398-7099

Chair — Robin A.L. Drew

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

Post-Retirement
Phil A. Distin; B.Sc. Ph.D.(Lond.), D.I.C.

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)*
Raynald Gauvin; B.Ing., Ph.D.(Montr.), Eng.
John E. Gruzleski; B.Sc., M.Sc.(Qu.), Ph.D.(Tor.), Eng. *(Gerald G. Hatch Professor of Mining and Metallurgy)*
Rod I.L. Guthrie; B.Sc., Ph.D.(Lond.), D.I.C., A.R.S.M., Eng. *(William C. Macdonald Professor of Mining and Metallurgy)*
Farmaraz (Ferri) P. Hassani; B.Sc., Ph.D.(Nott.), C.Eng.(U.K. Reg.) *(George Boyd Webster Professor of Mining Engineering)* (Director, Mining Engineering Program)
John J. Jonas; B.Eng.(McG.), Ph.D.(Cantab.), F.A.S.M., Eng. *(Henry Birks Professor of Metallurgy)*
Hani S. Mitri; B.Sc.(Cairo), M.Eng., Ph.D.(McMaster), Eng.
Jerzy Szpunar; B.Sc., M.Sc., Ph.D., D.Sc.(Krakow)

Associate Professors
Michel L. Bilodeau; B.A.Sc.(Montr.), M.Sc.App., Ph.D.(McG.), Eng.
Ralph Harris; B.Sc.(Qld), M.Eng., Ph.D.(McG.)
Mainul Hasan; B.Eng.(Dhaka), M.Sc.(Dhahran), Ph.D.(McG.)
Janusz A. Kozinski; B.A., M.Eng., D.Sc.(Krakow)*(William Dawson Scholar)*
André Laplante; B.A.Sc., M.A.Sc.(Montr.), Ph.D.(Tor.), Eng.
Frank Mucciardi; B.Eng., M.Eng., Ph.D.(McG.), Eng.
Jacques Ouellet; B.A.Sc.(Laval), M.A.Sc, Ph.D.(Montr.), Eng.
Steve Yue; B.Sc., Ph.D.(Leeds)

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

Adjunct Professors
Marc Betournay; William Caley; Roussos Dimitrakopoulos; Bryn Harris; Ahmad Hemami; Raad Jassim; Eric Lifshin; Martin Pugh; John H. Root; Raymond Thom, Eng.; William T. Thompson; Viwek Vaidya, Eng.; Albert E. Wraith

CO-OP Programs
Director — James A. Finch
Work-term Coordinator — Michel Vachon

The Department of Mining, Metals and Materials Engineering offers programs leading to the Bachelor of Engineering degree in Metals and Materials Engineering or Mining Engineering. In addition to regular courses and laboratories, the curriculum includes seminars, colloquia and student projects reinforced by field trips to industrial operations.

The equipment operated by the Department is the best available. On the metals and materials side there is a full range of laboratory facilities for extractive and 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.

Metals and Materials Engineering (CO-OP). The Metals and Materials Engineering 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 provide up-to-date training in metals/materials engineering. Students take core courses covering metals and materials extraction, processing, fabrication, applications and performance. The program conforms with requirements of the Canadian Engineering Accreditation Board (CEAB) and is designed to offer students 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 structure is reinforced with laboratory exercises. Graduates in Metals and Materials Engineering find employment in a wide range of industries which include the mineral/metal producing and processing sectors, as well as the aerospace and manufacturing industries. Students in the CO-OP program benefit from the practical learning experience arising from work-term employment in meaningful engineering jobs. Students also benefit from the non-tangible learning experience arising from the increased responsibilities required to obtain and successfully complete the work terms.

Mining Engineering (CO-OP). McGill, which has the oldest mining 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 throughout 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 Civil, Geological and Mining 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 $3000; 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 METALS AND MATERIALS ENGINEERING – CO-OP PROGRAM

REQUIRED COURSES		COURSE CREDITS	
Non-Departmental Courses			
CHEM 233	Selected Topics in Physical Chemistry	3	
CIVE 205	Statics	3	
CIVE 207	Solid Mechanics	4	
COMP 208	Computers in Engineering	3	
MATH 260	Intermediate Calculus	3	
MATH 261	Differential Equations	3	
MATH 265	Advanced Calculus	3	**22**
Departmental Courses			
MIME 200	Intro to the Minerals Industry	3	
MIME 202	Engineering Communication Skills	2	
MIME 209	Mathematical Applications	3	
MIME 212	Engineering Thermodynamics	3	
MIME 221	Engineering Professional Practice	1	
MIME 261	Structure of Materials	3	
MIME 280	Industrial Training 1	2	
MIME 310	Engineering Economy	3	
MIME 311	Modelling and Automatic Control	3	
MIME 317	Materials Characterization	3	
MIME 337	Electrotechnology	2	

MIME 341	Introduction to Mineral Processing	3	
MIME 350	Extractive Metallurgical Engineering	3	
MIME 352	Hydrochemical Processing	3	
MIME 356	Heat, Mass and Fluid Flow	4	
MIME 360	Phase Transformations in Solids	3	
MIME 362	Mechanical Properties	3	
MIME 367	Electronic Properties of Materials	3	
MIME 380	Industrial Training 2	2	
MIME 442	Modelling in Mineral Processing	3	
MIME 452	Process and Materials Design	4	
MIME 455	Advanced Process Engineering	3	
MIME 456	Steelmaking and Steel Processing	3	
MIME 465	Ceramic Engineering	3	
MIME 480	Industrial Training 3	2	
MIME 481	Industrial Training 4	2	
CHEM 455	Polymer Chemistry	3	**75**

COMPLEMENTARY COURSES

Technical Courses **12**

Four courses may be taken; one of these can be chosen from the Faculty list.

NOTE: Not all courses are given annually; verification with course instructor is advised.

CHEE 481	(3)	Polymer Engineering
CHEE 581	(3)	Polymer Composites Engineering
CHEM 585	(3)	Colloid Chemistry
CIVE 512	(3)	Advanced Civil Engineering Materials
MECH 530	(3)	Mechanics of Composite Materials
MIME 361	(3)	Liquid State Processing of Materials
MIME 410	(3)	Research Project
MIME 412	(3)	Corrosion and Degradation
MIME 451	(3)	Environmental Controls
MIME 457	(3)	Light Metals Extraction
MIME 463	(3)	Deformation Processing of Metals
MIME 515	(3)	Advanced Metallurgical and Materials Thermodynamics
MIME 544	(3)	Mineral Processing Systems 1
MIME 545	(3)	Mineral Processing Systems 2
MIME 551	(3)	Electrochemical Processing
MIME 555	(3)	Thermal Remediation of Wastes
MIME 560	(3)	Joining Processes
MIME 563	(3)	Hot Deformation of Metals
MIME 564	(3)	X-ray Diffraction Analysis of Materials
MIME 566	(3)	Texture, Structure and Properties of Polycrystalline Materials
MIME 567	(3)	Aluminum Casting Alloys
MIME 568	(3)	Topics in Advanced Materials
MIME 569	(3)	Electron Beam Analysis of Materials
PHYS 558	(3)	Solid State Physics

General Complementaries **6**

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 3.4).

TOTAL **115**

Advanced credit is given for MATH 260 Intermediate Calculus upon successful completion of a placement test (see section 2.4).

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

REQUIRED COURSES		**COURSE CREDITS**	
Non-Departmental Courses			
CIVE 205	Statics	3	
CIVE 207	Solid Mechanics	4	
COMP 208	Computers in Engineering	3	
EPSC 221	General Geology	3	
EPSC 225	Properties of Minerals	1	
MATH 260	Intermediate Calculus	3	
MATH 261	Differential Equations	3	
MATH 265	Advanced Calculus	3	
MECH 290	Graphics	3	**26**
Departmental Mining Courses			
MIME 200	Intro to the Minerals Industry	3	
MIME 202	Eng. Communication Skills	2	
MIME 203	Mine Surveying (2 weeks at beginning of summer)	2	
MIME 209	Mathematical Applications	3	
MIME 221	Engineering Professional Practice	1	
MIME 260	Materials Science and Engineering	3	
MIME 290	Industrial Work Period 1	2	
MIME 291	Industrial Work Period 2	2	
MIME 310	Engineering Economy	3	
MIME 322	Rock Fragmentation	3	
MIME 323	Rock and Soil Mass Characterization	3	
MIME 325	Mineral Industry Economics	3	
MIME 333	Materials Handling	3	
MIME 337	Electrotechnology	2	
MIME 340	Applied Fluid Dynamics	3	
MIME 341	Introduction to Mineral Processing	3	
MIME 392	Industrial Work Period 3	2	
MIME 419	Surface Mining	3	
MIME 420	Feasibility Study	3	
MIME 426	Development and Services	3	
MIME 484	Mining Project	3	**55**
École Polytechnique Mining Courses			
MPMC 320	CAO et informatique pour les mines	3	
MPMC 321	Mécanique des roches et contrôle des terrains	3	
MPMC 326	Recherche opérationnelle minière I	3	
MPMC 328	Environnement et gestion des rejets miniers	3	
MPMC 329	Géologie minière	2	
MPMC 330	Géotechnique minière	3	
MPMC 421	Exploitation en souterrain	3	
MPMC 422	Ventilation minière et hygiène du travail	3	**23**

COMPLEMENTARY COURSES

Either Choice I or II 8 or 9

Choice I (8 credits)

MIME 494	(2)	Industrial Work Period 4
and		two Technical Complementaries

or Choice II (9 credits)

MIME 350	(3)	Extractive Metallurgical Engineering
MIME 544	(3)	Mineral Processing Systems 1
and		one Technical Complementary

General Complementaries **6**

2 courses (6 credits), 1 course from Impact of Technology on Society and 1 course from Humanities and Social Sciences selected from an approved list (see section 3.4).

TOTAL **118 or 119**

Mining Technical Complementary Course List:

MIME 320	(3)	Extraction of Energy Resources
MIME 442	(3)	Modelling in Mineral Processing
MIME 520	(3)	Stability of Rock Slopes
MIME 521	(3)	Stability of Underground Openings
MIME 526	(3)	Mineral Economics
MIME 528	(3)	Mining Automation
MIME 544	(3)	Mineral Processing Systems 1
MIME 545	(3)	Mineral Processing Systems 2
MPMC 327	(3)	Hydrogéologie appliquée
MPMC 424	(2)	Gérance d'exploitation minière
MPMC 525	(3)	Recherce opérationnelle minière II

Advanced credit is given for MATH 260 Intermediate Calculus upon successful completion of a placement test (see section 2.4).

A fee of $300 is assessed by the University for each Industrial Work Period course.

Student Advising

Students entering the Mining or Metals and Materials Engineering programs must plan their schedule of studies in consultation with one of the departmental advisors: Professors Harris and Kozinski (Metallurgy) or Mr. J. Mossop (Mining).

COURSES OFFERED BY THE DEPARTMENT

For the Term (Fall and/or Winter), days, and times when courses will be offered, please refer to the 2002-2003 Class Schedule on the Web, http://www.mcgill.ca/students/. Class locations and names of instructors are also provided.

Students preparing to register are advised to consult the Class Schedule website for the most up-to-date list of courses available. New courses may have been added or courses rescheduled after this Calendar went to press.

The schedule of courses to be offered in Summer 2003 will be available on the website in January.

MIME has replaced 306 as the prefix for Mining, Metals and Materials Engineering courses.

MPMC has replaced 309 as the prefix for McGill/École Polytechnique courses. Those courses, associated with the CO-OP program in Mining Engineering, are listed after the MIME section.

The course credit weight is given in parentheses after the title.

● Denotes courses not offered in 2002-03.
▭ Denotes courses with limited enrolment.

Courses offered by the Department have been numbered to conform with the following classification system. The first digit is the level of instruction. The last two digits are classified as follows:

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

MIME 200 INTRODUCTION TO THE MINERALS INDUSTRY. (3) (3-3-3) Economic importance of the minerals industry. Mining: legislation, regulations, criteria for exploiting an ore deposit, mining methods, equipment. Extractive metallurgy: mineral processing, hydrometallurgy, pyrometallurgy. Environmental protection.

MIME 202 ENGINEERING COMMUNICATION SKILLS. (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.

MIME 203 MINE SURVEYING. (2) (Prerequisite: MIME 200 or permission of instructor) A two-week field school with laboratories and assignments. The role of the mine surveyor. Techniques and instrumentation for measurement of levels, angles and distances. Shaft, raise, drift and stope surveying techniques. Graphical presentation of survey data and computer applications. Monitoring techniques for mining excavations with deformation and displacement measurements.

MIME 209 MATHEMATICAL APPLICATIONS. (3) (3-2-4) Introduction to stochastic modelling of mining and metallurgical engineering processes. Description and analysis of data distributions observed in mineral engineering applications. Modelling with linear regression analysis. Taylor series application to error and uncertainty propagation. Metallurgical mass balance adjustments.

● **MIME 210 INTRODUCTION TO EXTRACTION METALLURGY.** (3)

MIME 212 ENGINEERING THERMODYNAMICS. (3) (3-1-5) Macro versus microscopic approach: patterns of Nature. First and second laws and their use. Property relationships: free energies, chemical potentials, activities, heat capacity. Chemical equilibrium. Reaction kinetics. Phase equilibrium for a pure substance. Experimental methods. Engineering applications: high-temperature metallurgical reactors, turbines, mixtures and solutions, phase diagrams, superconductivity.

MIME 221 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.

MIME 260 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.

MIME 261 STRUCTURE OF MATERIALS. (3) Classification of materials, electrons in atoms, molecules and solids, bonding in solids, elements of crystallography, common crystal structures, atoms positions, directions and planes in crystal structures, defects in crystalline solids, point defects, dislocations, structure of polycrystalline materials, grains, grain boundaries, non-crystalline solids.

MIME 280 INDUSTRIAL TRAINING 1. (2) 2 Four-month work period in industry. Work term report required upon completion.

MIME 290 INDUSTRIAL WORK PERIOD 1. (2) (Prerequisites: MIME 200 or MIME 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.

MIME 291 INDUSTRIAL WORK PERIOD 2.(2) (Prerequisite: MIME 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.

● **MIME 308 SOCIAL IMPACT OF TECHNOLOGY.** (3) (3-0-6) (Enrolment encouraged by students outside the Faculty of Engineering)

MIME 310 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.

MIME 311 MODELLING AND AUTOMATIC CONTROL. (3) (3-2-4) (Prerequisite: COMP 208) 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.

MIME 314 TECHNICAL REPORT. (2)

● **MIME 317 ANALYTICAL AND CHARACTERIZATION TECHNIQUES.** (3) (2-3-4) (Prerequisite: MIME 260)

MIME 320 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.

MIME 322 ROCK FRAGMENTATION. (3) (3-3-3) (Prerequisite: MIME 200) Principles of drilling, penetration rates, performance and factors to consider in the choice of a drilling method. Characteristics of explosives, firing systems and blast patterns. Blasting techniques in surface and underground workings and in permafrost. Special blasting techniques at excavation perimeters. Vibration and noise control. Economics of drill/blast practice, interface with transport and crushing systems. Legislation and safety in explosives use and handling. Ripping and fullface boring machines.

MIME 323 ROCK AND SOIL MASS CHARACTERIZATION. (3) (3-3-3) (Prerequisites: EPSC 221 and MIME 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.

MIME 325 MINERAL INDUSTRY ECONOMICS. (3) (3-1-5) (Prerequisite: MIME 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.

MIME 333 MATERIALS HANDLING. (3) (3-3-3) (Prerequisite: MIME 200) Physical and mechanical characteristics of materials related to loading, transport and storage. Dynamics of particles, systems and rigid bodies, mass-acceleration, work-energy, impulse-momentum. Types and selection of excavation and haulage equipment. Layout of haul roads. Rail transport. Conveyor belts and chain conveyors. Mine hoists. Layouts of mine shafts.

MIME 337 ELECTROTECHNOLOGY. (2) (3-1-2) Emphasises role of electrical equipment in the mining, metals and materials industry sectors. Operating theory and technical standards of prime electrical equipment, transformers, motors, generators, rectifiers, variable speed drives, circuit breakers, starters. DC and AC theory for circuit components, resistance, capacitance, inductance and impedance. Distribution system single line diagrams.

MIME 340 APPLIED FLUID DYNAMICS. (3) (3-3-4) (Prerequisite: CIVE 205) Flow analysis and manometry. Conservation of mass and momentum. Flow in pipes and ducts, analysis of pipe networks. First and second law of thermodynamics and their applications. Open channel flows. Dimensional analysis and similitude. Flow measurements. Settling and separation of particles. Non-Newtonian flow and slurry transport. Fluidized beds. Filtration of liquid/solid mixtures.

MIME 341 INTRODUCTION TO MINERAL PROCESSING. (3) (2-3-4) (Prerequisite: MIME 250) Theory and practice of unit operations including: size reduction-crushing and grinding; size separation-screening and classification; mineral separation-flotation, 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.

MIME 350 EXTRACTIVE METALLURGICAL ENGINEERING. (3) (2-3-4) (Prerequisites: MIME 250, MIME 212) Principle non-ferrous base-metal pyrometallurgical extraction processes, relevant thermodynamics, heat and mass balances, transport phenomena (copper, nickel, lead, zinc, aluminum magnesium). Ores, gangue, fuels slag, fluxes, recovery, refining, minor elements, byproducts and the environment. Roasting, drying, smelting, converting, reverberatory furnaces, flash furnaces, continuous and batch operations, injection practices and oxygen enrichment. Simulation, modelling, control and optimization.

MIME 351 NON-FERROUS EXTRACTIVE METALLURGY. (3)

MIME 352 HYDROCHEMICAL PROCESSING. (3) (3-2-4) (Prerequisites: CHEM 233, MIME 212, MIME 250) (Corequisite: MIME 355) Analysis and description of dissolution (leaching), solute separation (solvent extraction, ion exchange, carbon adsorption) and deposition operations (precipitation, crystallization, electrolysis) in aqueous 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.

● **MIME 354 PROCESS ENGINEERING LABORATORY.** (2) (0-3-3) (Prerequisite: MIME 355)

MIME 356 HEAT, MASS AND FLUID FLOW. (4) Fluid statics and dynamics. Newton's laws of viscosity and motion, control volume analyses. Navier Stokes, Euler. Bemoulli and Steady Flow Energy Equations. turbulence and Reynolds stress equations. Molecular conduction/diffusion processes in heat and mass transfer). Convective flows. Transport coefficients in slags, metals and gases. Radiative heat transfer. Transient/steady state flow.

MIME 360 PHASE TRANSFORMATIONS: SOLIDS. (3) (2-3-4) (Prerequisites MIME 212 and MIME 260, CHEM 233) Free energy (equilibrium) and kinetic (non-equilibrium) considerations, phase diagrams and TTT diagrams, solid state diffusion, diffusional (nucleation and growth) and shear (martensitic) transformations.

● **MIME 361 LIQUID STATE PROCESSING OF MATERIALS.** (3) (2-3-4) (Prerequisites: MIME 260, MIME 360)

MIME 362 MECHANICAL PROPERTIES. (3) (2-3-4) (Prerequisite: MIME 360) Stress-strain behaviour. Elasticity and plasticity of metals, ceramics and polymers. Dislocations theory. Single crystal and polycrystalline slip. Mechanical twinning. Strengthening mechanisms. Process-property and microstructure-property relationships. Notch toughness and fracture mechanics. Failure, fracture and damage accumulation. Fatigue. Creep and creep rupture. Fractography. Design considerations in materials selection.

● **MIME 367 ELECTRONIC PROPERTIES OF MATERIALS.** (3) (3-3-3) (Prerequisite: MIME 260)

MIME 380 INDUSTRIAL TRAINING 2. (2) 2 Four-month work period in industry. Work term report required upon completion.

MIME 392 INDUSTRIAL WORK PERIOD 3. (2) (Prerequisite: 75 credits including MIME 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.

MIME 410 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.

● **MIME 412 CORROSION AND DEGRADATION.** (3) (2-3-4) (Prerequisites: MIME 260; MIME 352)

MIME 419 SURFACE MINING. (3) (3-3-3) (Prerequisites: MIME 322, MIME 333 and MIME 325) Choice of a surface mining method. Analysis of soil and rock mass properties related to surface mining. Calculation and monitoring of stripping ratios, ultimate pit depth, slope stability, rock reinforcement, bench and berm dimensioning and ramp design. Loading and hauling systems. Surface layout and development. Water drainage systems. Productions and cost analysis. Computerized design techniques.

MIME 420 FEASIBILITY STUDY. (3) (1-2-6) (Prerequisites: MIME 419, MIME 426 and MPMC 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.

MIME 426 DEVELOPMENT AND SERVICES.(3) (3-3-3) (Prerequisite: MIME 324 and MIME 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.

MIME 442 MODELLING AND CONTROL: MINERAL PROCESSING. (3) (2-3-4) (Prerequisite: MIME 341) 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.

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

MIME 451 ENVIRONMENTAL CONTROLS: MET'L PLANTS. (3) (3-2-4) (Prerequisite: MIME 352) 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.

● **MIME 452 PROCESS AND MATERIALS DESIGN.** (4)

MIME 455 ADVANCED PROCESS ENGINEERING. (3) (3-1-5) (Prerequisite: MIME 355) Transport phenomena in non-idealized systems. Solutions for transient heat and mass transfer processes involving thermal and molecular diffusion in materials processing systems. Natural and forced convection in heat and mass transfer. Dimensionless correlations. Fick's Laws and Fourier's Laws. Exact solutions. Numerical approximations for transient systems. Equivalences between heat and mass transfer. Finite difference modelling of conduction, convection and radiation heat transfer and diffusion and convection mass transfer.

MIME 456 STEELMAKING AND STEEL PROCESSING. (3) (2-2-5) (Prerequisites: MIME 360, MIME 455) 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.

MIME 457 LIGHT METALS EXTRACTION AND PROCESSING. (3) (2-0-7) (Prerequisites: MIME 350, MIME 352) Physiochemical, kinetic and economic aspects of light metals extraction, refining and finishing for marketing. Alumina production, aluminum electrolysis, carbon technology, alloying and casting, magnesium smelting and electrolysis, strontium, lithium, sodium extraction.

MIME 463 DEFORMATION PROCESSING OF METALS. (3) (3-3-3) (Prerequisite: MIME 362) 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.

MIME 465 CERAMIC ENGINEERING. (3) (2-3-4) (Prerequisite: MIME 360) Classification of technical ceramics, refractories and glasses. Powder metallurgy. Structure and bonding of ceramics and glasses. Common crystal structures. Physical properties. Mechanical properties and fracture behaviour. Powder processing and consolidation techniques. Sintering and densification of powders. Refractories: production and applications. Glass forming systems, processing and properties.

MIME 480 INDUSTRIAL TRAINING 3. (2) (See details listed under MIME 481) Four-month work period in industry. Work term report due upon completion of MIME 481.

MIME 481 INDUSTRIAL TRAINING 4. (2) Four-month work period in industry. This course is intended to be taken immediately after MIME 480 at the same work location. One work term report and one seminar is required upon completion of this course. If MIME 480 and MIME 481 are in different work locations, the work term report should be in two parts following the co-op handbook guidelines.

MIME 484 MINING PROJECT. (3) (0-0-9) (Corequisites: MIME 419, MIME 426, MPMC 328 and MPMC 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.

MIME 494 INDUSTRIAL WORK PERIOD 4. (2) (0-0-6) (Prerequisites: MIME 419, MIME 426, MPMC 328 and MPMC 421) A four-month industrial work period after which the student must submit a report.

● **MIME 511 MICROPROCESSORS IN MINING AND METALLURGICAL ENGINEERING.** (3)

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

MIME 520 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.

MIME 521 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.

● **MIME 524 MINERAL RESOURCES ECONOMICS.** (3) (3-0-6) (Prerequisite: MIME 310 or equivalent, or permission of instructor)

MIME 526 MINERAL ECONOMICS. (3) (3-1-5) (Prerequisite: MIME 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 respect to capacity and cutoff grade.

● **MIME 528 MINING AUTOMATION.** (3) (3-3-3) (Prerequisite: MIME 426)

MIME 544 ANALYSIS: MINERAL PROCESSING SYSTEMS 1. (3) (2-3-4) (Prerequisite: MIME 341) 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, hydrodynamics of collection and froth zones, mixing, scale-up and design, measurements and control; surface and electrochemistry, including absorption, surface charge, coagulation, electron transfer reactions, electrochemistry in plant practice.

MIME 545 ANALYSIS: MINERAL PROCESSING SYSTEMS 2. (3) (4-2-3) (Prerequisite: MIME 341) Gold recovery (as a Professional Development Seminar): methods of recovery (gravity, flotation, cyanidation), refractory gold (roasting, pressure oxidation, bacterial leaching), dissolved gold recovery (Merrill-Crowe) and activated carbon methods. Sampling: definition of errors, sample extraction, size, and processing. Mass balancing: basic considerations, definition of networks, software. Blending: auto-correlation functions, transfer functions, blending systems. Effect of feed variability.

● **MIME 546 SURFACE CHEM IN MATERIALS PROC.** (3)

MIME 551 ELECTROCHEMICAL PROCESSING. (3) (3-2-4) (Prerequisite: MIME 352) Characterization of aqueous, fused salt and solid electrolytes; laws of electrolysis; ion transport mechanisms; interfacial phenomena (electrolyte-electrolyte, electrode-electrolyte); reversible cells and potentials; electrode kinetics, overpotential and potential-current laws; industrial applications; electrolytic winning and refining, electroplating, surface cleaning and coating, electrodialysis and electrochemical sensors.

MIME 553 IMPACT OF MATERIALS PRODUCTION. (3) (3-0-6) (Prerequisite: Permission of instructor.) Impact on the environment of the production of major materials. Pollution control practices, emerging technologies, cost, resources and conservation. Review of flowsheets for various production methods. Analysis of

the use of materials, prices, consumption, fabrication, and recycling of waste materials.

● **MIME 555 THERMAL REMEDIATION OF WASTES.** (3) (3-0-6) (Prerequisites: CHEM 111 and MIME 212 or equivalent)

MIME 560 JOINING PROCESSES. (3) (3-3-3) (Prerequisite: MIME 361 or equivalent) Physics of joining; interfacial requirements; energy sources, chemical, mechanical and electrical; homogeneous hot-joining, arc-, Mig-, Tig-, gas-, thermite- and Plasma-welding; Autogeneous hot-joining, forge-, pressure-, friction-, explosive-, electron beam- and laser-welding; Heterogeneous hot-joining, brazing, soldering, diffusion bonding; Heterogeneous cold joining, adhesives, mechanical fastening; Filler materials; Joint metallurgy; Heat affected zone, non-metallic systems; joint design and economics; defects and testing methods.

MIME 561 ADVANCED MATERIALS DESIGN. (3) (0-4-5) (Prerequisite: MIME 362 or equivalent) Advanced topics in materials design problems. Discussion and laboratory work, supplemented by detailed technical reports. Special attention is given to selection, design and failure problems in various materials systems.

● **MIME 562 SOLIDIFICATION PROCESSING.** (3)

MIME 563 HOT DEFORMATION OF METALS. (3) (2-2-5) (Prerequisite: MIME 463 and MIME 360) High temperature deformation processing of metallic materials. Topics include static and dynamic recrystallization, recovery, precipitation; effect of deformation on phase transformations and microstructural evolution during industrial processing. Mathematical modelling of microstructural evolution.

MIME 564 X-RAY DIFFRACTION ANALYSIS OF MATERIALS. (3) (2-3-4) (Prerequisite: MIME 317 or equivalent) 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 determining 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 analysis are presented.

MIME 566 TEXTURE, STRUCTURE & PROPERTIES OF POLYCRYSTALLINE MATERIALS (3) (2-3-4) (Prerequisite: MIME 317) 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 recrystallization textures in order to obtain the properties required of industrial products. Finally, the correlation between texture and the anisotropy of elastic, plastic and magnetic properties of engineering materials is described and analyzed.

● **MIME 567 ALUMINUM CASTING ALLOYS.** (3) (3-0-6) (Prerequisite: MIME 361 or equivalent)

MIME 568 TOPICS IN ADVANCED MATERIALS. (3) (Prerequisite: MIME 362 or equivalent) New and emerging materials. Composites. Coatings. Electronic materials. Current and future technologies. Specialised property requirements. Novel processing and fabrication techniques. Future developments.

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

MPMC 320 CAO ET INFORMATIQUE POUR LES MINES. (3) (2-3-4) Présentation de techniques informatisées 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 numérisantes, d'interfaces pour capteurs analogique/numérique et numérique/ analogique. Notions de géometrie descriptive appliquées à des problèmes miniers.

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

MPMC 326 RECHERCHE OPÉRATIONNELLE I. (3) (3-3-3) (Prérequis: MATH 260) Logistique minière. Modèles de localisation optimale: Steiner, HAP, construction itérative. Modèles de détermination des contours optimaux des exploitations à ciel ouvert: conventionnels, Lerchs et Grossman, Ford et Fulkerson. Programmation dynamique et modèles d'optimisation du taux de production et de la teneur de coupure. Modèles de planification: cheminement critique et PERT, programmation linéaire et non-linéaire, théorie des graphes. Modèles de capacité: théorie des files d'attente, simulation, silos et stockage. Modèles de mélange.

MPMC 327 HYDROGÉOLOGIE APPLIQUÉE. (3) (3-3-3) (Prérequis: EPSC 221 et MATH 261) Eau souterraine et cycle hydrologique. Aquifère et aquitard. Charge hydraulique et piézomètre. Mouvement de l'eau souterraine. Loi de Darcy. Mesures et valeurs de perméabilité. Réseau d'écoulement. Essais de pompage: régime transitoire permanent, effet de frontière, drainage. Facteurs influenÁant les niveaux d'eau. Qualité des eaux souterraines. Types de pollutants et leur propagation. Méthodes de traitement et d'étanchéisation. Techniques de modélisation. Exploration et gestion des eaux souterraines. Recharge artificielle. Intrusions salines.

MPMC 328 ENVIRONNEMENT ET GESTION DES REJETS MINIERS. (3) (3-3-3) (Prérequis: MIME 200 et MIME 291) Effets du milieu de travail sur l'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'impacts; effluents miniers: origine, nature et traitement des effluents; entreposage des résidus; restauration des sites.

MPMC 329 GÉOLOGIE MINIÈRE. (2) (2-2-2) (Prérequis: EPSC 221, MIME 200 et MIME 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.

MPMC 330 GÉOTECHNIQUE MINIÈRE. (3) (3-3-3) (Prérequis: MIME 323) Propriétes mécaniques des matériaux meubles. Conception d'empilements et de digues de retention pour les matériaux miniers. Conception de structures enfouies. Problèmes particuliers avec les résidus miniers: liquéfaction, déposition, etc. Écoulement gravitaire des matériaux meubles.

MPMC 421 EXPLOITATION EN SOUTERRAIN.(3) (3-3-3) (Prérequis: MIME 322, MIME 325 et MIME 333) Étude des caractéristiques des principales méthodes d'abattage utilisées en souterrain. Méthodes d'analyse simplifiée d'un gisement quant à son exploitation en fosse ou en souterrain. Dimensionnement des ouvrages et choix des équipements. Calculs des quantités, des équipements et des coûts reliés aux excavations souterraines. Conception d'un circuit de remblai hydraulique.

MPMC 422 VENTILATION MINIÈRE ET HYGIÈNE DU TRAVAIL . (3) (3-3-3) (Prérequis: MIME 340) Description des composantes d'un système de ventilation. Ventilation naturelle et mécanique. Principes de mesure et de modélisation des écoulements de l'air dans les réseaux de ventilation. Techniques de calcul des pertes de charges dans un circuit. Choix des composantes pour assurer et régulariser les écoulements. Simulation informatisée des écoulements. Chauffage de l'air.

4.8 School of Urban Planning

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

Associate Professors
David F. Brown; B.A.(Bishop's), M.U.P.(McG.), Ph.D.(Sheffield)
Raphaël Fischler; B.Eng.(Eindhoven), M.Sc., M.C.P.(MIT), Ph.D.(U.C. Berk.)

Assistant Professors
Madhav G. Badami; B.Tech., M.S.(I.I.T., Madras) M.E.Des.(Calg.), Ph.D.(Br.Col.) *(joint appt. with McGill School of Environment)*
Lisa Bornstein; B.Sc.(U.C.Berk.),M.R.P.(C'nell), Ph.D.(U.C.Berk.)
Murtaza Haider; B.Sc.(Peshawar), M.A.Sc. *(joint appt. with Civil Engineering)*

Associate Member
Gordon O. Ewing; M.A.(Glas.), M.A., Ph.D.(McG.)

Instructor
François Dufaux; B.Arch.(Laval), M.U.P.(McG.)

Adjunct Professors
David Farley; B.Arch.(McG.), M.Arch., Master of City Planning(Harvard)
Mario Polèse; B.A.(CUNY), M.A., Ph.D.(Penn.)

Guest Lecturers
Cameron Charlebois, Luc Danielse, Marc Denhez, Andrew Hoffmann, Peter Jacobs, Brenda Lee, Léon Ploegaerts, Alain Trudeau, Ray Tomalty, 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 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 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 *Graduate Studies Calendar*, available on the web at http://www.mcgill.ca.

While the School of Urban Planning is a graduate progam, a number of undergraduate courses are taught by the faculty members affiliated with the School. These are listed below.

UNDERGRADUATE COURSES OFFERED BY THE SCHOOL

For the Term (Fall and/or Winter), days, and times when courses will be offered, please refer to the 2002-2003 Class Schedule on the Web, http://www.mcgill.ca/students/. Class locations and names of instructors are also provided.

Students preparing to register are advised to consult the Class Schedule website for the most up-to-date list of courses available. New courses may have been added or courses rescheduled after this Calendar went to press.

The schedule of courses to be offered in Summer 2003 will be available on the website in January.

URBP has replaced 409 as the prefix for Urban Planning courses.

The course credit weight is given in parentheses after the title.

▭ Denotes courses with limited enrolment.

URBP 501 PRINCIPLES AND PRACTICE 1. (2) This six-week intensive course exposes students to issues and techniques that are applicable in diverse professional planning contexts. The subject matter, geographic area, scale of intervention and institutional location of planning varies from semester to semester. The course focuses on a specific case study and is taught by a visiting lecturer with professional experience in the selected subject matter.

URBP 505 GEOGRAPHIC INFORMATION SYSTEMS. (3) An introduction to fundamental geographic information system (GIS) concepts and a range of GIS applications in urban and regional planning.

Undergraduate courses offered jointly by the School and other academic units

GEOG 351 QUANTITATIVE METHODS. (3) (Fall) (3 hours) (Prerequisite: GEOG 203 or permission of instructor) Survey design; uni- and multi-dimensional scaling; cost-benefit analysis and matrix methods of plan evaluation; multiple regression and correlation; logic models; gravity models; population projection.

ARCH 550 URBAN PLANNING 1. (3) (2-0-7) (Prerequisite: B.Sc.(Arch.) or permission of instructor) (Not normally open to Urban Planning students) (Section 01: Architecture students) (Section 02: others; limited enrolment.) Theory and practice. An

examination of different basic approaches to urban planning with special reference to Quebec.

ARCH 551 URBAN PLANNING 2. (3) (2-1-6) (Prerequisite: ARCH 550) (Section 01: Architecture students) (Section 02: others; limited enrolment.) Urban design and project development, theory and practice. Detailed analysis of selected examples of the development process and of current techniques in urban design. Includes case studies from Quebec and elsewhere.

CIVE 433 URBAN PLANNING. (3) (3-1-5) (Prerequisites: CIVE 421 and MIME 310. Corequisite: CIVE 319) 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.

PUB1 004 LAND USE PLANNING. (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.

GRADUATE 600-LEVEL COURSES

Generally, undergraduate students are not permitted to enrol in graduate 600-level courses. However, in exceptional circumstances, the Graduate Studies Office does grant this permission upon the request of the department on behalf of the student. A list of such courses, described in detail in the *Graduate Studies Calendar*, is as follows:

URBP 612	History and Theory of Planning
URBP 614	Urban Environmental Planning
URBP 619	Transport and Land Development
URBP 620	Computer Applications in Planning
URBP 621	Theories of Urban Form
URBP 625	Principles And Practice of Planning 2
URBP 626	Principles And Practice of Planning 3
URBP 628	Practical Experience

5 Minor Programs and Choice of Electives or Complementary Courses

Minors are coherent sequences of courses which may be taken in addition to the courses required for the B.Eng. degree. Minor programs normally consist of 24 credits, allowing up to 12 credits of overlap with the degree program. The real credit cost to the student is typically 9 to 15 credits, representing one semester beyond the B.Eng. degree program. All courses in a Minor program must be passed with a grade of C or better.

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 advisors.

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. Further information is available through the Faculty of Engineering Student Affairs Office.

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 3.4), may be used to satisfy some of these requirements. In no case will more than 9 credits taken from these complementary studies requirements be credited towards the Minor in Arts.

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.
3. The selection of courses for the Minor is to be done in consultation with the Minor Advisor, Ms. Judy Pharo, Faculty of Engineering Student Affairs Office.

For further information, contact Professor B. Haskel, Political Science, or Ms. Pharo, Student Affairs Office, Faculty of Engineering.

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 Ms. Judy Pharo, Faculty of Engineering Student Affairs Office, 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 386 of the Science section.

A Chemical Engineering student may complete the Biotechnology Minor by taking BIOL 200, BIOL 201, BIOL 202, MIMM 211, BIOT 505, plus one course from the list of additional courses not including MIME 310. The Department of Chemical Engineering permits students in the Minor program to complete BIOT 505 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: CHEM 212, CHEM 233 and CHEM 234 (or CEGEP equivalent)
2. At least 15 credits from the following list, two of which must be laboratory courses (* indicates lab). Note that CHEM 212 is a prerequisite for most of the courses listed below. If students take CHEM 222* instead of CHEM 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

CHEM 281	Inorganic Chemistry 1
CHEM 371	Inorganic Chemistry Laboratory*
CHEM 381	Chemistry of Transition Elements
CHEM 591	Advanced Coordination Chemistry

Analytical Chemistry

CHEM 257D1	Introductory Analytical Chemistry*
CHEM 257D2	Introductory Analytical Chemistry*
or CHEM 277D1	Classical Methods of Analysis*
CHEM 277D2	Classical Methods of Analysis*
CHEM 307	Environmental Analysis

CHEM 367 Instrumental Analysis 1
CHEM 377 Instrumental Analysis 2

Organic Chemistry
CHEM 302 Introductory Organic Chemistry 3
CHEM 352 Structural Organic Chemistry
CHEM 362 Advanced Organic Laboratory*
CHEM 382 Organic Chemistry of Natural Products
CHEM 402 Advanced Bio-organic Chemistry

Physical Chemistry
CHEM 345 Molecular Properties & Structure 1
CHEM 355 Molecular Properties & Structure 2
CHEM 363 Physical Chemistry Laboratory*
CHEM 393 Physical Chemistry Laboratory*
CHEM 455 Introductory Polymer Chemistry

Please consult the program coordinators for more information: Prof. D. Cooper (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, COMP 208 Computers in Engineering, and other courses in the core of the various Engineering programs are listed on page 282. Descriptions of other Computer Science courses can be found on page 394 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 (COMP) 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.

For further information, please check the School of Computer Science website http://www.cs.mcgill.ca/acadpages/undergrad.

Minor in Computer Science for Engineering Students
[Program revisions are under consideration for September 2002. Go to http://www.mcgill.ca (Course Calendars) in July for details.]

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

Required Course (3 credits)
COMP 302 (3) Programming Languages and Paradigms

Complementary Courses (21 credits)
3 credits – one of the following courses:
COMP 203 (3) Introduction to Computing 2
COMP 250 (3) Introduction to Computer Science
COMP 251 (3) Data Structures and Algorithms
3 credits – one of the following courses:
COMP 206 (3) Intro to Software Systems
ECSE 221 (3) Introduction to Computer Engineering
3 credits – one of the following courses:
COMP 273 (3) Introduction to Computer Systems
ECSE 222 (3) Introduction to Computer Engineering 2
3 credits – one of the following courses:
COMP 350 (3) Numerical Computing
MECH 409 (3) Numerical Methods in Mechanical Engineering
9 credits chosen from Computer Science courses numbered 300 or higher, or any course making considerable use of computing and approved by the School of Computer Science for the Minor.*

* Students may consult with the School of Computer Science about the acceptabiity of particular courses. The courses in other departments are at a variety of levels. Some may be required coures in the student's Engineering program; some are courses that may be taken as technical complementaries. Students should consult with their advisors about the possibility of taking specific courses.

Notes
A. Courses COMP 202 Introduction to Computing 1, and COMP 208 Computers in Engineering (compulsory for some Engineering students) do not form part of the Minor.
B. COMP 202 is a prerequisite for COMP 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.

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:
CIVE 208 Civil Eng Systems Analysis or an equivalent course in Operations Research
CIVE 302 Probabilistic Systems or equivalent
MIME 310 Engineering Economy
COMP 208 Computers in Engineering or equivalent

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:

FACC 220 (3) Law for Architects and Engineers
INDR 294 (3) Intro to Labour-Management Relations
MGCR 211 (3) Introduction to Financial Accounting
MGCR 341 (3) Finance 1

and one of:
CIVE 324 (3) Construction Project Management
MECH 472 (3) Case Studies in Project Mgmt

2. Either 3 or 4 credits, as follows:
a) 4 credits - Any two of the following relating to Building Structures:
ARCH 446 (2) Mechanical Services in Buildings
ARCH 447 (2) Electrical Services
ARCH 451 (2) Building Regulations and Safety
CIVE 492 (2) Structures

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

3. Other Construction-Related Complementaries: 6 credits
Any two of the following:
ABEN 411 (3) Off-Road Power Machinery
BUSA 462 (3) Management of New Enterprises
CIVE 446 (3) Construction Engineering
CIVE 527 (3 Renovation & Preservation of Infrastructure
CIVE 586 (3) Earthwork Engineering
ECSE 461 (3) Electric Machinery
FINE 445 (3) Real Estate Finance
MIME 520 (3) Stability of Rock Slopes
MIME 521 (3 Stability of Underground Openings
MPMC 321 (3) Mécanique des roches et contrôle des pressions de terrains

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 complementaries. In addition, it is presumed that all Engineering students will have a sufficient background in statistics. Engineering Economy, MIME 310, does not form part of this minor. For more information see the Department of Economics, Leacock Room 443.

Required Courses (9 credits)
ECON 230D1* Microeconomic Theory
ECON 230D2* Microeconomic Theory
ECON 209** Macroeconomic Analysis and Applications

Complementary Courses (9 credits) from:
ECON 225 Economics of the Environment
ECON 302D1 Money and Banking
ECON 302D2 Money and Banking
ECON 303D1 Canadian Economic Policy
ECON 303D2 Canadian Economic Policy
ECON 305 Industrial Organization
ECON 306D1 Labour Economics and Institutions
ECON 306D2 Labour Economics and Institutions
ECON 308 Public Policies Toward Business
ECON 311 United States Economic Development
ECON 313 Economic Development
ECON 314 Economic Development 2
ECON 316 The Underground Economy
ECON 321 The Quebec Economy
ECON 326 Ecological Economics
ECON 329 The Economics of Confederation
ECON 330D1 Macroeconomic Theory
ECON 330D2 Macroeconomic Theory
ECON 331 Economic Development: Russia and the USSR
ECON 332 Comparative Economic Systems
ECON 333 Topics in Comparative Economic Systems
ECON 335 The Japanese Economy
ECON 337 Introductory Econometrics 1
ECON 344 The International Economy, 1830 - 1914
ECON 345 The International Economy Since 1914
ECON 347 Economics of Climate Change
ECON 404 Transportation
ECON 405 Natural Resource Economics
ECON 406 Topics in Economic Policy
ECON 408D1 Public Sector Economics
ECON 408D2 Public Sector Economics
ECON 411 Economic Development: A World Area
ECON 416 Topics in Economic Development 2
ECON 420 Topics in Economic Theory
ECON 423D1 International Trade and Finance
ECON 423D2 International Trade and Finance
ECON 426 Labour Economics
ECON 434 Current Economic Problems
ECON 440 Health Economics
ECON 447 Economics of Information and Uncertainty
ECON 467D12 Econometrics - Honours
ECON 467D Econometrics - Honours
ECON 525 Project Analysis
ECON 534 The Pensions Crisis
ECON 546 Game Theory

Mining Engineering students will be permitted to include Mineral Economics (MIME 526) among these 18 credits.

* Students may, with consent of instructor, take ECON 250D1/ECON 250D2 Introduction to Economic Theory - Honours, in place of ECON 230D1/ECON 230D2.

** This requirement is waived for students who choose ECON 330D1/ECON 330D2 from the list of complementaries. Students may **not** take both ECON 209 and ECON 330D1/ ECON 330D2.

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, courses taken towards the Humanities and Impact course requirements for the Major cannot double-count as Minor program courses.
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)
CHEE 230 Environmental Aspects of Technology
or CIVE 225 Environmental Engineering
or MIME 308 Social Impact of Technology
or equivalent environmental impact course

A. ENGINEERING COURSES (21 credits)

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

Chemical Engineering
CHEE 351 Separation Processes
CHEE 370 Elements of Biotechnology
CHEE 430 Technology Impact Assessment (not open to students who have passed WILD 437)
CHEE 452 Particulate Systems (offered in alternate years)
CHEE 471 Industrial Water Pollution Control (not open to students who have passed CIVE 430)
CHEE 472 Industrial Air Pollution Control
CHEE 591 Environmental Bioremediation

Civil Engineering and Applied Mechanics
CIVE 225 Environmental Engineering (not part of the Minor for Civil Engineering Students)
CIVE 323 Hydrology and Water Resources (not open to students who have passed ABEN 217)
CIVE 421 Municipal Systems

CIVE 430 Water Treatment and Pollution Control (not open to students who have passed CHEE 471)
CIVE 451 Geoenvironmental Engineering
CIVE 526 Solid Waste Management
CIVE 550 Water Resources Management
CIVE 553 Stream Pollution and Control
CIVE 572 Advanced Hydraulics
CIVE 574 Fluid Mechanics of Water Pollution
CIVE 575 Fluid Mechanics of Air Pollution
CIVE 577 River Engineering
CIVE 585 Groundwater Hydrology

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

Mining, Metals and Materials Engineering
MIME 412 Corrosion and Degradation
MIME 451 Environmental Controls
MIME 555 Thermal Remediation of Wastes
MPMC 327 Hydrogéologie appliquée
MPMC 328 Environnement et gestion des rejets miniers
MPMC 422 Ventilation et hygiène du travail

B. NON-ENGINEERING COURSES (6 credits)

Agricultural Sciences (Macdonald Campus)
AEBI 200 Biology of Organisms 1
AEBI 201 Biology of Organisms 2
AEBI 205 Principles of Ecology
AEPH 510 Agricultural Micrometeorology
ENTO 380 Food Systems and the Environment
MICR 230 The Microbial World (not open to students who have passed CHEE 370)
MICR 331 Microbial Ecology (not open to students who have passed CHEE 370)
MICR 341 Mechanisms of Pathogenicity
SOIL 210 Principles of Soil Science (not part of the Minor for Agricultural Engineering Students)
SOIL 331 Soil Physics
WILD 333 Physical and Biological Aspects of Pollution
WILD 375 Issues in Environmental Sciences
WILD 415 Conservation Law
WILD 437 Assessing Environmental Impact (not open to students who have passed CHEE 430)
WOOD 420 Environmental Issues in Forestry
ZOOL 315 Science of Inland Waters

Anthropology
ANTH 206 Environment and Culture

Atmospheric and Oceanic Sciences
ATOC 210 Introduction to Atmospheric Science (not open to students who have passed GEOG 321)
ATOC 220 Introduction to Oceanic Sciences

Biology
BIOL 205 Biology of Organisms
BIOL 208 Introduction to Ecology
BIOL 432 Limnology
BIOL 470 Lake Management

Chemistry
CHEM 307 Environmental Analysis

Earth and Planetary Sciences
EPSC 243 Environmental Geology (not open to students who have passed or who will take EPSC 221)
EPSC 549 Groundwater Hydrology

Economics
ECON 225 Economics of the Environment
ECON 326 Ecological Economics
ECON 347 Economics of Climate Change

Geography
GEOG 200 Geographical Perspectives on World Environmental Problems
GEOG 201 Geographic Information Systems 1
GEOG 203 An Introduction to Environmental Studies
GEOG 205 Global Change: Past, Present and Future
GEOG 302 Environmental Analysis and Management Environmental Management 1
GEOG 308 Air Photo Interpretation and Remote Sensing
GEOG 321 Climatic Environments (not open to students who have passed ATOC 210)
GEOG 404 Environmental Management for Parks and Protected Areas

Law
CMPL 580 Environment and the Law

Microbiology and Immunology
MIMM 211 Biology of Microorganisms

Religious Studies (Macdonald Campus)
RELG 270 Religious Ethics and the Environment

Sociology
SOCI 328 Environmental Sociology

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 Program Coordinator. Email: info@mse.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 program and have it approved by both their regular Engineering Advisor and the MSE Advisor. For program details, see “Minor in Environment” on page 492 in the MSE section.

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 MIME 310 introduces the concept of costs into evaluations of engineering projects and architectural proposals. Prerequisite to entry to this Minor is a grade C or better in MIME 310.

Several additional courses are available, subject to timetable 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 MGCR 211, a course in statistics, and a course in micro-economics are prerequisite for MGCR 341. If included in the Minor in Management, MGCR 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)
MGCR 211 Introduction to Financial Accounting
MGCR 320 Managing Human Resources

Complementary Courses (9 credits)
3 credits, one of List A:
MGCR 213 Introduction to Managerial Accounting
MGCR 341 Finance 1
MGCR 373 Operations Research
MGCR 382 International Business

3 credits, one of List B:

BUSA 462	Management of New Enterprises
or BUSA 465	Technological Entrepreneurship
MGCR 222	Organizational Behaviour
MGCR 352	Marketing Management 1
or MRKT 360	Marketing of Technology
MGCR 360	Social Context of Business
MGCR 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 MGCR 373. There are three courses in Engineering that qualify: CIVE 208, MECH 474 and MPMC 326. It should be noted that MGCR 373 does not count as a technical complementary course.

A student embarking on the Minor must be prepared to take credits additional to the normal Engineering program. The student may choose the non-technical complementary course(s) required in his/her program from list B above, but under no circumstances will more than 6 credits of non-technical complementary courses count towards both the Engineering program and the Minor. Students considering this Minor should consult their advisor or the Faculty of Engineering Student Affairs Office.

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 Minor prior to graduation. For further information, please contact the coordinator, Prof. J. Szpunar, Room 2M020, Wong Building.

Required Courses (15 credits)

MIME 260	Materials Science and Engineering
or CHEE 380	Materials Science
MIME 367	Electronic Properties of Materials
MIME 465	Ceramic Engineering
CHEE 481	Polymer Engineering
CHEE 484	Materials Engineering

Complementary Courses (9 credits)

Three courses to be chosen from the following list:

CHEE 381	Polymer Technology
CHEE 483	Industrial Rheology
CHEE 487	Chemical Processing in the Electronics Industry
CHEE 530C	Structure and Properties of Paper
CHEE 581	Polymer Composites Engineering
CHEM 455	Introductory Polymer Chemistry
ECSE 545	Microelectronics Technology
MECH 530	Mechanics of Composite Materials
MIME 360	Phase Transformations in Solids
MIME 361	Liquid State Processing of Materials
MIME 362	Mechanical Properties
MIME 412	Corrosion and Degradation
MIME 560	Joining Processes
MIME 561	Advanced Materials Design
MIME 563	Hot Deformation of Metals
MIME 564	X-Ray Diffraction Analysis of Materials
MIME 566	Texture, Structure and Properties of Polycrystalline Materials
MIME 569	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 MATH 247 (or MATH 223), MATH 260 (or MATH 222), MATH 261 (or MATH 315 or MATH 325), MATH 265 (or MATH 248 or MATH 314), MATH 266, MATH 270, MATH 319.

At least 18 credits must be chosen from the Mathematics and Statistics courses approved for the Mathematics Majors or Honours program, or from MATH 249, MATH 363, MATH 381, MATH 386. The remaining credits may be chosen from mathematically allied courses.

In addition to an Engineering Advisor, each student in the Minor program must have an Advisor 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 Advisor. Please consult the Department of Mathematics and Statistics for an Advisor.

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:

PHYS 253	Thermal Physics
PHYS 357	Quantum Physics 1
PHYS 457	Quantum Physics 2

and at least 9 credits chosen from the following:

PHYS 332	Physics of Fluids
PHYS 362	Statistical Mechanics
PHYS 451	Classical Mechanics
PHYS 514	General Relativity
PHYS 551	Quantum Theory
PHYS 557	Nuclear Physics
PHYS 558	Solid State Physics
PHYS 559	Advanced Statistical Mechanics
PHYS 562	Electromagnetic Theory
PHYS 567	Particle Physics

Students who take PHYS 357 and PHYS 457 can omit PHYS 271 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.

5.13 Technological Entrepreneurship Minor

Engineering students may obtain a Minor in Technological Entrepreneurship by completing 6 courses (18 credits) as listed below. Up to two courses (6 credits) may be double-counted for credit towards the Humanities and Social Sciences Complementary Courses.

This Minor is offered jointly by the Faculties of Engineering and Management. It will appeal to those students who have a concept, process or product idea in mind and who want to explore the opportunity of commercializing it. It will also be of interest to students who have a general interest in entrepreneurship and intend to pursue a career in small and medium sized high technology/ engineering companies.

Students considering the Minor should consult Ms. Judy Pharo, Faculty of Engineering Student Affairs Office, email: advisor@emf.lan.mcgill.ca

Required Courses (18 credits)

BUSA 465	(3)	Technological Entrepreneurship
FACC 480	(3)	Technological Entrepreneurship Project
MGCR 320	(3)	Managing Human Resources
MGPO 562	(3)	Organizational Strategies for Advanced Technology Firms
MRKT 360	(3)	Marketing of Technology
ORGB 321	(3)	Leadership

5.14 Software Engineering Minor

This Minor will prepare an engineering student for a career in software engineering. It will provide a foundation in basic computer science, computer programming and software engineering practice.

The Minor consists of 24 credits (8 courses). Up to four of the courses (12 credits) may be double-counted for credit towards the B. Eng. degree in Electrical Engineering or Computer Engineering. Students in other programs may double-count up to three courses (9 credits).

Students considering this Minor should contact Ms. Judy Pharo, Faculty of Engineering Student Affairs Office, email: advisor@emf.lan.mcgill.ca.

Required Courses (9 credits)

ECSE 221 (3) Introduction to Computer Engineering
ECSE 321 (3) Introduction to Software Engineering
ECSE 428 (3) Software Engineering Practice

Complementary Courses (15 credits)

one course (3 credits), either:
COMP 203 (3) Introduction to Computing 2
or COMP 250 (3) Introduction to Computer Science

At least one course (3 credits) must be selected from the following list of engineering courses:
CHEE 458 (3) Computer Applications
CHEE 571 (3) Small Computer Applications in Chemical Eng.
CIVE 460 (3) Matrix Structural Analysis
CIVE 550 (3) Water Resources Management
CIVE 572 (3) Computational Hydraulics
ECSE 424 (3) Human-Computer Interaction
ECSE 427 (3) Operating Systems
ECSE 526 (3) Artificial Intelligence
ECSE 531 (3) Real Time Systems
ECSE 532 (3) Computer Graphics
MECH 474 (3) Selected Topics in Operations Research
MECH 524 (3) Computer Integrated Manufacturing
MECH 539 (3) Computational Aerodynamics
MECH 545 (3) Advanced Stress Analysis
MECH 576 (3) Computer Graphics and Geometrical Modelling

No more than two courses (6 credits) can be selected from the following list of courses offered by the School of Computer Science:
COMP 302 (3) Programming Languages and Paradigms
COMP 335 (3) Software Engineering Methods
COMP 420 (3) Files and Database Systems
COMP 421 (3) Introduction to Database Systems
COMP 424 (3) Topics in Artificial Intelligence
COMP 426 (3) Automated Reasoning
COMP 431 (3) Algorithms and Data Structures
COMP 433 (3) Personal Software Engineering
COMP 538 (3) Person-Machine Communication

6 Courses Given by other Faculties for Engineering Students

6.1 Faculty of Education

EDEC 206 COMMUNICATION IN ENGINEERING. (3) (Limited enrolment) (Restricted to B.Eng. students who have not taken EDES 201 or EDEC 202) (Because this course uses a workshop format, attendance at first class is desirable.) 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 writing in engineering.

6.2 Faculty of Science

Note: All Science courses have limited enrolment.

DEPARTMENT OF CHEMISTRY

CHEM 233 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.

CHEM 234 TOPICS IN ORGANIC CHEMISTRY. (3) (3-0-6) (Prerequisite: CHEM 212 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.

SCHOOL OF COMPUTER SCIENCE

COMP 202 INTRODUCTION TO COMPUTING 1. (3) (3 hours) (Prerequisite: a CEGEP level mathematics course) (Restriction Note A: COMP 202 and COMP 208 cannot both be taken for credit. COMP 202 is intended as a general introductory course, while COMP 208 is intended for students interested in scientific computations.) (Restriction Note N: COMP 202 cannot be taken for credit with or after COMP 250.) Overview of components of microcomputers, the internet design and implementation of programs using a modern high-level language, an introduction to modular software design and debugging. Programming concepts are illustrated using a variety of application areas.

COMP 208 COMPUTERS IN ENGINEERING. (3) (3 hours) (Prerequisite: differential and integral calculus. Corequisite: linear algebra: determinants, vectors, matrix operations.) (Restriction Note A: COMP 202 and COMP 208 cannot both be taken for credit. COMP 202 is intended as a general introductory course, while COMP 208 is intended for students interested in scientific computations.) 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.

COMP 250 INTRODUCTION TO COMPUTER SCIENCE. (3) (Prerequisites: Familiarity with a high level programming language and CEGEP level Math.) (Restriction Note B: COMP 203 and COMP 250 are considered to be equivalent from a prerequisite point of view, and cannot both be taken for credit.) (Restriction Note K: Open only to students registered in a Core Group* or Mathematics Group* program, or the Major in Computer Engineering. * as defined in the SOCS section, Undergraduate Programs Calendar) 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.

COMP 302 PROGRAMMING LANGUAGES AND PARADIGMS. (3) (3 hours) (Prerequisite: COMP 250 or COMP 203) (Restriction Note L: Open only to students registered in a Core Group* or Mathematics Group* program, or the Major in Computer Engineering, or the Minor in Computer Science. * as defined in the SOCS section, Undergraduate Programs Calendar) Programming language design issues and programming paradigms. Binding and scoping, parameter passing, lambda abstraction, data abstraction, type checking. Functional and logic programming.

Department of Earth and Planetary Sciences

EPSC 221 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 NSprocesses, 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 identifica-

tion, basic techniques of airphoto and geological map interpretation, and structural geology.

EPSC 225 PROPERTIES OF MINERALS. (1) (1 hour lecture, 1 hour lab) (Not open to students who have taken EPSC 210) 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 and environmental issues, and the identification of hand specimens.

DEPARTMENT OF MATHEMATICS AND STATISTICS

MATH 247 LINEAR ALGEBRA. (3) (Prerequisite: MATH 133 or equivalent. Intended for Honours Physics and Engineering students) (Not open to students who have taken or are taking MATH 236, MATH 223 or MATH 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.

MATH 248 ADVANCED CALCULUS 1. (3) (Prerequisites: MATH 133 and MATH 222 or consent of Department. Intended for Honours Mathematics, Physics and Engineering students) (Not open to students who have taken or are taking MATH 314) Partial derivatives; implicit functions; Jacobians; maxima and minima; 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.

MATH 249 ADVANCED CALCULUS 2. (3) (Prerequisite: MATH 248. Intended for Honours Physics and Engineering students) (Not open to students who have taken or are taking MATH 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.

MATH 260 INTERMEDIATE CALCULUS. (3) (3-1-5) (Prerequisites: MATH 141, MATH 133 or equivalent) Review of sequences and series. Power series, Taylor's theorem and Taylor's series, computations using series. Review of vectors, lines and planes, curves and curvature, conics, polar coordinates. Surfaces. Differential calculus of several variables. Double and triple integrals.

MATH 261 DIFFERENTIAL EQUATIONS. (3) (3-1-5) (Corequisite: MATH 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.

MATH 265 ADVANCED CALCULUS. (3) (3-1-5) (Prerequisites: MATH 260 or MATH 222 or MATH 151 or equivalent) Implicit functions, constrained and unconstrained extrema 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.

MATH 266 LINEAR ALGEBRA AND BOUNDARY VALUE PROBLEMS. (4) (4-1-7) (Prerequisites: MATH 261, MATH 265) Review of matrix algebra, vector spaces and linear transformations, eigenvalue problems and applications to systems of linear ordinary differential equations. Partial differential equations in engineering, Fourier analysis, Sturm-Liouville theory, solutions of boundary value problems in cartesian, cylindrical and spherical coordinates.

MATH 270 APPLIED LINEAR ALGEBRA. (3) (3-1-5) (Prerequisite: MATH 261) Review of matrix algebra, solution of linear equations, triangular factorization and Gaussian reduction, vector spaces, inner products, orthogonality concepts, projections, least squares. Eigenvalues and eigenvectors, diagonalization of matrices and quadratic forms, Cayley-Hamilton theorem, the exponential matrix, analytical and numerical techniques for solving linear systems of ordinary differential equations, nonlinear equations and stability.

MATH 325 ORDINARY DIFFERENTIAL EQUATIONS. (3) (3-0-6) (Prerequisite: MATH 222. Intended for Honours Mathematics, Physics and Engineering programs.) (Not open to students who have taken MATH 261, MATH 315) First and second order equations, linear equations, series solutions, Frobenius method, introduction to numerical methods and to linear systems, Laplace transforms, applications.

MATH 363 DISCRETE MATHEMATICS. (3) (3-0-6) (Prerequisites: MATH 265 and either MATH 270 or consent of instructor) Logic and combinatorics. Mathematical reasoning and methods of proof. Sets, relations, functions, partially ordered sets, lattices, Boolean algebra. Propositional and predicate calculi. Recurrences and graph theory.

MATH 381 COMPLEX VARIABLES AND TRANSFORMS. (3) (3-1-5) (Prerequisite: MATH 265) Analytic functions, Cauchy-Riemann equations, simple mappings, Cauchy's theorem, Cauchy's integral formula, Taylor and Laurent expansions, residue calculus. Properties of one and two-sided Fourier and Laplace transforms, the complex inversion integral, relation between the Fourier and Laplace transforms, application of transform techniques to the solution of differential equations. The Z-transform and applications to difference equations.

DEPARTMENT OF PHYSICS

PHYS 251 CLASSICAL MECHANICS 1. (3) (3 hours lectures) (Prerequisite: CEGEP physics. Corequisite: MATH 222) (Not open to students taking or having taken PHYS 230.) Newton's laws, work energy, angular momentum. Harmonic oscillator, forced oscillations. Inertial forces, rotating frames. Central forces, centre of mass, planetary orbits, Kepler's laws.

PHYS 271 QUANTUM PHYSICS. (3) (3-0-6) (Prerequisite: PHYS 251 or CIVE 281) The observed properties of atoms and radiation from atoms. Electron waves. The Schroedinger Equation in one dimension. Quantum mechanics of the hydrogen atom. Angular momentum and spin. Quantum mechanics of many electron systems. Basic ideas of electrons in solids and solid state physics.

PHYS 350 ELECTROMAGNETISM. (3) (3 hours lectures) (Prerequisites: MATH 248, MATH 325. Honours students or permission of the instructor) (Not open to students having taken PHYS 340) Fundamental laws of electric and magnetic fields in both integral and differential form.