The Faculty of Science is divided into four parts. All sections can be accessed from the Undergraduate Programs Calendar Front Page - click on the link at the bottom of the page.

12.8 Computer Science (COMP)

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Laurie Hendren; B.Sc., M.Sc.(Queen's), Ph.D.(C'nell)
Tim H. Merrett; B.Sc.(Queen's), D.Phil.(Oxon.)
Monroe M. Newborn; B.E.E.(R.P.I.), Ph.D.(Ohio St.), F.A.C.M.
Prakash Panangaden; M.Sc.(I.I.T. Kanpur), M.S.(Chicago), Ph.D.(Wis.)
Gerald F.G. Ratzer; B.Sc.(Glas.), M.Sc.(McG.)
Bruce Reed; B.Sc., Ph.D.(McG.)
Denis Thérien; B.Sc.(Montr.), M.Sc., Ph.D.(Wat.) *(James McGill Professor)*
Godfried T. Toussaint; B.Sc.(Tulsa), Ph.D.(Br.Col.) *(on leave 2002-03)*

Associate Professors
Claude Crepeau; B.Sc., M.Sc.(Montr.) Ph.D.(M.I.T.)
Gregory Dudek; B.Sc.(Queen's), M.Sc., Ph.D.(Tor.)
Nathan Friedman; B.A.(W.Ont.), Ph.D.(Tor.)
Carl Tropper; B.Sc.(McG.), Ph.D.(Brooklyn Poly.)
Sue Whitesides; M.S.E.E.(Stan.), Ph.D.(Wis.)

Assistant Professors
David Bryant; B.Sc., Ph.D.(U. of Canterbury)
Xiao-Wen Chang; B.Sc., M.Sc.(Nanjing), Ph.D.(McG.)
Karel Driesen; Licentiate, Masters (Free Brussels Univ.), Ph.D.(U.C. Santa-Barbara)
Michael Trevor Hallett; B.Sc.(Queen's), Ph.D.(Victoria)
Bettina Kemme; B.Sc.(U. of Seville), M.Sc.(UC Santa Barbara), Ph.D.(ETH, Zurich)
Michael Langer; B.Sc.(McG.), M.Sc.(U.C. Santa Barbara), Ph.D.(McG.)
Doina Precup; B.Sc.(Tech. U. of Cluj-Napoca), M.Sc., Ph.D.(Mass.)
Kaleem Siddiqi; B.Sc.(Lafayette), M.Sc., Ph.D.(Brown)
Hans Vangheluwe; B.Sc., M.Sc., Ph.D.(Ghent)
Clarke Verbrugge; B.A.(Queen's), Ph.D.(McG.)

Faculty Lecturer
Joseph Vybinal; M.Sc.(McG.)

Adjunct Professors
Stefan Brands, Renato De Mori, Khaled El Emam, Syed Hyder, François Laviolette, Keith Paton

The study of computer science encompasses everything from pure theory to hands-on applications including the analysis of algorithms, programming languages, compilers, databases, operating systems, robotics, computer vision, artificial intelligence and computational biology.

The School currently operates a general purpose computing facility to support teaching, a large undergraduate workstation laboratory and seven dedicated laboratories for research in computational geometry and robotics, parallel processing, compilers, concurrent programming, software engineering, database systems, mobile robotics, and cellular automata.

The teaching facility consists of a network of over 140 Pentium III and IV workstations running FREEBSD, Linux, and Windows 2000. The facility also includes several compute engines including 3 SUN sparc20 servers, 2 SUN Ultrasparc and 2 SUN Enterprise 250s. Dialup access is provided through the Computing Centre along with PPP network connections. For introductory courses most work is completed using the Windows 2000 workstations and compute engines. All other courses use UNIX as a development environment.

The School of Computer Science offers a Majors program and an Honours program through the Faculty of Science, and a Minor program through the Faculties of Science and Engineering. The School also offers Major and Minor Concentrations through the Faculty of Arts. In conjunction with the Department of Mathematics and Statistics, the School offers a Joint Honours program, a Joint Majors program and two Faculty programs through the Faculty of Science. Special programs involving Computer Science are also available in the Faculties of Management, Engineering, and Music. For further details on programs outside the Faculty of Science, consult the other faculties' sections of this Calendar.

All students planning to enter Computer Science programs should make an appointment with an academic adviser through the School's Undergraduate secretary.

Software Engineering Programs

The School will offer a B.Sc. Major program in Software Engineering (subject to Ministry of Education approval). The B.Sc. program **will not** lead to accreditation.

The School, jointly with the Department of Electrical and Computer Engineering, will also offer a Bachelor of Software Engineering program (subject to Ministry of Education approval).

Graduates of the B.S.E. should be eligible for accreditation (once accreditation standards for Software Engineers have been adopted). For B.S.E. program details, refer to the Faculty of Engineering section, page 218.

Some graduate courses in Computer Science are available to suitably qualified senior undergraduates. The School also offers graduate research studies leading to M.Sc. and Ph.D. degrees. For further details, consult the Graduate Studies Calendar.

The School's courses are available as electives to Engineering students. Engineering students interested in a Minor in Computer Science should consult "Computer Science Courses and Minor Program" on page 238 in the Faculty of Engineering section.

An industrial internship year is available to Computer Science students. IYES, the Internship Year Program for Engineering and Science, is a pre-graduate work experience program for Computer Science students normally between their U2 and U3 years. See the Faculty of Engineering section 2.9 for further information on IYES.

Admission to Computer Science and Software Engineering Programs is limited. Students seeking admission to the programs are required to have completed MATH 140 and MATH 141 (or MATH 150 and MATH 151) and MATH 133 or the CEGEP equivalents. They must have at least a B- average in these courses to be considered for admission which will be based on overall GPA or CEGEP grades as well as grades in the courses above. Students transferring from other programs within McGill may be admitted on the same criteria up to the maximum program capacity. Students not admitted may be placed on a waiting list for admission should vacancies occur. **Application deadline for U0 or transfer students from other departments is April 20.** All students must meet with a departmental academic adviser prior to registration in any program.

MINOR PROGRAM IN COMPUTER SCIENCE (24 credits)
[Program revisions are under consideration for September 2002. Go to http://www.mcgill.ca (Course Calendars) in July for details.]

The Computer Science Minor may be taken in conjunction with any program in the Faculties of Science and Engineering (with the exception of the other programs based on Computer Science) with the approval of the Adviser of the student's main program and the School of Computer Science. By the time of registration in the penultimate year, students must declare their intent to receive a Computer Science Minor and approval must be given by the School for the particular sequence of courses the student wishes

to call the Computer Science Minor. All courses must be passed with a grade of C or better.

Students may receive credit towards their Computer Science Minor by taking certain approved courses outside the School of Computer Science. These courses must have a high computer science content. A student will not be permitted to receive more than six credits from such courses. These courses must be approved by the School of Computer Science in advance.

If a student's Major program requires Computer Science courses, up to six credits of Computer Science courses may be used to fulfill both Major and Minor requirements.

Required Courses (12 credits)

COMP 202	(3)	Introduction to Computing 1
COMP 203	(3)	Introduction to Computing 2
COMP 206	(3)	Intro to Software Systems
COMP 302	(3)	Programming Languages and Paradigms

Complementary Courses (12 credits)
selected from:

COMP 251	(3)	Data Structures and Algorithms
COMP 273	(3)	Intro. to Computer Systems
COMP 303	(3)	Programming Techniques
COMP 304	(3)	Object-oriented Design
COMP 310	(3)	Comp. Systems and Organization
COMP 335	(3)	Software Engineering Methods
COMP 350	(3)	Numerical Computing
or MATH 317	(3)	Numerical Analysis
COMP 360	(3)	Algorithm Design Techniques
COMP 361	(3)	Systems Programming Project
COMP 409	(3)	Concurrent Programming
COMP 410	(3)	Mobile Computing
COMP 412	(3)	Software for e-Commerce
COMP 420	(3)	Files and Databases
COMP 421	(3)	Database Systems
COMP 423	(3)	Data Compression
COMP 424	(3)	Artificial Intelligence 1
COMP 426	(3)	Automated Reasoning
COMP 433	(3)	Personal Software Engineering
COMP 435	(3)	Basics of Computer Networks
COMP 505	(3)	High-Performance Computer Architecture
COMP 506	(3)	Advanced Analysis of Algorithms
COMP 507	(3)	Computational Geometry
COMP 520	(4)	Compiler Design
COMP 522	(4)	Modelling and Simulation
COMP 524	(3)	Theoretical Found. of Prog. Lang.
COMP 526	(3)	Probabilistic Reasoning and AI
COMP 534	(3)	Team Software Engineering
COMP 535	(3)	Computer Networks
COMP 537	(3)	Internet Programming
COMP 538	(3)	Person-Machine Communication
COMP 540	(3)	Matrix Computations
COMP 557	(3)	Fundamentals of Computer Graphics
COMP 558	(3)	Fund. of Computer Vision
COMP 560	(3)	Graph Algorithms and Applications
COMP 562	(3)	Computational Biology Methods
COMP 566	(3)	Discrete Optimization 1
COMP 567	(3)	Discrete Optimization 2
COMP 573	(3)	Microcomputers
COMP 575	(3)	Fundamentals of Distributed Algorithms

or from courses outside of the School approved by the adviser, to a maximum of 6 credits.

MINOR PROGRAM IN COMPUTATIONAL MOLECULAR BIOLOGY (24 credits)

Computational molecular biology is the subdiscipline of bioinformatics that is located at the intersection of computer science and molecular biology. The focus of this area is on techniques for managing and analyzing molecular sequence data. This program will provide undergraduate students in the biological sciences with the skills from computer science to solve computational problems arising in molecular biology and genomics and to provide students with the necessary skills to build software tools from these algorithms.

Required Courses (21 credits)

COMP 202	(3)	Introduction to Computing 1
COMP 203	(3)	Introduction to Computing 2
COMP 251	(3)	Data Structures and Algorithms
COMP 330	(3)	Theoretical Aspects of Computer Science
COMP 360	(3)	Algorithm Design Techniques
COMP 562	(3)	Computational Biology Methods
MATH 240	(3)	Discrete Structures and Computing

Complementary Course (3 credits)
one of:

COMP 350	(3)	Numerical Computing
COMP 421	(3)	Database Systems
COMP 424	(3)	Artificial Intelligence 1
COMP 522	(4)	Modelling and Simulation
COMP 526	(3)	Probabilistic Reasoning and AI

FACULTY PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE See page 413 in the Mathematics and Statistics section for complete program information.

FACULTY PROGRAM IN MATHEMATICS, STATISTICS AND COMPUTER SCIENCE See page 413 in the Mathematics and Statistics section for complete program information.

MAJOR PROGRAM IN COMPUTER SCIENCE (60 credits)
[Program revisions are under consideration for September 2002. Go to http://www.mcgill.ca (Course Calendars) in July for details.]

To enter the program, students must have completed MATH 140 and MATH 141, or their equivalents. MATH 133, or its equivalent, may be taken prior to entry or concurrently with COMP 250 during the first semester in the program. Freshman Program students interested in Computer Science should try to take COMP 202 if possible, but it is not required for entry to the Major. A student entering with insufficient programming background may take COMP 202 but it will not count for program credit.

Required Courses (42 credits)

COMP 250	(3)	Intro to Computer Science
COMP 251	(3)	Data Structures and Algorithms
COMP 206	(3)	Intro to Software Systems
COMP 273	(3)	Intro. to Computer Systems
COMP 302	(3)	Programming Languages and Paradigms
COMP 310	(3)	Comp. Systems and Organization
COMP 330	(3)	Theoretical Aspects of Computer Science
COMP 350	(3)	Numerical Computing
COMP 360	(3)	Algorithm Design Techniques
MATH 222	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 240	(3)	Discrete Structures and Computing
MATH 323	(3)	Probability Theory
MATH 340	(3)	Abstract Algebra and Computing

Complementary Courses (18 credits)
15 credits from:

COMP 303	(3)	Programming Techniques
COMP 304	(3)	Object-oriented Design
COMP 335	(3)	Software Engineering Methods
COMP 361	(3)	Systems Programming Project
COMP 409	(3)	Concurrent Programming
COMP 410	(3)	Mobile Computing
COMP 412	(3)	Software for e-Commerce
COMP 420	(3)	Files and Databases
COMP 421	(3)	Database Systems
COMP 423	(3)	Data Compression
COMP 424	(3)	Artificial Intelligence 1
COMP 426	(3)	Automated Reasoning
COMP 433	(3)	Personal Software Engineering
COMP 435	(3)	Basics of Computer Networks
COMP 505	(3)	High-Performance Computer Architecture

COMP 506 (3) Advanced Analysis of Algorithms
COMP 507 (3) Computational Geometry
COMP 520 (4) Compiler Design
COMP 522 (4) Modelling and simulation
COMP 524 (3) Theoretical Found. of Prog. Lang.
COMP 525 (3) Formal Verification
COMP 526 (3) Probabilistic Reasoning and AI
COMP 531 (3) Theory of Computation
COMP 534 (3) Team Software Engineering
COMP 535 (3) Computer Networks
COMP 537 (3) Internet Programming
COMP 538 (3) Person-Machine Communication
COMP 540 (3) Matrix Computations
COMP 547 (3) Cryptography and Data Security
COMP 557 (3) Fundamentals of Computer Graphics
COMP 558 (3) Fund. of Computer Vision
COMP 560 (3) Graph Algorithms and Applications
COMP 562 (3) Computational Biology Methods
COMP 566 (3) Discrete Optimization 1
COMP 567 (3) Discrete Optimization 2
COMP 573 (3) Microcomputers
COMP 575 (3) Fundamentals of Distributed Algorithms
ECSE 323 (3) Digital System Design
ECSE 426 (3) Microprocessor Systems
ECSE 531 (3) Real Time Systems
ECSE 548 (3) Introduction to VLSI Systems

3 credits from Mathematics selected from:
MATH 314 (3) Advanced Calculus
MATH 315 (3) Ordinary Differential Equations
MATH 322 (3) Dynamical Systems, Fractals and Chaos
MATH 324 (3) Statistics
MATH 348 (3) Topics in Geometry
MATH 407 (3) Dynamic Programming
MATH 417 (3) Mathematical Programming
MATH 591 (3) Mathematical Logic 1

JOINT MAJOR PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE See page 414 in the Mathematics and Statistics section for complete program information.

JOINT MAJOR PROGRAM IN PHYSICS AND COMPUTER SCIENCE See page 430 in the Physics section for complete program information.

MAJOR PROGRAM IN SOFTWARE ENGINEERING
(72 to 74 credits) (Subject to Ministry of Education approval)

To enter this program, students must meet the eligibility requirements for the Major program in Computer Science.

Holders of this degree will **not** be eligible for accreditation (when accreditation standards for Software Engineers are introduced). Students wishing to be accredited should enroll in the Bachelor of Software Engineering degree program, see page 218.

Required Courses (48 credits)
MATH 260 (3) Intermediate Calculus
ECSE 221 (3) Introduction to Computer Engineering
ECSE 321 (3) Introduction to Software Engineering
ECSE 322 (3) Computer Engineering
ECSE 427 (3) Operating Systems
ECSE 428 (3) Software Engineering
ECSE 429 (3) Validation & Verification
ECSE 495 (3) Software Engineering Project
COMP 202 (3) Introduction to Computing 1
COMP 206 (3) Intro to Software Systems
COMP 250 (3) Intro to Computer Science
COMP 251 (3) Data Structures and Algorithms
COMP 302 (3) Programming Languages and Paradigms
COMP 330 (3) Theoretical Aspects of Computer Science
COMP 360 (3) Algorithm Design Techniques
COMP 361 (3) Systems Programming Project

Complementary Courses (24 to 26 credits)
12 credits of mathematics, one course from each of the following four groups:
MATH 223 (3) Linear Algebra
or MATH 270 (3) Applied Linear Algebra
MATH 240 (3) Discrete Structures and Computing
or MATH 363 (3) Discrete Mathematics
or MATH 381 (3) Complex Variables and Transforms
MATH 261 (3) Differential Equations
or MATH 324 (3) Statistics
MATH 323 (3) Probability Theory
or ECSE 305 (3) Probability and Random Signals

12 to 14 credits of technical complementaries, chosen from the following courses:
ECSE 200 (3) Fundamentals of Electrical Engineering
ECSE 210 (3) Circuit Analysis
ECSE 291 (2) Electrical Measurement Lab
ECSE 303 (3) Signals and Systems 1
ECSE 304 (3) Signals and Systems 2
ECSE 323 (5) Digital Systems Design
ECSE 404 (3) Control Systems
ECSE 411 (3) Communications Systems
ECSE 420 (3) Parallel Computing
ECSE 421 (3) Embedded Systems
ECSE 422 (3) Fault-Tolerant Computing
ECSE 424 (3) Human-Computer Interaction
ECSE 425 (3) Computer Organization and Architecture
ECSE 426 (3) Microprocessor Systems
or COMP 573 (3) Microcomputers
ECSE 504 (3) Computer Control
ECSE 522 (3) Asynchronous Circuits and Systems
ECSE 526 (3) Artificial Intelligence
ECSE 529 (3) Image Processing & Communication
ECSE 530 (3) Logic Synthesis
ECSE 531 (3) Real Time Systems
ECSE 532 (3) Computer Graphics
or COMP 557 (3) Fundamentals of Computer Graphics
COMP 350 (3) Numerical Computing
COMP 409 (3) Concurrent Programming
COMP 410 (3) Mobile Computing
COMP 412 (3) Software for e-commerce
COMP 420 (3) Files and Databases
COMP 424 (3) Artificial Intelligence 1
COMP 433 (3) Personal Software Engineering
COMP 505 (3) High-Performance Computer Architecture
COMP 520 (4) Compiler Design
COMP 524 (3) Theoretical Found. of Prog. Lang.
COMP 535 (3) Computer Networks
COMP 560 (3) Graph Algorithms and Applications
COMP 566 (3) Discrete Optimization 1
COMP 575 (3) Fundamentals of Distributed Algorithms

HONOURS PROGRAM IN COMPUTER SCIENCE (72 credits)
[Program revisions are under consideration for September 2002. Go to http://www.mcgill.ca (Course Calendars) in July for details.]

Honours students must maintain a CGPA of 3.00 and must have at least this average upon graduation as well.

Required Courses (45 credits)
all Major Program required courses, plus
COMP 400 (3) Technical Project and Report

Complementary Courses (27 credits)
24 credits from Major Program in Computer Science complementary courses in Computer Science.
3 credits from Major Program in Computer Science complementary courses in Mathematics.

JOINT HONOURS PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE See page 415 in the Mathematics and Statistics section for complete program information. Students must consult an Honours adviser in both Departments.

MINOR IN COGNITIVE SCIENCE Students following Major or Honours programs in Computer Science may want to consider the Minor in Cognitive Science.

INTERNSHIP PROGRAMS – INTERNSHIP YEAR FOR ENGINEERING AND SCIENCE (IYES)

The following programs are also available with an Internship component. For more information, please see section 2.9 in the Faculty of Engineering section.

Major in Computer Science
Honours in Computer Science

COURSE DESCRIPTIONS

NOTE: Some restrictions and changes may have occurred after this Calendar went to press. Please check the SOCS web page http://www.cs.mcgill.ca/acadpages/undergrad.

Computer Science Course Restriction Notes
The following programs are defined as belonging to the Core Group or the Mathematics Group to simplify the explanation of course restrictions:

Core Group:
Major in Computer Science
Honours in Computer Science
Joint Major in Mathematics and Computer Science
Joint Major in Physics and Computer Science
Joint Honours in Mathematics and Computer Science
Major in Software Engineering
Bachelor of Software Engineering
Major Concentration in the Foundations of Computing
Minor Concentration in Foundations of Computing
Minor Concentration in Computer Science
Faculty Program in Mathematics and Computer Science
Faculty Program in Mathematics, Statistics and Computer Science

Mathematics Group:
Honours in Mathematics
Honours in Applied Mathematics
Honours in Probability and Statistics

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. Credits for either of these courses will not count towards the 60-credit Major in Computer Science.

B. COMP 203 and COMP 250 are considered to be equivalent from a prerequisite point of view, and cannot both be taken for credit. Computer Science Major and Honours students are strongly advised to take MATH 240 with COMP 250 but before COMP 251.

C. COMP 330 and COMP 530 cannot both be taken for credit.

D. Credit will not be given for COMP 102 if it is taken concurrently with, or after, any of: COMP 202, COMP 203, COMP 208, COMP 250.

E. COMP 431 is open only to B.Eng. students in Electrical and Computer Engineering. Credit will be given for only one of: COMP 431, COMP 251, COMP 360, COMP 405.

F. Management students cannot receive credit for COMP 102.

G. Open only to students registered in a Core Group* or Mathematics Group* program. (* as defined above)

H. Students registered in a Core Group* (with the exception of those in the Minor Concentration in Computer Science Stream I) or Mathematics Group* program may NOT take this course. (* as defined above)

I. Open only to students registered in a Core Group* or Mathematics Group* program, or the Minor in Computer Science. (* as defined above)

J. Open only to students registered in a Core Group* or Mathematics Group* program, or the Minor in Computer Science, or the Minor in Cognitive Science. (* as defined above)

K. Open only to students registered in a Core Group* or Mathematics Group* program, or the Major in Computer Engineering. (* as defined above)

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 above)

M. COMP 250 and COMP 203 cannot both be taken for credit.

N. COMP 202 cannot be taken for credit with or after COMP 250.

Please note: courses may have been rescheduled or new courses added after this Calendar went to press. Students preparing to register are advised to consult the 2002-2003 Class Schedule on the Web, http://www.mcgill.ca/minerva-students for the most up-to-date information.

The Class Schedule includes the term(s), days, and times when courses will be offered, as well as class locations and names of instructors.

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

The course credit weight is given in parentheses after the title. Term(s) offered (Fall, Winter, Summer) may appear after the credit weight to indicate when a course would normally be taught. Please check the Class Schedule to confirm this information.

COMP has replaced 308 as the prefix for Computer Science courses.

All courses have limited enrolment.

● Denotes courses not offered in 2002-03.

COMP 102 COMPUTERS AND COMPUTING. (3) (Fall) (2 hours lectures; 2 hours laboratory) (Prerequisite: high school level mathematics course on functions.) (Restriction Notes: D, F) A course for students with no previous knowledge of computer science who may be interested in further study. The structure of a computer; methodologies for problem solving - algorithm design and data structures, the limitations of computers. An introduction to programming in a high level language.

● **COMP 199 FYS: EXCURSIONS IN COMPUTER SCIENCE.** (3) (Fall) (3 hours) (Prerequisite: high school mathematics) (Open only to newly admitted students in U0 or U1, who may take only one FYS. Students who register for more than one will be obliged to withdraw from all but one of them.) (Maximum 25)

COMP 202 INTRODUCTION TO COMPUTING 1. (3) (Fall and Winter) (3 hours) (Prerequisite: a CEGEP level mathematics course) (Restriction Notes: A, N) 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 203 INTRODUCTION TO COMPUTER 2. (3) (Fall and Winter) (3 hours) (Prerequisites: MATH 133 and COMP 202) (Restriction Notes: B, H, M) Basic data structures. Representation of arrays, stacks, and queues. Linked lists and their applications to binary trees. Internal sorting. Graph representation. Elementary graph algorithms.

COMP 206 INTRODUCTION TO SOFTWARE SYSTEMS. (3) (Fall and Winter) (3 hours) (Prerequiste: COMP 203 or COMP 250) (Restriction Note: I) Comprehensive overview of programming in C, use of system calls and libraries, debugging and testing of code; use of developmental tools like make, version control systems.

COMP 208 COMPUTERS IN ENGINEERING. (3) (Fall and Winter) (3 hours) (Prerequisite: differential and integral calculus. Corequisite: linear algebra: determinants, vectors, matrix operations.) (Restriction Note: A) 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 algo-

rithms such as root finding, numerical integration and differential equations. Non-numerical algorithms for sorting and searching.

COMP 250 INTRODUCTION TO COMPUTER SCIENCE. (3) (Fall and Winter) (Prerequisites: Familiarity with a high level programming language and CEGEP level Math.) (Restriction Notes: B, K, M) 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 251 DATA STRUCTURES AND ALGORITHMS. (3) (Fall and Winter) (Prerequisites: MATH 240 and either COMP 250 or COMP 203) (Not open to students who have taken or are taking COMP 252.) (Restriction Notes: B, E, G) Design and analysis of algorithms. Complexity of algorithms. Data structures. Introduction to graph algorithms and their analysis.

COMP 252 ALGORITHMS AND DATA STRUCTURES. (3) (Winter) (3 hours) (Prerequisite: COMP 250 and MATH 240) (Open only to students registered in following programs: Honours in Computer Science, Joint Honours in Mathematics and Computer Science, Honours in Applied Mathematics, Honours in Mathematics.) (Not open to students who have taken or are taking COMP 251.) The design and analysis of data structures and algorithms. The description of various computational problems and the algorithms that can be used to solve them, along with their associated data structures. Proving the correctness of algorithms and determining their computational complexity.

COMP 273 INTRODUCTION TO COMPUTER SYSTEMS. (3) (Fall and Winter) (Prerequisite: COMP 206) (Restriction Note: I) Computer structure, machine instruction execution, addressing techniques, digital representation of data. Assemblers, cross-assemblers and simulators. Interrupts. Input and output programming and devices. System support macros and software. Program segmentation and linkage.

COMP 302 PROGRAMMING LANGUAGES AND PARADIGMS. (3) (Fall and Winter) (3 hours) (Prerequisite: COMP 250 or COMP 203) (Restriction Note: L) Programming language design issues and programming paradigms. Binding and scoping, parameter passing, lambda abstraction, data abstraction, type checking. Functional and logic programming.

COMP 303 PROGRAMMING TECHNIQUES. (4) (Winter) (3 hours, 3 lab hours) (Prerequisites: COMP 206, COMP 251, COMP 302) (Restriction Note: I) Software architecture, design patterns, object-oriented programming concepts, profiling and optimization. Students will implement a significant programming project.

COMP 304 OBJECT-ORIENTED DESIGN. (3) (Fall) (3 hours) (Prerequisites: COMP 206, COMP 251, COMP 302) (Restriction Note: I) The object model, objects and classes, verification and testing, object-oriented analysis, unified modeling language and design patterns.

COMP 310 COMPUTER SYSTEMS AND ORGANIZATION. (3) (3 hours) (Prerequisite: COMP 273) (Restriction Note: I) Control and scheduling of large information processing systems. Operating system software - resource allocation, dispatching, processors, access methods, job control languages, main storage management. Batch processing, multiprogramming, multiprocessing, time sharing.

COMP 330 THEORETICAL ASPECTS: COMPUTER SCIENCE. (3) (3 hours) (Prerequisite: COMP 251.) (Restriction Notes: C, I) Mathematical models of computers, finite automata, Turing machines, counter machines, push-down machines, computational complexity.

COMP 335 SOFTWARE ENGINEERING METHODS. (3) (Winter) (3 hours) (Corequisite: COMP 302) This course in software engineering teaches basic concepts and methods for software development. The focus is on engineering and analysing requirements, design and code. Small software development exercises will be given where students would learn how to apply different methods.

COMP 350 NUMERICAL COMPUTING. (3) (Fall) (3 hours) (Prerequisites: MATH 222 and MATH 223 and one of: COMP 202, COMP 208, COMP 250; or equivalents.) (Restriction Note: I) Computer representation of numbers, IEEE Standard for Floating Point Representation, computer arithmetic and rounding errors. Numerical stability. Matrix computations and software systems. Polynomial interpolation. Least-squares approximation. Iterative methods for solving a nonlinear equation. Discretization methods for integration and differential equations.

COMP 360 ALGORITHM DESIGN TECHNIQUES. (3) (Fall and Winter) (3 hours) (Prerequisite: COMP 251) (Not open to students who have taken or are taking COMP 362.) (Restriction Notes: E, I) A study of techniques for the design and analysis of algorithms.

● **COMP 361 SYSTEMS PROGRAMMING PROJECT.** (3) (Winter) (Prerequisite: COMP 206) (Restriction Note: I)

COMP 362 HONOURS ALGORITHM DESIGN. (3) (Winter) (Prerequisite: COMP 252) (Not open to students who have taken are are taking COMP 360.) Basic algorithmic techniques, their applications and limitations. Problem complexity, how to deal with problems for which no efficient solutions are known.

COMP 400 TECHNICAL PROJECT AND REPORT. (3) (Fall and Winter) (Prerequisites: 15 Computer Science credits. For Honours students) A computer related project, typically a programming effort, along with a report will be carried out in cooperation with a staff member in the School of Computer Science.

COMP 409 CONCURRENT PROGRAMMING. (3) (Fall) (Prerequisites: COMP 251, COMP 302, and COMP 310 or ECSE 427) (Restriction Note: I) Characteristics and utility of concurrent programs; formal methods for specification, verification and development of concurrent programs; communications, synchronization, resource allocation and management, coherency and integrity.

● **COMP 410 MOBILE COMPUTING.** (3) (Winter) (Prerequisite: COMP 310) (Restriction Note: I)

● **COMP 412 SOFTWARE FOR E-COMMERCE.** (3) (Fall) (Prerequisites: ECSE 427 or COMP 310) (Restriction Note: I)

COMP 420 FILES AND DATABASES. (3) (Fall) (Prerequisite: COMP 302) (Restriction Note: I) Language essentials for file processing; sequential files; sorting, updating, tree files; direct files; files of structured data; basics of relational databases.

COMP 421 DATABASE SYSTEMS. (3) (Winter) (3 hours) (Prerequisites: COMP 206, COMP 251, COMP 302) (Restriction Note: I) The relational model of databases, an introduction to object-oriented concepts. Relational algebra, conceptual design of databases, concurrency control issues and databases.

COMP 423 DATA COMPRESSION. (3) (Winter) (3 hours) (Prerequisites: COMP 251, MATH 223, MATH 323) Information Theory. Huffman, arithmetic and dictionary codes. Context Modelling. Lossy compression and quantization. Signal processing. Applications to text, image, speech, audio and video data.

COMP 424 TOPICS: ARTIFICIAL INTELLIGENCE 1. (3) (Fall) (3 hours) (Prerequisites: COMP 206, COMP 251, COMP 302) (Restriction Note: J) Introduction to search methods in AI problems. Mechanical theorem-proving techniques, game playing by computers, the minimalxand alpha-beta algorithms, and heuristic approaches to state space search problems.

● **COMP 425 TOPICS: ARTIFICIAL INTELLIGENCE 2.** (3)

COMP 426 AUTOMATED REASONING. (3) (Winter) (3 hours) (Prerequisites: COMP 424; or COMP 302 with MATH 340) (Restriction Note: J) Representing and reasoning with knowledge. The case for logics. Introduction to Logic Programming and, for example, PROLOG. Introduction to some Artificial Intelligence applications of Logic Programming: Meta-interpreters, Expert Systems and their implementation, Planning, Natural Language Processing, Machine Learning.

COMP 431 ALGORITHMS AND DATA STRUCTURES. (3) (Fall) (3 hours) (Prerequisites: ECSE 222 and MATH 363) (Restriction Note: E) Advanced data structures: heaps, binary search trees, graphs, algorithmic analysis: space-time analysis, worst-case and expected complexity. Examples of searching sorting and merging. Algorithm design: divide-and-conquer, dynamic programming,

greedy methods, backtracking. Algorithms: set manipulation, tree traversals. Memory management: hashing, dynamic storage allocation and garbage collection.

● **COMP 433 PERSONAL SOFTWARE ENGINEERING.** (3) (Fall) (3 hours) (Prerequisite: COMP 335)

COMP 435 BASICS OF COMPUTER NETWORKS. (3) (Winter) (3 hours) (Prerequisite: COMP 310) (COMP 435 and COMP 535 cannot both be taken for credit.) (Restriction Note: I) Exposition of the first four layers of the ISO model for computer network protocols. Socket programming. Network administration and configuration and Security issues.

COMP 490 INTRO TO PROB ANAL ALGORITHMS. (3) (Fall) ((3 hours)) (Prerequisites: COMP 251 and MATH 323) Fundamental tools from probability are used to analyze algorithms. Notions covered included independence, generaing functions, probability inequalities, random walks and Markov chains. Analysis of probabilitic recurrences, Las Vegas algorithms, randomized approximation algorithms, random sampling methods, Monte Carlo techniques and algorithms for combinatorial search and graph theoretic problems.

● **COMP 505 ADVANCED COMPUTER ARCHITECTURE.** (3) (Fall) (3 hours) (Prerequisites: COMP 302 and COMP 273 or equivalent)

COMP 506 ADVANCED ANALYSIS OF ALGORITHMS. (3) (Winter) (3 hours) (Prerequisite: COMP 330 or COMP 360 or COMP 405 or COMP 431) The study of computational complexity and intractability: Cook's Theorem, NP-completeness, oracles, the polynomial hierarchy, lower bounds, heuristics, approximation problems.

COMP 507 COMPUTATIONAL GEOMETRY. (3) (Fall) (3 hours) (Prerequisite: COMP 360 or COMP 405 or equivalent or corequisite COMP 506) Problems in computational geometry; worst-case complexity of geometric algorithms; expected complexity of geometric algorithms and geometric probability; geometric intersection problems; nearest neighbor searching; point inclusion problems; distance between sets; diameter and convex hull of a set; polygon decomposition; the Voronoi diagram and other planar graphs; updating and deleting from geometric structures.

COMP 520 COMPILER DESIGN. (4) (Fall) (3 hours, 1 hour consultation) (Prerequisites: COMP 273 and COMP 302) The structure of a compiler. Lexical analysis. Parsing techniques. Syntax directed translation. Run-time implementation of various programming language constructs. Introduction to code generation for an idealized machine. Students will implement parts of a compiler.

COMP 522 MODELLING AND SIMULATION. (3) (Fall) (3 hours) (Prerequisites: COMP 251, COMP 302, COMP 350) Simulation and modeling processes, state automata, Petri Nets, state charts, discrete event systems, continuous-time models, hybrid models, system dynamics and object-oriented modeling.

COMP 524 THEORETICAL FOUNDATION OF PROGRAMMING LANGUAGE. (3) (Fall) (3 hours) (Prerequisite: COMP 302, and MATH 340 or MATH 235) Operational and denotational semantics of programming languages. Equivalence theorems for first-order languages. Lambda calculus. Type-inference, typed lambda calculus. Polymorphism. Elements of domain theory and fixed-point induction.

● **COMP 525 FORMAL VERIFICATION.** (3) (Winter) (3 hours) (Prerequisites: COMP 251, COMP 310, COMP 330 and MATH 340)

COMP 526 PROBABILISTIC REASONING AND AI. (3) (Winter) (3 hours) (Prerequisites: COMP 206, COMP 360, COMP 424 and MATH 323) Belief networks, Utility theory, Markov Decision Processes and Learning Algorithms.

COMP 531 THEORY OF COMPUTATION. (3) (Winter) (3 hours) (Prerequisite: COMP 330) Models for sequential and parallel computations: Turing machines, boolean circuits. The equivalence of various models and the Church-Turing thesis. Unsolvable problems. Model dependent measures of computational complexity. Abstract complexity theory. Exponentially and super-exponentially difficult problems. Complete problems.

● **COMP 534 TEAM SOFTWARE ENGINEERING.** (3) (Winter) (3 hours) (Prerequisite: COMP 433 or equivalent)

COMP 535 COMPUTER NETWORKS 1. (3) (Fall) (3 hours) (Prerequisite: COMP 310) (Students may not take COMP 435 and COMP 535 for credit) Exposition of the first four layers of the ISO model for computer network protocols, i.e., the physical, data, network, and transport layers. Basic hardware and software issues with examples drawn from existing networks, notably SNA, DECnet, and ARPAnet.

COMP 537 INTERNET PROGRAMMING. (3) (Winter) (3 hours) (Prerequisites: COMP 251 and COMP 302, and any one of COMP 310, COMP 420, COMP 424, or COMP 433) Sockets, User Datagram Protocol (UDP), Transmission utility protocals; Remote Terminal Protocol (Telnet), Simple Mail Transfer Protocol (SMTP), File Transfer Protocol (FTP) Hypertext Transfer Protrocol (HTTP), Internet resource database and search engines. Remote File Systems. Distributed objects, Common Object Request Broker Architecture (CORBA).

● **COMP 538 PERSON-MACHINE COMMUNICATION.** (3) (Winter) (3 hours) (Prerequisites: COMP 251, COMP 302).

COMP 540 MATRIX COMPUTATIONS. (3) (Winter) (3 hours) (Prerequisite: MATH 327 or COMP 350) Designing and programming reliable numerical algorithms. Stability of algorithms and condition of problems. Reliable and efficient algorithms for solution of equations, linear least squares problems, the singular value decomposition, the eigenproblem and related problems. Perturbation analysis of problems. Algorithms for structured matrices.

COMP 547 CRYPTOGRAPHY AND DATA SECURITY. (3) (Fall) (3 hours) (Prerequisite: COMP 360) (Restriction: Not open to students who have taken 308-647) This course presents an in-depth study of modern cryptography and data security. The basic information theoretic and computational properties of classical and modern cryptographic systems are presented, followed by a cryptanalytic examination of several important systems. We will study the applications of cryptography to the security of systems.

COMP 557 COMPUTER GRAPHICS. (3) (Winter) (3 hours) (Prerequisite: MATH 223 and COMP 251) The study of fundamental mathematical, algorithmic and representational issues in computer graphics. The topics to be covered are: overview of graphics process, projective geometry, homogeneous coordinates, projective transformations, quadrics and tensors, line-drawing, surface modelling and object modelling reflectance models and rendering, texture mapping, polyhedral representations, procedural modeling, and animation.

COMP 558 FUNDAMENTALS OF COMPUTER VISION. (3) (Winter) (3 hours) (Prerequisites: COMP 206, COMP 360, MATH 222, MATH 223) (Restriction: not open to students who have taken 308-766 before January 2001) Biological vision, edge detection, projective geometry and camera modeling, shape from shading and texture, stereo vision, optical flow, motion analysis, object representation, object recognition, graph theoretic methods, high level vision, applications.

COMP 560 GRAPH ALGORITHMS AND APPLICATIONS. (3) (Fall) (3 hours) (Prerequisite: COMP 360 or COMP 405 or COMP 431 or MATH 343) Algorithms for connectivity, partitioning, clustering, colouring and matching. Isomorphism testing. Algorithms for special classes of graphs. Layout and embeddings algorithms for graphs and networks.

COMP 562 COMPUTATIONAL BIOLOGY METHODS. (3) (Fall) (3 hours) (Prerequisites: COMP 330, COMP 350, COMP 360 and MATH 323) Application of computer science techniques to problems arising in biology and medicine, techniques for modeling evolution, aligning molecular sequences, predicting structure of a molecule and other problems from computational biology.

COMP 566 DISCRETE OPTIMIZATION 1. (3) (Fall) (3 hours) (Prerequisites: COMP 360 or COMP 405 and MATH 223) Use of computer in solving problems in discrete optimization. Linear programming and extensions. Network simplex method. Applications of linear programming. Vertex enumeration. Geometry of linear programming. Implementation issues and robustness. Students will do a project on an application of their choice.

COMP 567 DISCRETE OPTIMIZATION 2. (3) (Winter) (3 hours) (Prerequisites: COMP 566 or MATH 417) Formulation, solution and applications of integer programs. Branch and bound, cutting plane, and column generation algorithms. Combinatorial optimization. Polyhedral methods. A large emphasis will be placed on modeling. Students will select and present a case study of an application of integer programming in an area of their choice.

COMP 573 MICROCOMPUTERS. (3) (Fall or Winter) (3 hours) (Prerequisite: COMP 273) Characteristics and internal structure of microcomputers and workstations. Architectures of current CISC and RISC micro processors. Assembler and machine languages for microcomputers. System software. Applications for single and networked microcomputers. Students will be assigned "hands-on'' projects.

COMP 575 FUNDAMENTALS OF DISTRIBUTED ALGORITHMS. (3) (Winter) (3 hours) (Prerequisite: COMP 310) Study of a collection of algorithms which are basic to the world of concurrent programming. Discussion of algorithms from the following areas: termination detection, deadlock detection, global snapshots, clock synchronization, fault tolerance (byzantine and self-stabilizing systems). Students will implement algorithms on the BBN butterfly and will present papers on topics in these areas.

COMP 577 DISTRIBUTED DATABASE SYSTEMS. (3) (Fall) (3 hours) (Prerequisites: COMP 421 and COMP 310) Issues related to distributed database both from a theoretical and practical point of view. Fundamental problems of distributed systems such as time or failure, distributed transaction management, fault-tolerance, replication, data distribution, and system architecture and design.

12.9 Earth and Planetary Sciences (EPSC)

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Chair — Alfonso Mucci

Emeritus Professors
Wallace H. MacLean; B.Geol.Eng.(Colorado Sch. of Mines), M.Sc.(Appl.), Ph.D.(McG.)
Eric W. Mountjoy; B.A.Sc.(U.B.C.), Ph.D.(Tor.) *(William E. Logan Emeritus Professor of Geology)*
Colin W. Stearn; B.Sc.(McM.), M.S., Ph.D.(Yale), F.R.S.C.

Professors
Jafar Arkani-Hamed; B.Eng.(Tehran), Ph.D.(M.I.T.)
Don M. Francis; B.Sc.(McG.), M.Sc.(U.B.C.), Ph.D.(M.I.T.) *(Dawson Professor of Geology)*
Andrew J. Hynes; B.Sc.(Tor.), Ph.D.(Cantab.) *(William E. Logan Professor of Geology)*
Olivia G. Jensen; B.Sc., M.Sc., Ph.D.(U.B.C.)
Robert F. Martin; B.Sc.(Ott.), M.S.(Penn. State), Ph.D.(Stan.)
Alfonso Mucci; B.Sc., M.Sc.(Montr.), Ph.D.(Miami)
A.E. (Willy) Williams-Jones; B.Sc., M.Sc.(Natal), Ph.D.(Queen's)

Associate Professors
Don Baker; B.A.(Chic.), Ph.D.(Penn.)
Jeanne Paquette; B.Sc., M.Sc.(McG.), Ph.D.(Stonybrook)
John Stix; AB (Dart.), M.Sc., Ph.D.(Tor.)
Hojatollah Vali; B.Sc., M.Sc., Ph.D.(Munich) *(Director, Electron Microscopy Centre)*

Assistant Professor
Mairi Best; B.Sc.(Laurentian), Ph.D.(Chic.)
Bruce Hart; B.A.(McM.), M.Sc.(U.Q.à Rimouski), Ph.D.(W.Ont.)

The domain of Earth and Planetary Sciences includes the solid Earth and its hydrosphere and extends to the neighbouring terrestrial planets. It is a multidisciplinary field in which the principles of chemistry, physics, and mathematics are applied to the rich problems of the real world in order to understand how planets like the Earth work; in the past, the present, and the future.

Career opportunities are many and varied for graduates in the Earth and Planetary Sciences. There is presently a demand for graduates with expertise in many disciplines of the Earth Sciences. Our students are recruited for employment in the petroleum and mining industries, and in the environmental sector. During the summer months undergraduate students are generally able to obtain employment from industry or government agencies, providing them with both financial benefits and first-hand geoscientific experience. Career opportunities in planetary science are presently limited to universities and research organizations.

The Department has a full-time staff of 13 professors and one faculty lecturer. There are approximately 50 graduate and 60 undergraduate students. Classes are therefore small at all levels, resulting in an informal and friendly atmosphere throughout the Department in which most of the faculty and students interact on a first name basis. Emphasis is placed equally on quality teaching and research providing undergraduate students with a rich and exciting environment in which to explore and learn.

The undergraduate curriculum is designed to provide both a rigorous foundation in the physical sciences and the flexibility to create an individualized program in preparation for careers in industry, teaching, or research. In addition to the Major and Honours undergraduate programs, the Department also offers a Joint Major in Physics and Geophysics which provides a rigorous mathematics and physics preparation and a geological background in the geosciences.

The Minor in Earth and Planetary Sciences offers Science students from other departments the opportunity to obtain exposure to the Earth Sciences, while the Minor in Geochemistry is oriented towards Chemistry Major students who want to see the application of chemistry to problems in the Earth and Planetary Sciences.

Students interested in any of the programs should inquire at Room 238, Frank Dawson Adams Building, (514) 398-6767, or should consult the Undergraduate Director, A.E. Williams-Jones, Room 317, Frank Dawson Adams Building, (514) 398-1676, if they do not have an adviser.

MINOR PROGRAM IN EARTH AND PLANETARY SCIENCES (18 credits)

Required Courses (7 credits)
EPSC 210 (3) Introduction to Mineralogy
EPSC 212 (4) Introductory Petrology

Complementary Courses (11 credits)
EPSC 201 (3) Understanding Planet Earth
or EPSC 233 (3) Earth & Life History

8 credits selected from:
EPSC 203 (3) Structural Geology 1
EPSC 231 (2) Field School 1
EPSC 243 (3) Environmental Geology
EPSC 334 (3) Invertebrate Palentology
EPSC 350 (3) Tectonics
EPSC 451 (3) Hydrothermal Mineral Deposits
EPSC 452 (3) Mineral Deposits
EPSC 542 (3) Chemical Oceanography
BIOL 352 (3) Vertebrate Evolution
Other Earth and Planetary Sciences courses may be substituted with permission.

MINOR PROGRAM IN GEOCHEMISTRY (25 credits)
Required Courses (10 credits)
EPSC 201 (3) Understanding Planet Earth
EPSC 210 (3) Introduction to Mineralogy
EPSC 212 (4) Introductory Petrology

Complementary Courses (15 credits)
15 credits selected from:
EPSC 220 (3) Principles of Geochemistry
EPSC 243 (3) Environmental Geology
EPSC 501 (3) Crystal Chemistry

EPSC 519 (3) Isotope Geology
EPSC 542 (3) Chemical Oceanography
EPSC 545 (3) Low-Temperature Geochemistry

MAJOR PROGRAM IN EARTH AND PLANETARY SCIENCES (66 credits)
Undergraduate Director: A.E. Williams-Jones, FDA 317, (514) 398-1676

U1 Required Courses (27 credits)
EPSC 210 (3) Introduction to Mineralogy
EPSC 220 (3) Principles of Geochemistry
EPSC 233 (3) Earth and Life History
MATH 222 (3) Calculus 3
EPSC 203 (3) Structural Geology
EPSC 212 (4) Introductory Petrology
EPSC 312 (3) Spectroscopy of Minerals
approved (3) statistics course
EPSC 231 (2) Field School 1

Note: Students who have not had the following course or its equivalent in CEGEP or the Freshman Program may be required to take MATH 133 Vectors, Matrices and Geometry.

U2 and/or U3 Required Courses (24 credits)
EPSC 320 (3) Elementary Earth Physics
EPSC 334 (3) Invertebrate Paleontology
EPSC 350 (3) Tectonics
EPSC 423 (3) Igneous Petrology
EPSC 445 (3) Metamorphic Petrology
EPSC 452 (3) Mineral Deposits
EPSC 455 (3) Sedimentary Geology
EPSC 519 (3) Isotope Geology

Complementary Courses (15 credits)
3 credits, one of:
EPSC 331 (3) Field School 2
EPSC 341 (3) Field School 3
plus 12 credits (4 courses) chosen from the following:
EPSC 330 (3) Earthquakes & Earth Structure
EPSC 425 (3) Sediments to Sequences
EPSC 435 (3) Geophysical Applications
EPSC 451 (3) Hydrothermal Mineral Deposits
EPSC 501 (3) Crystal Chemistry
EPSC 530 (3) Volcanology
EPSC 542 (3) Chemical Oceanography
EPSC 547 (3) High Temperature Geochemistry
EPSC 548 (3) Processes of Igneous Petrology
EPSC 549 (3) Hydrogeology
EPSC 550 (3) Selected Topics 1
EPSC 551 (3) Selected Topics 2
EPSC 552 (3) Selected Topics 3
EPSC 570 (3) Cosmochemistry
EPSC 580 (3) Aqueous Geochemistry
EPSC 590 (3) Applied Geochemistry Seminar

Note: Courses at the 300 or higher level in other departments in the Faculties of Science and Engineering may also be used as complementary credits, with the permission of the Director of Undergraduate Studies.

HONOURS PROGRAM IN EARTH SCIENCES (75 credits) (CGPA ≥ 3.20)

U1 Required Courses (27 credits)
EPSC 210 (3) Introduction to Mineralogy
EPSC 220 (3) Principles of Geochemistry
EPSC 233 (3) Earth and Life History
MATH 222 (3) Calculus 3
EPSC 203 (3) Structural Geology
EPSC 212 (4) Introductory Petrology
EPSC 312 (3) Spectroscopy of Minerals
approved (3) statistics course
EPSC 231 (2) Field School 1

Note: Students who have not had the following course or its equivalent in CEGEP or the Freshman Program may be required to take MATH 133 Vectors, Matrices and Geometry.

U2 and/or U3 Required Courses (33 credits)
EPSC 320 (3) Elementary Earth Physics
EPSC 350 (3) Tectonics
EPSC 423 (3) Igneous Petrology
EPSC 445 (3) Metamorphic Petrology
EPSC 452 (3) Mineral Deposits
EPSC 455 (3) Sedimentary Geology
EPSC 480D1 (3) Honours Research Project
EPSC 480D2 (3) Honours Research Project
EPSC 519 (3) Isotope Geology
MATH 314 (3) Advanced Calculus
MATH 315 (3) Ordinary Differential Equations

Complementary Courses (15 credits)
3 credits, one of:
EPSC 331 (3) Field School 2
EPSC 341 (3) Field School 3
plus 12 credits (4 courses) chosen from the following:
EPSC 330 (3) Earthquakes & Earth Structure
EPSC 334 (3) Invertebrate Paleontology
EPSC 425 (3) Sediments to Sequences
EPSC 435 (3) Geophysical Applications
EPSC 451 (3) Hydrothermal Mineral Deposits
EPSC 501 (3) Crystal Chemistry
EPSC 530 (3) Volcanology
EPSC 542 (3) Chemical Oceanography
EPSC 547 (3) High Temperature Geochemistry
EPSC 548 (3) Processes of Igneous Petrology
EPSC 549 (3) Hydrogeology
EPSC 550 (3) Selected Topics 1
EPSC 551 (3) Selected Topics 2
EPSC 552 (3) Selected Topics 3
EPSC 570 (3) Cosmochemistry
EPSC 580 (3) Aqueous Geochemistry
EPSC 590 (3) Applied Geochemistry Seminar

Note: Courses at the 300 or higher level in other departments in the Faculties of Science and Engineering may also be used as complementary credits, with the permission of the Director of Undergraduate Studies.

HONOURS PROGRAM IN PLANETARY SCIENCES (81 credits) CGPA ≥ 3.20

U1 Required Courses (27 credits)
EPSC 210 (3) Introduction to Mineralogy
EPSC 220 (3) Principles of Geochemistry
EPSC 233 (3) Earth and Life History
MATH 222 (3) Calculus 3
EPSC 203 (3) Structural Geology
EPSC 212 (4) Introductory Petrology
EPSC 312 (3) Spectroscopy of Minerals
MATH 223 (3) Linear Algebra
EPSC 231 (2) Field School 1

Note: Students who have not had the following course or its equivalent in CEGEP or the Freshman Program may be required to take MATH 133 Vectors, Matrices and Geometry.

U2 and/or U3 Required Courses (42 credits)
EPSC 320 (3) Elementary Earth Physics
EPSC 330 (3) Earthquakes & Earth Structure
EPSC 350 (3) Tectonics
EPSC 423 (3) Igneous Petrology
EPSC 480D1 (3) Honours Research Project
EPSC 480D2 (3) Honours Research Project
EPSC 510 (3) Geodynamics & Geomagnetism
EPSC 519 (3) Isotope Geology
EPSC 570 (3) Cosmochemistry
MATH 314 (3) Advanced Calculus

MATH 315 (3) Ordinary Differential Equations
MATH 317 (3) Numerical Analysis
MATH 319 (3) Partial Differential Equations
PHYS 340 (3) Electricity & Magnetism

Complementary Courses (12 credits)
3 credits, one of:
PHYS 251 (3) Classical Mechanics
PHYS 230 (3) Dynamics of Simple Systems
plus 9 credits (3 courses) chosen from the following:
EPSC 334 (3) Invertebrate Paleontology
EPSC 425 (3) Sediments to Sequences
EPSC 435 (3) Geophysical Applications
EPSC 451 (3) Hydrothermal Mineral Deposits
EPSC 501 (3) Crystal Chemistry
EPSC 530 (3) Volcanology
EPSC 542 (3) Chemical Oceanography
EPSC 547 (3) High Temperature Geochemistry
EPSC 548 (3) Processes of Igneous Petrology
EPSC 549 (3) Hydrogeology
EPSC 550 (3) Selected Topics 1
EPSC 551 (3) Selected Topics 2
EPSC 552 (3) Selected Topics 3
EPSC 570 (3) Cosmochemistry
EPSC 580 (3) Aqueous Geochemistry
EPSC 590 (3) Applied Geochemistry Seminar

Note: Courses at the 300 or higher level in other departments in the Faculties of Science and Engineering may also be used as complementary credits, with the permission of the Director of Undergraduate Studies.

JOINT MAJOR PROGRAM IN PHYSICS AND GEOPHYSICS
See page 430 in the Physics section for complete program information.

COURSE DESCRIPTIONS

Please note: courses may have been rescheduled or new courses added after this Calendar went to press. Students preparing to register are advised to consult the 2002-2003 Class Schedule on the Web, http://www.mcgill.ca/minerva-students for the most up-to-date information.

The Class Schedule includes the term(s), days, and times when courses will be offered, as well as class locations and names of instructors.

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

The course credit weight is given in parentheses after the title. Term(s) offered (Fall, Winter, Summer) may appear after the credit weight to indicate when a course would normally be taught. Please check the Class Schedule to confirm this information.

EPSC has replaced 186 as the prefix for Earth and Planetary Sciences courses.

All courses have limited enrolment.

● Denotes courses not offered in 2002-03.

The following courses are without prerequisite and could be taken by students in the Faculty of Arts: EPSC 200, EPSC 201, EPSC 233, and EPSC 243. Other courses assume as a prerequisite completion of the courses required in the Sciences option of the CEGEP curriculum.

EPSC 200 THE TERRESTRIAL PLANETS. (3) (Fall or Winter) (3 hours lectures) A comparative survey of the planets of our solar system with an emphasis on the terrestrial planets and their implications for the Earth as a planet. Topics include: structure and origin of the solar system, meteorites, and comparisons of the terrestrial planets in terms of their rotational properties, magnetic fields, atmospheres, surface histories, internal structure, chemical composition, volcanism, and tectonics.

EPSC 201 UNDERSTANDING PLANET EARTH. (3) (Fall or Winter) (3 lectures; afternoon field trips) Learn about Earth's origin, its place in the solar system, its internal structure, rocks and minerals, the formation of metal and fossil fuel deposits, and the extinction of dinosaurs. Discover the impact of the volcanic eruptions, earthquakes and mountain chains on Earth's past, present and future. Explore 125 million-year-old Mount Royal.

EPSC 203 STRUCTURAL GEOLOGY 1. (3) (Winter) (2 hours lectures, 3 hours laboratory) Primary igneous and sedimentary structures, attitudes of planes and lines, stress and strain, fracturing of rocks, faulting, homogeneous strain, description and classification of folds, foliation and lineation, orthographic and stereographic projections.

EPSC 205 ASTROBIOLOGY. (3) (Winter) (3 hours lectures) (Not open to students who have taken or are taking ANAT 205) Astrobiology is the search for the origin, evolution and destiny of life in the universe. The course will provide insight into the formation and evolution of habitable worlds, the evolution of life and the biogeochemical cycles in the Earth's oceans and atmosphere, and the potential for biological evolution beyond an organism's planet of origin.

EPSC 210 INTRODUCTORY MINERALOGY. (3) (Fall) (2 hours lecture, 3 hours laboratory) Crystal chemistry and identification of the principal rock-forming and ore minerals. Elementary crystallography. Optional 2-day field trip.

EPSC 212 INTRODUCTORY PETROLOGY. (4) (Winter) (3 hours lecture, 3 hours laboratory) (Prerequisite: EPSC 210) Survey course of igneous, sedimentary and metamorphic rocks and the processes leading to their formation. Emphasis in the laboratory on hand-specimen description and classification, supplemented by thin sections.

● **EPSC 215 ANALYSIS OF GEOLOGICAL DATA.** (3) (3 lectures, and problems) (Note: Credit for other statistics courses may preclude credit for this course and conversely. See "Course Overlap" under "Faculty Degree Requirements")

EPSC 220 PRINCIPLES OF GEOCHEMISTRY. (3) (Fall) (2 lectures, 3 hours laboratory) (Prerequisites: EPSC 201, EPSC 210) Basic concepts in geochemistry and the application of geochemical principles of chemistry to geological subdisciplines. Particular emphasis on origin of elements, controls on their distribution in Earth and cosmos, isotopes, organic geochemistry and water chemistry. Application of phase diagrams to geology.

EPSC 231 FIELD SCHOOL 1. (2) (Summer: Two-week field school in May) (Prerequisite: EPSC 203, EPSC 212, or equivalent) Geological mapping of selected areas, preparation of maps, reports from field notes, aerial photographs, etc.

EPSC 233 EARTH AND LIFE HISTORY. (3) (Fall) (3 lectures) Interpretation of stratified rocks; history of Earth with special emphasis on the regions of North America; outline of the history of life recorded in fossils.

EPSC 243 ENVIRONMENTAL GEOLOGY. (3) (Fall and Winter) (3 hours lectures) Introduction to the relationship of geological processes and materials to the human environment; geologic hazards; hydrogeology; impacts of waste disposal, energy use, land resource development.

EPSC 250 NATURAL DISASTERS. (3) (Fall) (3 lectures) (Restriction: Not open to students who have taken or are taking ATOC 250) This course examines the science behind different types of disasters and our ability or inability to control and predict such events. From this course the student will gain an appreciation of natural disasters beyond the newspaper headlines, and will better understand how the effects of disasters can be reduced.

EPSC 312 SPECTROSCOPY OF MINERALS. (3) (Winter) (6 hours laboratory and relevant in-lab lectures) (Prerequisite: EPSC 210) Interaction of minerals with electromagnetic radiation. Optical mineralogy on thin and polished sections. Demonstrations of other spectroscopic techniques applied to the identification of minerals and to the analysis of their composition and structure.

EPSC 320 ELEMENTARY EARTH PHYSICS. (3) (Fall) (3 hours lectures) (Prerequisite: MATH 222) Physical properties of Earth and the processes associated with its existence as inferred from

astronomy, geodesy, seismology, geology, terrestrial magnetism and thermal evolution.

EPSC 330 EARTHQUAKES AND EARTH STRUCTURE. (3) (Winter) (3 hours lectures, tutorial as required) (Prerequisites: MATH 314, EPSC 320. Corequisites: MATH 319) Seismic wave theory; body waves, surface waves and free oscillations; seismicity and earthquakes; seismology and Earth's internal structure.

EPSC 331 FIELD SCHOOL 2. (3) (Summer) (Two-week field school in May) Geological field study of igneous, sedimentary and metamorphic terranes of the Appalachian origin, including preparation of stratigraphic sections, and edited field notes.

EPSC 334 INVERTEBRATE PALEONTOLOGY. (3) (Winter) (2 lectures and one laboratory period) Preservation of fossils; the fossil record of invertebrates; use of fossils in stratigraphy and paleoecology; fossils in evolutionary studies. Fossils of invertebrates are studied in the laboratory.

● **EPSC 341 FIELD SCHOOL 3.** (3) (Summer) (Prerequisites: EPSC 210, EPSC 203, EPSC 212 and EPSC 231 or permission of the instructor)

EPSC 350 TECTONICS. (3) (Winter) (Prerequisites: EPSC 320, Calculus 3 or equivalent) Rheology of the Earth, mechanics of the crust and mantle and core, convection in the mantle, evolution and kinematics and deformations of the oceanic and continental plates, thermal evolution of the Earth, the unifying theory of plate tectonics.

● **EPSC 401 ADVANCED ENVIRONMENTAL GEOLOGY.** (3) (Winter) (1 lecture, 2 seminar) (Prerequisite: EPSC 220 or CHEM 204 or equivalent. Corequisite: EPSC 580)

● **EPSC 405 PLANETARY GEOLOGY.** (3) (Summer) (3 lecture) (Prerequisites: EPSC 210, EPSC 203, EPSC 212 or permission of the instructor)

● **EPSC 423 IGNEOUS PETROLOGY.** (3) (Winter) (2 hours lectures, 3 hours laboratory) (Prerequisites: EPSC 212, EPSC 312)

EPSC 425 SEDIMENTS TO SEQUENCES. (3) (Winter) (2 lecture, 3 laboratory) (Prerequisites: EPSC 210, EPSC 212) Processes and products of modern and ancient carbonate and siliciclastic depositional environments. Sequence stratigraphy as a tool for studying the fundamental controls (sea level, tectonics, sediment supply, etc.) on stratigraphic architecture.

● **EPSC 435 GEOPHYSICAL APPLICATIONS.** (3) (Fall) (3 hours lecture) (Prerequisites: Calculus 3, Linear Algebra and EPSC 320 or equivalents)

EPSC 445 METAMORPHIC PETROLOGY. (3) (Winter) (Prerequisites: EPSC 212, EPSC 303, EPSC 312) The origin, classification and petrological significance of metamorphic rocks, from the point of view of theory, experiment and field observations.

● **EPSC 451 HYDROTHERMAL MINERAL DEPOSITS.** (3) (Winter) (Prerequisite: EPSC 220)

EPSC 452 MINERAL DEPOSITS 2. (3) (Fall) (Prerequisite: EPSC 312, EPSC 220) A systematic review of the nature and origin of the major types of metallic and non-metallic mineral deposits; typical occurrences; geographic distribution; applications to exploration. Emphasis on magmatic ores, massive sulfides, iron formations.

EPSC 455 SEDIMENTARY GEOLOGY. (3) (Fall) (Prerequisites: EPSC 210, EPSC 212) This course discusses the origin, diagenesis, classification and economic importance of sedimentary rocks. Students will learn about the physical properties of sedimentary rocks, including porosity and permeability, different techniques for analyzing those rocks (thin sections, hand specimens, wireline logs) and the types of sedimentary basins within which sediments accumulate.

EPSC 480D1 HONOURS RESEARCH PROJECT. (3) (Fall) (For Honours students in 3rd year) (Students must also register for EPSC 480D2) (No credit will be given for this course unless both EPSC 480D1 and EPSC 480D2 are successfully completed in consecutive terms) A written proposal outlining the studies to be undertaken must be submitted to the undergraduate Student Adviser by May 1st of the U-2 year. The proposal will be reviewed by a committee and a decision forwarded by mail. If approved the investigation will be supervised by a staff member, and the results must be presented in the form of an undergraduate thesis.

EPSC 480D2 HONOURS RESEARCH PROJECT. (3) (Winter) (Prerequisite: EPSC 480D1) (No credit will be given for this course unless both EPSC 480D1 and EPSC 480D2 are successfully completed in consecutive terms) See EPSC 480D1 for course description.

EPSC 482 INDEPENDENT STUDIES 1. (3) (Fall or Winter) (May not be taken concurrently with EPSC 480) Research and/or reading project in Earth and Planetary Sciences, designed by the student in consultation with a Faculty supervisor. A statement of the proposed project and the method of evaluation must be approved by the Director of Undergraduate studies before October 15. This statement will be included in the student's file.

EPSC 482D1 INDEPENDENT STUDIES 1. (1.5) (Fall) (Students must also register for EPSC 482D2) (No credit will be given for this course unless both EPSC 482D1 and EPSC 482D2 are successfully completed in consecutive terms) (EPSC 482D1 and EPSC 482D2 together are equivalent to EPSC 482) See EPSC 482 for course description.

EPSC 482D2 INDEPENDENT STUDIES 1. (1.5) (Winter) (Prerequisite: EPSC 482D1) (No credit will be given for this course unless both EPSC 482D1 and EPSC 482D2 are successfully completed in consecutive terms) (EPSC 482D1 and EPSC 482D2 together are equivalent to EPSC 482) See EPSC 482 for course description.

● **EPSC 483D1 INDEPENDENT STUDIES 2.** (1.5) (Fall) (To be taken concurrently with 182-500)

● **EPSC 483D2 INDEPENDENT STUDIES 2.** (1.5) (Winter)

EPSC 501 CRYSTAL CHEMISTRY. (3) (Winter) (2 hours lectures, 1 hour seminar) (Prerequisite: CHEM 203 or CHEM 213) Discussion of crystal structures and compositions of important mineral groups, especially oxides, sulphides and silicates. Solid solution. Relation of structure to morphology and to chemical and physical properties of the rock-forming minerals.

EPSC 510 GEODYNAMICS AND GEOMAGNETISM. (3) (Fall) (3 lecture) (Prerequisites: EPSC 320, MATH 319 or permission of the instructor. Corequisite: EPSC 350) The gravity field of the Earth and planets, body and orbital dynamics the Earth, moon and planets, tidal interactions of the Earth-moon-sun system, deformation of the Earth under static and dynamic loads, the magnetic field of the Earth and planets: the magnetosphere, the external radiation belts, magnetohydrodynamic models of the core dynamo, geochemical convection in the core, fluid dynamic motions of the outer core, dynamics of the inner core.

● **EPSC 519 ISOTOPE GEOLOGY.** (3) (Fall) (3 lectures) (Prerequisites: U2 core program)

EPSC 525 SUBSURFACE MAPPING. (3) (Winter) (Prerequisites: EPSC 455 or permission of instructor) This course will provide participants the opportunity to learn how different types of data (wireline logs, seismic, etc.) are employed to map geological features in the subsurface. Lectures will teach participants about the physical basis of each of the data types, and the basic mapping and analytical techniques (e.g., geostatistics, gridding) that are employed in subsurface mapping. The principal focus will be on applying these techniques and concepts to real-world data sets.

EPSC 530 VOLCANOLOGY. (3) (Fall) (2 hours lecture, 3 hours laboratory) (Prerequisites: EPSC 212 and EPSC 312, or permission of instructor) The physical mechanisms which drive volcanoes and volcanic activity are presented. Descriptive, practical and theorretical approaches to the study of volcanoes are discussed.

EPSC 542 CHEMICAL OCEANOGRAPHY. (3) (Fall) (Prerequisites: CHEM 213, CHEM 257 or equivalents, or registration in Graduate Program in Oceanography) History of chemical oceanography. Seawater composition and definition of salinity/chlorinity. Minor and trace-element distribution in the ocean. Geochemical mass balance. Dissolved gases in sea water. CO2 and the carbonate system. Chemical speciation. Physical chemistry of seawater.

Organic matter and the carbon cycle in the marine environment. Sediment geochemistry.

EPSC 545 LOW-TEMPERATURE GEOCHEMISTRY. (3) (Winter) (Prerequisites: CHEM 203, CHEM 213, EPSC 212, EPSC 312) Chemical evolution of the atmosphere and oceans. Detailed characterization of the major reactions and processes governing the weathering of rocks and the diagenesis of various types of sediments and sedimentary rocks. Basic concepts of chemical equilibria, reaction kinetics and transport applied to the interpretation of the diagenetic evolution of pore waters and sediments. Nature of the driving forces and an introduction to modeling of diagenesis. Relationship between organic matter and mineral diagenesis. Geochemical cycles.

● **EPSC 546 DIAGENESIS.** (3) (Fall) (2 lecture, 3 laboratory/seminars) (Prerequisites: EPSC 212, EPSC 220, EPSC 312)

EPSC 547 HIGH-TEMPERATURE GEOCHEMISTRY. (3) (Fall) (2 hours lectures, 3 hours laboratory) (Prerequisites: CHEM 203, CHEM 204 or CHEM 213, or permission of instructor) The application of thermodynamic principles to igneous and metamorphic petrology and economic geology. Topics include but are not restricted to: solid solutions in minerals, behaviour of geological fluids, phase equilibria, flow processes, estimation of thermodynamic data.

● **EPSC 548 PROCESSES OF IGNEOUS PETROLOGY.** (3) (Fall) (2 hours lecture, 1 hour seminar) (Prerequisite: EPSC 423)

● **EPSC 549 HYDROGEOLOGY.** (3) (Winter) (3 hours lecture, 1-2 hours laboratory) (Prerequisite: permission of the instructor)

EPSC 550 SELECTED TOPICS 1. (3) (Fall or Winter) (2 hours seminar, permission of department undergraduate advisor) Research seminar and/or lecture with readings in topics concerning aspects of current interests in Earth & Planetary Sciences.

EPSC 551 SELECTED TOPICS 2. (3) (Fall or Winter) (2 hours seminar, permission of department undergraduate advisor) Research seminar and/or lecture with readings in topics concerning aspects of current interest in Earth & Planetary Sciences.

EPSC 552 SELECTED TOPICS 3. (3) (Fall or Winter) (2 hours seminar, permission of department undergraduate advisor) Research seminar and/or lecture with readings in topics concerning aspects of current interest in Earth & Planetary Sciences.

● **EPSC 570 COSMOCHEMISTRY.** (3) (Fall) (3 hours lecture) (Prerequisites: EPSC 220, EPSC 210 or permission of instructor)

● **EPSC 580 AQUEOUS GEOCHEMISTRY.** (3) (Winter) (3 hours lecture) (Prerequisites: EPSC 210, EPSC 212 or permission of instructor)

● **EPSC 590 APPLIED GEOCHEMISTRY SEMINAR.** (3) (Winter) (3 hours seminar) (Prerequisite: permission of instructor)

The following courses are offered by the Department of Earth and Planetary Sciences for Faculty of Engineering students:

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

EPSC 225 PROPERTIES OF MINERALS. (1) (Fall) (1 hour lecture, 1 hour laboratory) (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.

12.10 Environmental Studies

Science students who are interested in studying the environment should refer to the McGill School of Environment section, page 491, where they will find information concerning the Minor, the Major, and the Diploma in Environment.

12.11 Experimental Medicine (EXMD)

Email: experimental.medicine@mcgill.ca

Experimental Medicine is a division of the Department of Medicine. Information regarding these courses may be obtained by calling the telephone numbers indicated below.

EXMD 401 – (514) 934-1934, ext. 35738
EXMD 502 and EXMD 503 – (514) 934-1934, ext. 35243 or 35833
EXMD 504 – (514) 934-8038
EXMD 506 – (514) 934-1934, ext. 42908
EXMD 507 and EXMD 508 – (514) 398-3864, ext. 3249
EXMD 509 – (514) 934-8308
EXMD 510 – (514) 934-1934, ext. 43022
EXMD 511 – (514) 398-3466
EXMD 512 – (514) 987-5550

COURSES

Please note: courses may have been rescheduled or new courses added after this Calendar went to press. Students preparing to register are advised to consult the 2002-2003 Class Schedule on the Web, http://www.mcgill.ca/minerva-students for the most up-to-date information.

The Class Schedule includes the term(s), days, and times when courses will be offered, as well as class locations and names of instructors.

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

The course credit weight is given in parentheses after the title. Term(s) offered (Fall, Winter, Summer) may appear after the credit weight to indicate when a course would normally be taught. Please check the Class Schedule to confirm this information.

EXMD has replaced 516 as the prefix for Experimental Medicine courses.

All courses have limited enrolment.

● Denotes courses not offered in 2002-03.

EXMD 401 PHYSIOLOGY AND BIOCHEMISTRY ENDOCRINE SYSTEMS. (3) (Winter) (Prerequisite: BIOL 200 and BIOL 201) Offered in conjunction with the Department of Physiology. The course provides a basic knowledge of endocrine systems encompassing biosynthesis, metabolism and physiological actions of hormones. Specific topics covered are hormones of the hypothalamus, pituitary, adrenals, thyroids, parathyroids, pancreas, gut and the gonads. The role of hormones and growth factors in pregnancy and fetal development are also discussed.

EXMD 502 ADVANCED ENDOCRINOLOGY. (3) (Fall) (Prerequisite: EXMD 301 or an equivalent course) This course is designed for U3 students who are in a major or honours program in anatomy, biology, biochemistry or physiology and for graduate students. A multidisciplinary approach will be used to teach biosynthesis and processing of hormones, their regulation, function and mechanism of action. The material will cover hypothalamic, pituitary, thyroid, atrial and adrenal hormones as well as prostaglandins and related substances.

EXMD 503 ADVANCED ENDOCRINOLOGY. (3) (Winter) Study of the parathyroids, gut and pancreatic hormones and growth factors. In addition, the role of hormones and growth factors in reproduction and fetal maturation will be discussed.

EXMD 504 BIOLOGY OF CANCER. (3) (Fall) (Prerequisite: A good knowledge of biology at the cellular and molecular level. Open to U3 and graduate students only) An introduction to the biology of malignancy. A multidisciplinary approach dealing with the etiology of cancer, the biological properties of malignant cells, the host

response to tumour cell growth and the principles of cancer therapy.

EXMD 506 ADVANCED APPLIED CARDIOVASCULAR PHYSIOLOGY. (3) (Winter) (Prerequisite: PHGY 313 or by permission of Instructors) Offered in conjunction with the Department of Physiology. Current topics, methods and techniques for studying the cardiovascular system. Basic and applied cardiac electrophysiology, mechanisms of pacemaker activity, arrhythmias, the effects of drugs on cardiac functions, fetal circulation, coronary circulation, mechanics of blood flow, cardiovascular diseases, renal and neural control of the circulation, and cardiac assist devices.

EXMD 507 ADVANCED APPLIED RESPIRATORY PHYSIOLOGY. (3) (Fall) (Prerequisite: PHGY 313) Offered in conjunction with the Department of Physiology. In depth coverage of respiratory biology including: functional anatomy of the respiratory system, pulmonary statics and dynamics, chest wall and respiratory muscles, ventilation and perfusion, control of breathing, and defense mechanisms. This course is aimed at providing a solid grounding in pulmonary biology and its research applications.

EXMD 508 ADVANCED TOPICS IN RESPIRATION. (3) (Winter) (Prerequisite: EXMD 507) Offered in conjunction with the Department of Physiology. In depth coverage of developmental physiology, pulmonary vascular physiology, biology of airway smooth muscle, respiratory epithelium and molecular biology of respiratory muscles. Dyspnea, mechanical ventilation and respiratory failure will also be covered. This course emphasizes application of respiratory biology to basic and applied research and touches on pulmonary pathophysiology.

EXMD 509 GASTROINTESTINAL PHYSIOLOGY AND PATHOLOGY. (3) (Fall and Winter) (Prerequisite: Graduate students, U3 undergraduates) Course deals with various aspects of gastrointestinal and hepatic function in health and altered physiological states. The principal focus is on the recent literature pertaining to cell and molecular mechanisms underlying the motility secretory process, absorption and secretion. The molecular biology of the hepatic viruses and various aspects of colonic neoplasia will also be considered.

EXMD 510 BIOANALYTICAL SEPARATION METHODS. (3) (Fall) The student will be taught the capabilities and limitations of modern separation methods (gas and high-performance liquid chromatography, capillary electrophoresis, hyphenated techniques). Application of these techniques to solve analytical problems relevant to biomedical research will be emphasized, with special attention being paid to the processing of biological samples.

EXMD 511 JOINT VENTURING WITH INDUSTRY. (3) (Winter) (Offered in conjunction with the Centre for Continuing Education) Using problem-based learning, the course examines the various business interactions between researchers and their business partners in support and development of research into commercial endeavours using models such as venture capital, business partnerships, or grants-in-aid.

- **EXMD 512D1 RECENT PROGRESS IN AIDS RESEARCH.** (3)
- **EXMD 512D2 RECENT PROGRESS IN AIDS RESEARCH.** (3)

12.12 Geography (GEOG)

Burnside Hall, Room 705
805 Sherbrooke Street West
Montreal, QC H3A 2K6

Telephone: (514) 398-4111
Fax: (514) 398-7437
Website: http://www.geog.mcgill.ca

Chair — T.R. Moore

Emeritus Professor
B.J. Garnier; M.A.(Cantab.)

Professors
P.G. Brown; B.A.(Haverford), M.A., Ph.D.(Col.) *(joint appt. with McGill School of Environment and Natural Resource Sciences)*
T.R. Moore; B.Sc.(Swansea), Ph.D.(Aberd.)
N.T. Roulet; B.Sc., M.Sc.(Trent), Ph.D.(McM.)

Associate Professors
G.L. Chmura; B.Sc.(Mass.), M.Sc.(R.I.), Ph.D.(L.S.U.)
O.T. Coomes; B.Sc.(U.Vic.), M.A.(Tor.), Ph.D.(Wis.)
G.O. Ewing; M.A.(Glas.), M.A., Ph.D.(McM.)
M.F. Lapointe; B.Sc., M.Sc.(McG.), Ph.D.(Br.Col.)
J.E. Lewis; M.A.(Ind.), Ph.D.(Ill.)
T.C. Meredith; B.E.S.(Wat.), M.Sc., Dip.Cons.(Lond.), Ph.D.(Camb.)
L. Müller-Wille; Dr.phil.(Münster)
W.H. Pollard,; B.A., M.Sc.(Guelph), Ph.D.(Ott.)
G.W. Wenzel; M.A.(Manit.), Ph.D.(McG.)

Assistant Professors
W.M. Brown; B.A.(St.M.), M.A., Ph.D.(McM.)
C.A. Kull; B.A.(Dart.), M.A.(Colo.), M.Sc.(Yale), Ph.D.(Berkeley)
N.A. Ross; B.A., M.A.(Queen's), Ph.D.(McM.)
R.E. Sieber; B.Sc.(Mich. St.), M.P.A.(W. Mich.), Ph.D.(Rutgers) *(joint appt. with McGill School of Environment)*
I.B. Strachan; B.Sc.(Tor.), M.Sc., Ph.D.(Queen's) *(joint appt. with Natural Resource Sciences)*

The Department of Geography offers programs in both Arts and Science. To avoid duplication, course descriptions that are of special interest to Arts students appear in the Geography entry in the Faculty of Arts section. Many Science students choose to take some of these courses. All B.A. programs in Geography (including Urban Systems) are listed in the Faculty of Arts entry, beginning on page 99**.**

Geography is the study of physical environments and human habitats. It deals with people and places. It covers issues such as global warming and climate change, regional economic disparities, urban transportation, native land claims and permafrost problems. Both a physical and a social science, it provides a unique opportunity to obtain a broad exposure to modes of analysing the many environmental and locational problems of contemporary society.

The World Commission on Environment and Development has identified the evidence and possible consequences of currently widespread land use practices which cannot be sustained. Geography is an integrative discipline concerned with the relations between culture systems and resource bases. Students interested in understanding, or working towards the resolution of, the environmental "crisis" should select courses which deal with (1) the dynamics of natural systems (courses in the physical geography of terrestrial, atmospheric and hydrological systems); (2) the dynamics of human systems (courses in cultural, social, economic, political and urban geography); (3) the context of development and land use changes; and (4) practical skills such as Geographical Information Systems, cartography, remote sensing, image analysis and resource management.

Students may pursue programs focusing on urban systems, the geography of economic development, people and their natural environment, the geography of living systems. The interdisciplinary Minor in Environment is also available to students in Arts or Science. Students planning to enter a program in Geography should telephone (514) 398-4111 for an appointment with an adviser and should consult the *Department of Geography Undergraduate Handbook,* which is available from the departmental office.

Graduates find employment in a wide range of industrial and commercial activities, as well as in government and education. Others pursue graduate work in geography or urban planning.

PREREQUISITES

There are no departmental prerequisites for entrance to the B.Sc. Geography programs. Students who have completed college or pre-university geography courses fully equivalent to those in the first year of university may, with an adviser's approval, substitute other courses as part of their program.

MINOR PROGRAM IN GEOGRAPHY (expandable into the B.Sc. Major in Geography) (18 credits)

The Minor in Geography is designed to provide students in the Faculty of Science with an overview of basic elements of geography at the introductory and advanced level.

This Minor permits no overlap with any other programs.

Required Courses (12 credits)
GEOG 203 (3) Environmental Systems
GEOG 216 (3) Geography of the World Economy
GEOG 217 (3) Introduction to Urban Geography
GEOG 302 (3) Environmental Management 1

Complementary Courses (6 credits)
6 credits of Geography courses at the 300 and 400 level.

B.Sc. MINOR IN GEOGRAPHICAL INFORMATION SYSTEMS (18 credits)

The Minor in GIS is designed to provide students in the Faculty of Science who have an interest in GIS with a basic, but comprehensive, knowledge of concepts and methods relating to the analysis of geospatial data.

Required Courses (15 credits)
GEOG 201 (3) Introductory Geo-Information Science
GEOG 306 (3) Raster Geo-Information Science
GEOG 307 (3) Socioeconomic Applications of GIS
GEOG 308 (3) Principles of Remote Sensing
GEOG 506 (3) Perspectives on Geographic Information Analysis

Complementary Course (3 credits)
one course to be chosen from:
GEOG 535 (3) Remote Sensing and Interpretation
GEOG 551 (3) Environmental Decisions
URBP 505 (3) GIS in Planning
ATOC 414 (3) Applications of Remote Sensing
COMP 420 (3) Files and Databases
COMP 557* (3) Fundamentals of Computer Graphics
*Note prerequisites

B.Sc. MAJOR PROGRAM IN GEOGRAPHY (58 credits)

The Major is designed to provide a coverage of the main elements of physical geography.

Required Courses (22 credits)
GEOG 201 (3) Introductory Geo-Information Science
GEOG 203 (3) Environmental Systems
GEOG 216 (3) Geography of the World Economy
GEOG 217 (3) Introduction to Urban Geography
GEOG 272 (3) Earth's Changing Surface
GEOG 302 (3) Environmental Management 1
GEOG 351 (3) Quantitative Methods
GEOG 290 (1) Local Geographical Excursion (In 2002 reserve Sept. 27-29)

Complementary Courses (36 credits)
3 credits of statistics chosen from:
SOCI 350 (3) Statistics in Social Research
BIOL 373 (3) Biostatistical Analysis
MATH 203 (3) Principles of Statistics
PSYC 204 (3) Introduction to Psychological Statistics
3 credits of statistics, one of:
SOCI 350 (3) Statistics in Social Research
BIOL 373 (3) Biostatistical Analysis
MATH 203 (3) Principles of Statistics
PSYC 204 (3) Introduction to Psychological Statistics
3 credits from GIS techniques:
GEOG 306 (3) Raster Geo-Information Science
GEOG 308 (3) Principles of Remote Sensing
12 credits from systematic physical geography:
GEOG 305 (3) Geography of Soils
GEOG 321 (3) Climatic Environments
GEOG 322 (3) Environmental Hydrology
GEOG 350 (3) Ecological Biogeography
GEOG 372 (3) Running Water Environments
3 credits from field courses:
GEOG 495 (3) Field Studies - Physical Geography
GEOG 496 (3) Geographical Excursion
GEOG 497 (3) Ecology of Coastal Waters
GEOG 499 (3) Subarctic Field Studies: Schefferville
(Field course availability is determined each year in February.)
15 credits from **approved** courses in Geography, or elsewhere in the Faculty of Science, or in the Faculty of Engineering; at least 9 credits of which are to be taken outside Geography. Students may also include any courses that are not already counted towards the GIS techniques or the systematic physical geography requirements. Admission to 500-level courses in Geography requires the instructor's permission. It is not advisable to take more than one 500-level course in a semester.

Geography Approved Course List – Majors and Honours
GEOG 404 (3) Environmental Management 2
GEOG 501 (3) Modelling Environmental Systems
GEOG 505 (3) Global Biogeochemistry
GEOG 506 (3) Perspectives on Geographic Information Analysis
GEOG 522 (3) Advanced Environmental Hydrology
GEOG 523 (3) Advanced Climatology
GEOG 535 (3) Remote Sensing and Interpretation
GEOG 536 (3) Geocryology
GEOG 537 (3) Advanced Fluvial Geomorphology
GEOG 550 (3) Quaternary Paleoecology

B.Sc. HONOURS PROGRAM IN GEOGRAPHY (66 credits)

The Honours program is designed to provide specialized systematic training in physical geography. The student must maintain marks of B or higher and must complete a 6-credit research paper. Honours students are encouraged to participate in 500-level seminars with graduate students, but it is not advisable to take more than one in a semester.

Required Courses (24 credits)
GEOG 201 (3) Introductory Geo-Information Science
GEOG 203 (3) Environmental Systems
GEOG 272 (3) Earth's Changing Surface
GEOG 302 (3) Environmental Management 1
GEOG 351 (3) Quantitative Methods
GEOG 381 (3) Geographic Thought and Practice
GEOG 491D1 (3) Honours Research and Reading
GEOG 491D2 (3) Honours Research and Reading

Complementary Courses (42 credits)
6 credits of introductory courses, two of:
GEOG 210 (3) Global Places and Peoples
GEOG 216 (3) Geography of the World Economy
GEOG 217 (3) Introduction to Urban Geography
3 credits of statistics*, one of:
SOCI 350 (3) Statistics in Social Research
BIOL 373 (3) Biostatistical Analysis
MATH 203 (3) Principles of Statistics
PSYC 204 (3) Introduction to Psychological Statistics
* Credit given for statistics courses is subject to certain restrictions, see Faculty Degree Requirements, section 3.6.1 "Course Overlap"
3 credits from GIS techniques:
GEOG 306 (3) Raster Geo-Information Science
GEOG 308 (3) Principles of Remote Sensing
12 credits from systematic physical geography:
GEOG 305 (3) Geography of Soils
GEOG 321 (3) Climatic Environments
GEOG 322 (3) Environmental Hydrology
GEOG 350 (3) Ecological Biogeography
GEOG 372 (3) Running Water Environments

3 credits from field courses:
GEOG 495 (3) Field Studies - Physical Geography
GEOG 496 (3) Geographical Excursion
GEOG 497 (3) Ecology of Coastal Waters
GEOG 499 (3) Subarctic Field Studies: Schefferville
15 credits from **approved** courses - in Geography, or elsewhere in the Faculty of Science or the Faculty of Engineering; at least 9 credits of which are to be taken outside Geography. Students may also include any courses that are not already counted towards the GIS techniques or the systematic physical geography requirements. Admission to 500-level courses in Geography requires the instructor's permission. It is not advisable to take more than one in a semester.

ENVIRONMENTAL STUDIES COURSES

See the McGill School of Environment section for other courses that may be relevant to Geography programs.

COURSE DESCRIPTIONS

To avoid duplication, course descriptions that are of special interest to Arts students appear in the Geography entry in the Arts section 12.20. Many Science students choose to take some of these courses.

Please note: courses may have been rescheduled or new courses added after this Calendar went to press. Students preparing to register are advised to consult the 2002-2003 Class Schedule on the Web, http://www.mcgill.ca/minerva-students for the most up-to-date information.

The Class Schedule includes the term(s), days, and times when courses will be offered, as well as class locations and names of instructors.

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

The course credit weight is given in parentheses after the title. Term(s) offered (Fall, Winter, Summer) may appear after the credit weight to indicate when a course would normally be taught. Please check the Class Schedule to confirm this information.

GEOG has replaced 183 as the prefix for Geography courses.

All courses have limited enrolment.

● Denotes courses not offered in 2002-03.

GEOG 199 FYS: GEO-ENVIRONMENTS. (3) (Fall) (Open only to newly admitted students in U0 or U1, who may take only one FYS. Students who register for more than one will be obliged to withdraw from all but one of them.) (Maximum 25. Closed to Geography Majors) Geography studies the complex but crucial relationships between people and their physical and socio-cultural environments. The course is constructed around field trips and preparatory seminars which provide an opportunity for students to learn about a variety of physical environments and their utilisation.

GEOG 200 GEOGRAPHICAL PERSPECTIVES: WORLD ENVIRONMENTAL PROBLEMS. (3) (Fall) (3 hours)

GEOG 201 INTRODUCTORY GEO-INFORMATION SCIENCE. (3) (Fall) (3 hours and lab) An introduction to Geographic Information Systems. The systematic management of spatial data. The use and construction of maps. The use of microcomputers and software for mapping and statistical work. Air photo and topographic map analyses.

GEOG 203 ENVIRONMENTAL SYSTEMS. (3) (Fall) (3 hours) (Not open to B.A. students in Freshman year) An introduction to system-level interactions among climate, hydrology, soils and vegetation at the scale of drainage basins, including the study of the global geographical variability in these land-surface systems. The knowledge acquired is used to study the impact on the environment of various human activities such as deforestation and urbanisation.

GEOG 205 GLOBAL CHANGE: PAST, PRESENT AND FUTURE. (3) (Winter) (3 hours) An examination of global change, from the Quaternary Period to the present day involving changes in the physical geography of specific areas. Issues such as climatic change and land degradation will be discussed, with speculations on future environments.

GEOG 210 GLOBAL PLACES AND PEOPLES. (3) (Winter) (3hours)

GEOG 216 GEOGRAPHY OF THE WORLD ECONOMY. (3) (Fall) (3 hours).

GEOG 217 INTRODUCTION TO URBAN GEOGRAPHY. (3) (Winter) (3 hours)

GEOG 272 EARTH'S CHANGING SURFACE. (3) (Winter) (3 hours) Introduction to the study of landforms as products of geomorphic and geologic systems acting at and near the Earth's surface. The process geomorphology approach will be used to demonstrate how landforms of different geomorphic settings represent a dynamic balance between forces acting in the environment and the physical properties of materials present.

GEOG 290 LOCAL GEOGRAPHICAL EXCURSION. (1) (Fall) (1 credit) (Open to first-year Geography Major and Honours students only. Not open to students who have taken GEOG 199) Introduction to landscape interpretation and geographical site analysis in physical and human geography. A three-day fall excursion with preparatory and concluding seminars. September 27-29, 2002.

GEOG 300 HUMAN ECOLOGY IN GEOGRAPHY. (3) (Winter) (3 hours) (Prerequisite: GEOG 203 or ANTH 202 or BIOL 111)

GEOG 301 GEOGRAPHY OF NUNAVUT. (3) (Fall) (3 hours)

GEOG 302 ENVIRONMENTAL MANAGEMENT 1. (3) (Fall) (3 hours) (Prerequisite: Any 200-level course in Geography or MSE or BIOL 208 or permission of instructor.) An ecological analysis of the physical and biotic components of natural resource systems. Emphasis on scientific, technological and institutional aspects of environmental management. Study of the use of biological resources and of the impact of individual processes.

GEOG 305 GEOGRAPHY OF SOILS. (3) (Fall) (2 hours and laboratory) (Prerequisite: GEOG 203 or introductory course in biology or geology) Discussion of the major properties of soils; soil formation, classification and mapping; land capability assessment; the role and response of soils in natural and disturbed environments (e.g. global change, ecosystem disturbance).

GEOG 306 RASTER GEO-INFORMATION SCIENCE. (3) (Fall or Winter) (2 hours and laboratory) (Prerequisite: GEOG 201) Formal introduction to a computer-based Geographical Information System (GIS). Topics will focus on map analysis and on transforming and displaying spatial data. GIS will be used by students to solve problems in both physical and human geography.

GEOG 307 SOCIOECONOMIC APPLICATIONS OF GIS. (3) (Fall or Winter) (2 hours and laboratory) (Prerequisites: GEOG 201, MATH 203 or equivalent)

GEOG 308 PRINCIPLES OF REMOTE SENSING. (3) (Winter) (3 hours and laboratory periods) (Restriction: Not open to students who have taken or are taking ATOC 308) A conceptual view of remote sensing and the underlying physical principles are presented. Ground-based and satellite systems and the various components of the acoustic and electromagnetic spectrum - from visible to microwave - are discussed. Substantial emphasis is devoted to the application of remote sensed data in geography and atmospheric sciences.

GEOG 309 GEOGRAPHY OF CANADA. (3) (Fall) (3 hours) (Cross-listed with CANS 300)

GEOG 311 CANADA – A GEO-ECONOMIC PERSPECTIVE. (3) (Winter) (3 hours) (Prerequisite GEOG 216 or permission of the instructor)

GEOG 315 URBAN TRANSPORTATION GEOGRAPHY. (3) (Fall) (3 hours) (Prerequisite GEOG 217 or permission of instructor)

● **GEOG 316 POLITICAL GEOGRAPHY.** (3) (3 hours)

GEOG 321 CLIMATIC ENVIRONMENTS. (3) (Winter) (3 hours) (Prerequisite: GEOG 203 or ATOC 210 or permission of the instructor) Scope of climatology, physical, dynamic and applied. The Earth/atmosphere system, radiation and energy balances, governing meteorological processes. Movement and circulation of the

atmosphere on a local and global scale. Resulting weather systems.

GEOG 322 ENVIRONMENTAL HYDROLOGY. (3) (Winter) (3 hours) (Prerequisite: GEOG 203 or equivalent) Quantitative, experimental study of the principles governing the movement of water at or near the Earth's surface and how the research relates to the chemistry and biology of ecosystems.

GEOG 331 URBAN SOCIAL GEOGRAPHY. (3) (Fall) (3 hours) (Prerequisite: GEOG 216 or GEOG 217 or permission of instructor)

GEOG 350 ECOLOGICAL BIOGEOGRAPHY. (3) (Fall) (3 hours) (Prerequisite: GEOG 302 or ENVR 205) The study of the patterns of distribution of organisms in space and time with emphasis on plant communities. Ecological, geographical, historical and anthropological factors affecting these distribution patterns will be discussed. Particular consideration is given to methods for description and classification of plant communities.

GEOG 351 QUANTITATIVE METHODS. (3) (Fall) (3 hours) (Prerequisite: GEOG 203 or permission of instructor) (Credit for other statistics courses may preclude credit for this course conversely. See "Course Overlap" under "Course Requirements") 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.

● **GEOG 361 RURAL DEVELOPMENT - LATIN AMERICA.** (3)

● **GEOG 370 PROTECTED AREAS.** (3) (3 hours) (Prerequisite: BIOL 208 or GEOG 203 or AEBI 205)

GEOG 372 RUNNING WATER ENVIRONMENTS. (3) (Fall) (3 hours) (Prerequisites: GEOG 203 and GEOG 272, or ENVR 200 and ENVR 202) The course focuses on the physical habitat conditions found in streams, rivers, estuaries and deltas. Based on the laws governing flow of water and sediment transport, it emphasizes differences among these environments, in terms of channel form, flow patterns, substrate composition and mode of evolution. Flooding, damming, channelisation, forestry impacts.

GEOG 381 GEOGRAPHIC THOUGHT AND PRACTICE. (3) (Fall) (3 hours)

GEOG 398 FIELD STUDIES IN HUMAN GEOGRAPHY. (3) (Summer) (3 hours) (Prerequisite: Any introductory human geography course; or by permission of the instructor)

GEOG 404 ENVIRONMENTAL MANAGEMENT 2. (3) (Winter) (3 hours) (Prerequisite: GEOG 302 or permission of instructor) Practical application of environmental planning, analysis and management techniques with reference to the needs and problems of developing areas. Special challenges posed by cultural differences and traditional resource systems are discussed. This course involves practical field work in a developing area (Kenya or Panama).

● **GEOG 407 ISSUES IN GEOGRAPHY.** (3) (3 hours)

GEOG 408 GEOGRAPHY OF DEVELOPMENT. (3) (Fall) (3 hours) (Prerequisite: GEOG 216 or permission of instructor)

GEOG 410 GEOGRAPHY OF UNDERDEVELOPMENT: CURRENT PROBLEMS. (3) (Winter) (3 hours) (Prerequisite: GEOG 216 or permission of instructor)

● **GEOG 416 GEOGRAPHY OF AFRICA - SOUTH OF SAHARA.** (3)

GEOG 424 EUROPE: PLACES AND PEOPLES. (3) (Winter) (6 hours) (Prerequisite: At least one 300-level course in geography, anthropology, history, political science, sociology or permission of instructor.)

GEOG 490 GEOGRAPHY: INDEPENDENT STUDIES. (3) (Fall and Winter and Summer) (Open to U3 Geography Major students only) (Please see regulations concerning "Project Courses" in the Faculty Degree Requirements section) Research or reading projects permitting independent study under the guidance of a staff member specializing in the field of interest. A project must be arranged with an instructor before registration.

GEOG 490D1 GEOGRAPHY: INDEPENDENT STUDIES. (1.5) (Fall)
GEOG 490D2 GEOGRAPHY: INDEPENDENT STUDIES. (1.5) (Winter)

GEOG 491D1 HONOURS RESEARCH. (3) (Fall) (Prerequisite: 183-381) (For U3 B.A. and B.Sc. Honours and Joint Honours Geography students) (Students must also register for GEOG 491D2) (No credit will be given for this course unless both GEOG 491D1 and GEOG 491D2 are successfully completed in consecutive terms) Supervised reading, research and preparation of an undergraduate thesis under the direction of a member of staff.

GEOG 491D2 HONOURS RESEARCH. (3) (Winter) (Prerequisite: GEOG 491D1) (No credit will be given for this course unless both GEOG 491D1 and GEOG 491D2 are successfully completed in consecutive terms) See GEOG 491D1 for course description.

GEOG 491N1 HONOURS RESEARCH. (3) (Winter)
GEOG 491N2 HONOURS RESEARCH. (3) (Fall)

GEOG 492D1 JOINT HONOURS RESEARCH. (1.5) (Fall) (Only for those U3 Joint Honours students in Geography who opt to enrol in a parallel course in another department) (Students must also register for GEOG 492D2) (No credit will be given for this course unless both GEOG 492D1 and GEOG 492D2 are successfully completed in consecutive terms) Supervised reading, research and preparation of an undergraduate thesis under the direction of a member of staff.

GEOG 492D2 JOINT HONOURS RESEARCH. (1.5) (Winter) (Prerequisite: GEOG 492D1) (No credit will be given for this course unless both GEOG 492D1 and GEOG 492D2 are successfully completed in consecutive terms) See GEOG 492D1 for course description.

GEOG 492N1 JOINT HONOURS RESEARCH. (1.5) (Winter)
GEOG 492N2 JOINT HONOURS RESEARCH. (1.5) (Fall)

● **GEOG 494 URBAN FIELD STUDIES.** (3) (Prerequisites: 200-level courses in GIS, statistics, and urban geography, and GEOG 331)

GEOG 495 FIELD STUDIES - PHYSICAL GEOGRAPHY. (3) (Summer) (2-week field school) (Prerequisites: 6 credits from the following list of Systematic Physical Geography courses: GEOG 305, GEOG 321, GEOG 322, GEOG 350, GEOG 372) Field research projects in physical geography. Held locally in Monteregian or Eastern Township regions. The course is organised around field projects designed to formulate and test scientific hypotheses in a physical geography discipline. May summer session. Preregistration in Department required by March 15.

● **GEOG 496 GEOGRAPHICAL EXCURSION.** (3) (Prerequisites: GEOG 290 and permission of instructor)

GEOG 497 ECOLOGY OF COASTAL WATERS. (3) (Fall) (Students must register for a full semester of studies in the Bay of Fundy Field Semester. Enrolment is limited to 26.) (Exclusion: BIOL 542/BIOL 442) (Prerequisite: (GEOG 203 or ENVR 200) and (GEOG 350 or BIOL 208 or AEBI 205)) Study of ecology of coastal habitats such as salt marshes, rocky coasts, mud-flats, and shallow water environment of Eastern Canada. Emphasis on processes and factors critical to sustaining resources harvested from coastal ecosystems.

● **GEOG 498 HUMANS IN TROPICAL ENVIRONMENTS.** (3) (6 hours lecture for 4 weeks, 3 hours seminar, 2 hours laboratory, 8 hours conference) (Restriction: Location in Panama. Student must register for a full semester of studies in Panama) (Prerequisites: HISP 218, MATH 203 or equivalents)

GEOG 499 SUBARCTIC FIELD STUDIES. (3) (Fall) (Prerequisite: GEOG 203 or GEOG 301) An introduction to the geography of the subarctic with emphasis on the application of field methods in physical and/or human geography. The course will be given in 2002 at the McGill Subarctic Research Station, Schefferville, during ten days in late August. Preregistration in Department required by March 15; registration by first week in July.

GEOG 500 GEOGRAPHY OF REGIONAL IDENTITY. (3) (Fall) (3 hours) (Restriction: Graduate students and final year undergraduates and/or those who have taken GEOG 408)

GEOG 501 MODELLING ENVIRONMENTAL SYSTEMS. (3) (Fall) (1.15 hours lecture, 0.58 hours seminar, 0.69 hours project, 0.58 hours laboratory) (Restriction: open only to U2 or U3 students who have completed six or more credits from courses at the 300 level of Atmospheric and Oceanic Sciences, Biology, Chemistry, Earth

and Planetary Sciences, Geography, Natural Resource Sciences, or a McGill School of Environment domain, or permission of the instructor) (Prerequisites: MATH 139 or MATH 140, MATH 141, and MATH 203, or equivalent) (Enrolment limited to 20 students by availability of workstations) Most problems in environmental science deal with weak relationships and poorly defined systems. Model development and simulation will be used in this course to help improve understanding of environmental systems. Simulation of environmental systems is examined, focusing on problem definition, model development and model validation.

GEOG 502 GEOGRAPHY OF NORTHERN DEVELOPMENT. (3) (Fall) (3 hours) (Prerequisite: GEOG 301 or GEOG 436, or permission of instructor) Analysis of the evolution of development policies and their spatial implications in circumpolar areas with an emphasis on the application of geographical concepts. Special attention is given to indigenous peoples and new immigrant populations in northern North America.

GEOG 504 INDUSTRIAL RESTRUCTURING - GEOGRAPHIC IMPLICATIONS. (3) (Winter) (Prerequisites: GEOG 311 or permission of instructor) The objective of this seminar course is to develop an understanding of the geographical consequences of a variety of new forms of economic and social organization that are emerging in the North American and Western European settings. Key themes: technological and managerial change, changing labour processes, industrial re-location.

GEOG 505 GLOBAL BIOGEOCHEMISTRY. (3) (Winter) (2 hours and research) (Prerequisite: GEOG 305 or GEOG 322 and permission of instructor) An examination of the storage, transfers and cycling of major elements and substances, with an emphasis on the global scale and the linkages between the atmosphere, hydrosphere, lithosphere and biosphere.

GEOG 506 PERSPECTIVES ON GEOGRAPHIC INFORMATION ANALYSIS. (3) (Winter) (2 hours and laboratory) (Prerequisite: GEOG 201 and GEOG 306 and permission of instructor) Examination of a range of applications in automated processing of spatial data. Discussion will focus on both theoretical and practical aspects of Geographic Information Systems. Topics such as resource data base structure, methods of spatial interpolation and data quality and errors are covered. The application of Geographic Information Systems such as GRASS and digital image processing routines are used to answer questions in geographical research. Individual student projects will be emphasized.

● **GEOG 508 RESOURCES, PEOPLE, AND POWER.** (3) (3 hours) (Prerequisite: GEOG 408 or GEOG 410 or permission of instructor) .

GEOG 510 HUMID TROPICAL ENVIRONMENTS. (3) (Winter) (3 hours) (Prerequisite: GEOG 203 or equivalent and written permission of the instructor)

GEOG 513 BEHAVIOURAL GEOGRAPHY. (3) (Winter) (3 hours) (Prerequisite: a course in introductory statistics) The development of behavioural approaches in geography. A survey of methods and findings in the area of environmental and spatial cognition, preference and choice behaviour. Models of disaggregate and aggregate travel demand.

● **GEOG 522 ADVANCED ENVIRONMENTAL HYDROLOGY.** (3) (2 hours and 1 tutorial) (Prerequisite: GEOG 322, or permission of instructor)

● **GEOG 523 ADVANCED CLIMATOLOGY.** (3) (Fall) (3 hours) (Prerequisite: a previous course in climatology or meteorology, and written permission of the instructor)

● **GEOG 535 REMOTE SENSING AND INTERPRETATION.** (3) (Fall or Winter) (3 hours) (Prerequisite: GEOG 308 and written permission of instructor)

GEOG 536 GEOCRYOLOGY. (3) (Fall) (3 hours) (Prerequisite: GEOG 272 and any 300-level geomorphology course approved by instructor) Study of the unique geomorphic aspects of periglacial and permafrost environments. The focus will be on processes in cold climates, the impact of human activity on permafrost landscapes and potential impacts of climatic change.

GEOG 537 ADVANCED FLUVIAL GEOMORPHOLOGY. (3) (Winter) (Prerequisites: permission of instructor) An examination of current advances in fluvial geomorphology: sediment entrainment and transport, alluviation and river channel evolution.

GEOG 550 QUATERNARY PALEOECOLOGY. (3) (Winter) (2 hours, laboratory and seminar) (Prerequisite: course in ecology or biogeography, or permission of instructor) Examination of landscape and ecosystem response to climatic change; addressing persistent problems in Pleistocene and Holocene paleoecology: episodes of temporary warming and cooling, locations of glacial refugia and sea level change. Principles and methods of Quaternary paleoecology and paleoclimatological reconstruction.

● **GEOG 551 ENVIRONMENTAL DECISIONS.** (3) (2 hours seminar, 1 hour tutorial) (Prerequisites: GEOG 302, GEOG 306 or equivalents)

12.13 Immunology Interdepartmental Honours Program

The Honours Program in Immunology is offered by three Departments: Biochemistry, Microbiology and Immunology, and Physiology. The program is a demanding one which will prepare the student for graduate work in immunology.

All admissions to the Honours program will be after completion of the U1 year, and a student must have obtained a U1 GPA of 3.20. Admission to U3 requires a GPA of 3.20 in U2. Students who do not maintain Honours standing must transfer their registration to a program in one of three participating Departments.

For graduation in the Honours program, the student must complete a minimum of 90 credits, and achieve a CGPA of not less than 3.20. In addition, the five Immunology courses (MIMM 314, BIOC 503, MIMM 414, PHGY 419D1/PHGY 419D2, PHGY 513) must be passed with a grade not less than B.

U1 students who are interested in the program are advised to register in either the Faculty or Major program in Biochemistry or Physiology, or the Major program in Microbiology and Immunology. U1 students should inform their advisers of their intent to enter the Honours Immunology Program in U2.

Students wishing to enter the program must apply in writing by April 1 to:

Dr. M. Baines, Department of Microbiology and Immunology, Room 404, Lyman Duff Medical Sciences Building, 3775 University Street, Montreal, QC, H3A 2B4.
Telephone (514) 398-4443 or (514) 398-3928;
mgbaines@microimm.mcgill.ca

or Dr. W.S. Lapp, Department of Physiology, Room 1137, McIntyre Medical Sciences Building, 3655 Promenade Sir-William-Osler, Montreal, QC, H3G 1Y6.
Telephone (514) 398-4328 or (514) 398-4327);
wlapp@physio.mcgill.ca

All candidates will be interviewed for admission if demand exceeds the number of available places. Enrolment is limited.

INTERDEPARTMENTAL HONOURS PROGRAM IN IMMUNOLOGY (77 credits)
[Program revisions are under consideration for September 2002. Go to http://www.mcgill.ca (Course Calendars) in July for details.]

U1 Required Courses (20 credits)

BIOL 200	(3)	Molecular Biology
BIOL 201	(3)	Cell Biology and Metabolism
or BIOC 212	(3)	Molecular Mechanisms of Cell Function
CHEM 212	(4)	Organic Chemistry 1
CHEM 222	(4)	Organic Chemistry 2
CHEM 203	(3)	Survey of Physical Chemistry
or CHEM 204	(3)	Physical Chem./Biol. Sci. 1
PHGY 209	(3)	Mammalian Physiology 1

U1, U2 or U3 Required Course (3 credits)
BIOL 373 (3) Biostatistical Analysis
or MATH 203 (3) Principles of Statistics 1
or PSYC 204 (3) Introduction to Psychological Statistics

U1 Complementary Courses (6 credits)
Selected from:
MIMM 211 (3) Biology of Microorganisms
MIMM 212 (2) Laboratory in Microbiology
BIOL 202 (3) Basic Genetics
BIOL 205 (3) Biology of Organisms
BIOL 304 (3) Evolution
MATH 204 (3) Statistics 2
ANAT 214 (3) Systematic Human Anatomy
ANAT 261* (4) Introduction to Dynamic Histology
*students must take this course in U1 or U2

U2 Required Courses (15 credits)
BIOC 311 (3) Metabolic Biochemistry
BIOC 312 (3) Biochemistry of Macromolecules
MIMM 314 (3) Immunology
BIOC 300D1 (3) Laboratory in Biochemistry
and BIOC 300D2 (3) Laboratory in Biochemistry
or MIMM 386D1 (3) Laboratory in Microbiology
and MIMM 386D2 (3) Laboratory in Microbiology

U2 Complementary Courses (9 credits)
one of:
ANAT 261 (4) Introduction to Dynamic Histology
MIMM 211 (3) Biology of Microorganisms
PHGY 210 (3) Mammalian Physiology 2
plus 6 credits selected from:
BIOL 314 (3) Molecular Biology of Oncogenes
BIOL 300 (3) Molecular Biology of the Gene
PHGY 210 (3) Mammalian Physiology 2
CHEM 302 (3) Organic Chemistry 3
MATH 222 (3) Calculus 3
MATH 315 (3) Ordinary Differential Equations
or BIOL 309 (3) Mathematical Models in Biology
MIMM 323 (3) Microbial Physiology
MIMM 324 (3) Fundamental Virology
PATH 300 (3) Human Disease
PHAR 300 (3) Drug Action
PHAR 301 (3) Drugs and Disease
PHAR 303 (3) Toxicology
PHGY 311 (3) Intermediate Physiology 1
PHGY 312 (3) Intermediate Physiology 2
PHGY 313 (3) Intermediate Physiology 3

U3 Required Courses (18 credits)
MIMM 414 (3) Advanced Immunology
BIOC 503 (3) Immunochemistry
PHGY 419D1 (4.5) Project and Seminar in Immunology
PHGY 419D2 (4.5) Project and Seminar in Immunology
PHGY 513 (3) Cellular Immunology

U3 Complementary Courses (6 credits)
6 credits selected from:
BIOL 520 (3) Gene Activity in Development
BIOC 404 (3) Biophysical Chemistry
BIOC 450 (3) Protein Structure and Function
BIOC 454 (3) Nucleic Acids
BIOC 458 (3) Membranes & Cellular Signaling
or ANAT 458 (3) Membranes & Cellular Signaling
PHGY 531 (3) Topics in Applied Immunology
PHGY 552 (3) Cellular & Molecular Physiology
MIMM 413 (3) Parasitology
MIMM 465 (3) Bacterial Pathogenesis & Host Defences
MIMM 466 (3) Viral Pathogenesis and Host Defences
MIMM 509 (3) Seminars on Inflammatory Processes
PHAR 503 (3) Drug Design and Development 1
PHAR 504 (3) Drug Design and Development 2

12.14 Kinesiology for Science Students

The Minor in Kinesiology is designed to provide students in B.Sc. programs with basic but comprehensive knowledge of scientific bases of human physical activity and its relationship with health and well being.

Students registered in the Minor in Kinesiology for Science Students may not take additional courses outside the Faculties of Arts and of Science.

To obtain the Minor, all courses must be completed with a grade of C or better.

MINOR IN KINESIOLOGY FOR SCIENCE STUDENTS
(18 credits)

Required Courses (9 credits)
EDKP 206 (3) Biomechanics of Human Movement
EDKP 391 (3) Ergo-physiology
EDKP 492 (3) Psychology of Motor Performance

Complementary Courses (9 credits)
three of the following courses:
EDKP 261 (3) Motor Development
EDKP 330 (3) Physical Activity and Health
EDKP 485 (3) Exercise in Chronic Health Conditions
EDKP 495 (3) Scientific Principles of Training
EDKP 496 (3) Adapted Physical Activity
EDKP 498 (3) Social Psychology of Sport
EDKP 550 (3) Analyzing Instructional Behaviors
EDKP 553 (3) Physiological Assessment in Sport
EDKP 566 (3) Biomechanical Assessment in Sport

Note: Some courses have prerequisites, for details please refer to the Faculty of Education course listings.

12.15 Management Minor Program

The Minor in Management allows Science students to include courses in their undergraduate program that will help prepare them for a career in management. A Minor in Technological Entrepreneurship described in section 12.30 is also available to Science students.

Acceptance to the program is both competitive and restricted. At the time of application, a CGPA greater than 2.50 is required and at least one course (MGCR 211) toward the Minor program must have been completed with a grade of C or better.

Application procedures will be announced in September. Please consult Ron Critchley, Student Adviser, Faculty of Management Student Affairs Office, Bronfman 176, for details.

Students who are not formally registered for the Minor but who nevertheless complete all its requirements may apply to have the Minor approved during their last term.

Students registered in the Minor in Management may not take additional courses outside the Faculties of Arts and of Science.

To obtain the Minor in Management, all courses must be completed with a grade of C or better.

MINOR PROGRAM IN MANAGEMENT (24 credits)
Required Courses (9 credits)
MGCR 211 (3) Introduction to Financial Accounting
MGCR 293 (3) Managerial Economics
MATH 203 (3) Principles of Statistics 1
or its equivalent as authorized by the Faculty of Science. Students majoring in certain programs, for example in Mathematics, cannot take MATH 203 but must take MATH 324 instead. (Note: Credit for other statistics courses may preclude credit for this course and conversely. See "Course Overlap" on page 362.)

Complementary Courses (15 credits)
3 credits from:
MGCR 213 (3) Introduction to Management Accounting
MGCR 341 (3) Finance 1
MGCR 382 (3) International Business
3 credits from:
MGCR 222 (3) Organizational Behaviour

MGCR 320 (3) Managing Human Resources
MGCR 352 (3) Marketing Management 1
3 credits from:
MGCR 360 (3) Social Context of Business
MGCR 373 (3) Operations Research
MGCR 423 (3) Organizational Policy
6 credits from:
any approved 300- or 400-level Management courses for which the prerequisites, if any, have been met.

12.16 Mathematics and Statistics (MATH)

Burnside Hall, Room 1005
805 Sherbrooke Street West
Montreal, QC H3A 2K6

Telephone: (514) 398-3800
Fax: (514) 398-3899
Website: http://www.math.mcgill.ca

Chair — Kohur GowriSankaran

Emeritus Professors
Michael Barr; A.B., Ph.D.(Penn.) *(Peter Redpath Emeritus Professor of Pure Mathematics)*
Jal R. Choksi; B.A.(Cantab.), Ph.D.(Manc.)
Joachim Lambek; M.Sc., Ph.D.(McG.), F.R.S.C. *(Peter Redpath Emeritus Professor of Pure Mathematics)*
Arak M. Mathai; M.Sc.(Kerala), M.A., Ph.D.(Tor.)
William O.J. Moser; B.Sc.(Manit.), M.A.(Minn.), Ph.D.(Tor.)
V. Seshadri; B.Sc., M.Sc.(Madras), Ph.D.(Oklahoma)
John C. Taylor; B.Sc.(Acad.), M.A.(Queen's), Ph.D.(McM.)

Professors
William J. Anderson; B.Eng., Ph.D.(McG.)
William G. Brown; M.A.(Col.), B.A., Ph.D.(Tor.)
Marta C. Bunge; M.A., Ph.D.(Penn.)
Henri Darmon; B.Sc.(McG.), Ph.D.(Harv.)
Stephen W. Drury; M.A., Ph.D.(Cantab.)
Kohur GowriSankaran; B.A., M.A.(Madras), Ph.D.(Bombay)
Jacques C. Hurtubise; B.Sc.(Montr.), Ph.D.(Oxon.)
Niky Kamran; B.Sc., M.Sc.(Brussels), Ph.D.(Wat.)
Olga Kharlampovich; M.A.(Ural State), Ph.D.(Leningrad), Dr.of Sc.(Steklov Institute)
Michael Makkai; M.A., Ph.D.(Bud.)
Sherwin A. Maslowe; B.Sc.(Wayne State), M.Sc., Ph.D.(Calif.)
Charles Roth; M.Sc.(McG.), Ph.D.(Hebrew
Karl Peter Russell; Vor.Dip.(Hamburg), Ph.D.(Calif.
Georg Schmidt; B.Sc.(Natal), M.Sc.(S.A.), Ph.D.(Stan.)
George P.H. Styan; M.A., Ph.D.(Col.)
Luc Vinet; B.Sc., M.Sc., Ph.D.(Montr.), Doctorat 3^{e} cycle (Paris VI) *(joint appt. with Physics)*
David Wolfson; M.Sc.(Natal), Ph.D.(Purdue)
Keith J. Worsley; B.Sc., M.Sc., Ph.D.(Auckland)
Jian-Ju Xu; B.Sc., M.Sc.(Beijing), M.Sc., Ph.D.(Renss.)
Sanjo Zlobec; M.Sc.(Zagreb), Ph.D.(Northwestern)

Associate Professors
Peter Bartello; B.Sc.(Tor.), M.Sc., Ph.D.(McG.) *(joint appt. with Atmospheric and Oceanic Sciences)*
Vojkan Jaksic; B.S.(Belgrade), Ph.D.(Caltech)
Wilbur Jonsson; M.Sc.(Manit.), Dr.Rer.Nat.(Tubingen)
Ivo Klemes; B.Sc.(Tor.), Ph.D.(Cal.Tech.)
John P. Labute; B.Sc.(Windsor), M.A., Ph.D.(Harv.)
Bohdan Lawruk; M.Sc., Ph.D.(Lwow)
James G. Loveys; B.A.(St.M.), M.Sc., Ph.D.(S.Fraser)
Roger Rigelhof; B.Sc.(Sask.), M.Sc.(Wat.), Ph.D.(McM.)
Neville G.F. Sancho; B.Sc., Ph.D.(Belf.)
John A. Toth; B.Sc., M.Sc.(McM.), Ph.D.(M.I.T.) *(William Dawson Scholar)*

Assistant Professors
Masoud Asgharian; B.Sc.(Shahid Beheshti), M.Sc., Ph.D.(McG.)
Dave Bryant; B.Sc.Hons, Ph.D.(Canterbury) *(joint appt. with Computer Science)*
Martin J. Gander; M.S.(ETH), M.S., Ph.D.(Stan.)
Eyal Z. Goren; B.A., M.S., Ph.D.(Hebrew)
Dmitry Jakobson; B.Sc. (M.I.T.), Ph.D.(Princeton)
Dietmar Leisen; B.Sc.(Mainz), M.Sc., Ph.D.(Bonn) *(joint appt. with Management)*
Nilima Nigam; B.Sc.(I.I.T., Bombay), M.S., Ph.D.(Delaware)
Alain Vandal; B.Sc., M.Sc. (McGill), Ph.D.(Auckland)
Daniel T. Wise; B.A.(Yeshiva), Ph.D.(Princ.)

Assistant Professor (Special Category)
Vera Rosta; M.Sc., Ph.D.(Lorand Eotovos, Budapest)

Associate Members
Luc P. Devroye *(Computer Science),* P.R.L. Dutilleul *(Plant Science),* Leon Glass *(Physiology),* Jean-Louis Goffin *(Management),* James A. Hanley *(Epidemiology & Biostatistics)*, Lawrence Joseph *(Epidemiology & Biostatistics),* Michael Mackey *(Physiology),* Lawrence A. Mysak *(A.O.S.),* Prakash Panangaden *(Computer Science),* James O. Ramsay *(Psychology),* George Alexander Whitmore *(Management)*

Adjunct Professors
Donald A. Dawson; B.Sc., M.Sc.(McG.), Ph.D.(M.I.T.)
Victor Havin; M.Sc., Ph.D.(Leningrad)
M. Ram Murty; B.Sc.(Car.), Ph.D.(M.I.T.) F.R.S.C.
Brian Rowley; B.Sc.(Wat.), M.Sc., Ph.D.(McG.)
Robert A. Seely; B.Sc.(McG.), Ph.D.(Cantab)

Faculty Lecturers
Axel Hundemer; M.Sc., Ph.D.(Munich)
Fabrice Rouah; B.Sc.(C'dia), M.Sc.(McG.)

Mathematics has evolved to a discipline which is mainly characterized by its method of proof, its concern for a progressive broadening of its concepts, and by the search for mathematical entities and operations that represent aspects of reality. It is a subject which is pursued by many for its own sake, and regarded as part of the mainstream of human culture. Mathematics pervades modern society with an impact which, already immense, is rapidly growing.

The two principal divisions of mathematics are pure mathematics and applied mathematics. The pure mathematician is interested in abstract mathematical structures and in mathematics as an intellectual enterprise. The primary concern may not be with its utilitarian aspects or with the current needs of science and technology, although many problems in pure mathematics have developed from the sciences.

The applied mathematician is more interested in how mathematics can be used to study some aspects of the world. Mathematicians are engaged in the creation, study and application of advanced mathematical methods relevant to scientific problems. Statistical science and methodology today is concerned with phenomena in which there is a background of uncertainty arising from inherent variability and the investigator is obliged to arrive at decisions from limited data. A key tool in statistics is probability.

Some of the fields in which pure mathematicians work are algebra, analysis, geometry, topology, number theory and foundations. Applied mathematics which once referred to the application of mathematics to such disciplines as mechanics and fluid dynamics, has currently assumed a much broader meaning and embraces such diverse fields as communication theory, theory of optimization, theory of games and numerical analysis.

Mathematics offers many vocational possibilities. Such fields as teaching, computing, applied statistics and actuarial science offer opportunities for B.Sc. graduates. Opportunities to do original research in pure and applied mathematics are available in universities and research institutions. Employment is to be found in financially or technologically oriented business firms. The Department of Mathematics and Statistics through its various programs attempts to provide courses to suit the diverse interests within mathematics and statistics.

The Honours Program in Mathematics demands of the student a talent for abstraction in addition to a high level of competence in the use of mathematical tools. This program is intended for students who plan to work in an area where mathematical innovations may be needed. It is almost essential for students contemplating a career in mathematical research.

The Major Program involves the same subjects as the Honours Program but is less demanding in terms of abstraction. It is designed primarily for students who will need mathematical tools in their work but whose creative activity will involve applications of mathematics to other areas. Within the framework of the Mathematics Major, various combinations of courses are suggested to meet the needs of different students. These include course suggestions for secondary school teachers, careers in management, and for careers in industry, government or actuarial sciences.

It is possible for Major students to include a number of Honours courses in their programs. This will be an advantage for those students who plan to use their mathematics in graduate studies.

Students interested in a less intensive mathematics program linked to other disciplines are advised to consider the available Faculty Programs.

In planning their programs students are advised to seriously consider developing some depth in another discipline – preferably one for which mathematics has some relevance and use. Mathematics has been closely linked to areas such as computer science, physics and engineering but has recently come to play an increasingly important role in fields such as biology, linguistics, management and psychology. Students should consider completing the requirements for Minor programs such as those available in Cognitive Science, Computer Science and Statistics.

Students considering programs in Mathematics and Statistics should contact the Department to arrange for academic advising.

The student's attention is called to the fact that a B.Com. degree with a Major in Mathematics is available from the Faculty of Management. In addition the Faculty of Music offers the B.Mus. degree with Honours in Theory with Mathematics Option.

An industrial internship year is available to students enrolled in some Mathematics programs. IYES, the internship year program in Engineering and Science, is a pre-graduate work experience program available to eligible students and normally taken between their U2 and U3 years. See the Faculty of Engineering section 2.9 for further information on IYES.

Note: Students entering a program listed below which has MATH 222 (Calculus 3) as a required course and who have successfully completed a course equivalent to MATH 222 prior to coming to McGill are given exemption from taking MATH 222, but must replace it with a Complementary Mathematics course in the program of at least 3 credits.

MINOR PROGRAM IN MATHEMATICS (24 credits)

The Minor may be taken in conjunction with any primary program in the Faculty of Science (other than programs in Mathematics). Students should declare their intention to follow the Minor in Mathematics at the beginning of the penultimate year and should obtain approval for the selection of courses to fulfill the requirements for the Minor from the Departmental Chief Adviser (or delegate).

It is strongly recommended that students in the Minor Program take MATH 323. The remaining credits may be freely chosen from the required and complementary courses for Majors and Honours students in Mathematics, with the obvious exception of courses that involve duplication of material. Alternatively up to six credits may be allowed for appropriate courses from other departments.

All courses counted towards the Minor must be passed with a grade of C or better.

Generally no more than six credits of overlap are permitted between the Minor and the primary program. However, with an approved choice of substantial courses the overlap restriction may be relaxed to nine credits for students whose primary program requires 60 credits or more and to 12 credits when the primary program requires 72 credits or more.

Required Courses (9 credits)

MATH 222	(3)	Calculus 3
MATH 223*	(3)	Linear Algebra
MATH 315	(3)	Ordinary Differential Equations

*MATH 223 may be replaced by MATH 235 and MATH 236. In this case the complementary credit requirement is reduced by three.

Complementary Courses (15 credits)

To be selected from the required and complementary courses for Majors and Honours students in Mathematics, with MATH 323 strongly recommended; alternatively up to 6 credits may be allowed for appropriate courses from other departments.

MINOR PROGRAM IN STATISTICS (24 credits)

The Minor may be taken in conjunction with any primary program in the Faculty of Science. Students should declare their intention to follow the Minor in Statistics at the beginning of the penultimate year and must obtain approval for the selection of courses to fulfill the requirements for the Minor from the Departmental Chief Adviser (or delegate).

All courses counted towards the Minor must be passed with a grade of C or better. Generally no more than six credits of overlap are permitted between the Minor and the primary program. However, with an approved choice of substantial courses the overlap restriction may be relaxed to nine credits for students whose primary program requires 60 credits or more and to 12 credits when the primary program requires 72 credits or more.

Required Courses (15 credits)

MATH 222	(3)	Calculus 3
MATH 223*	(3)	Linear Algebra
MATH 323	(3)	Probability Theory
MATH 324	(3)	Statistics
MATH 423	(3)	Regression and Analysis of Variance

*MATH 223 may be replaced by MATH 235 and MATH 236. In this case the complementary credit requirement is reduced by three.

Complementary Courses (9 credits)

selected from:

MATH 447	(3)	Stochastic Processes
MATH 523	(4)	Generalized Linear Models
MATH 525	(4)	Sampling Theory & Applications
MATH 556	(4)	Mathematical Statistics 1
MATH 557	(4)	Mathematical Statistics 2
SOCI 504	(3)	Quantitative Methods of Social Research 1
SOCI 505	(3)	Quantitative Methods of Social Research 2
CHEM 593	(3)	Statistical Mechanics
GEOG 351	(3)	Quantitative Methods
PHYS 362	(3)	Statistical Mechanics
PHYS 559	(3)	Advanced Statistical Mechanics

No more than 6 credits may be taken outside the Department of Mathematics and Statistics.

Further credits (if needed) may be freely chosen from the required and complementary courses for Majors and Honours students in Mathematics, with the obvious exception of courses that involve duplication of material.

FACULTY PROGRAMS

Programs linking mathematics and other disciplines are available. With careful selection of courses in U1, it is possible to transfer to a Major program in Mathematics in U2. Except where otherwise noted these Faculty Programs lead to a B.Sc. degree. Students interested in any of these Faculty Programs should consult the Department of Mathematics and Statistics for an adviser.

FACULTY PROGRAM IN BIOLOGY AND MATHEMATICS

See page 379 in the Biology section for complete program information.

FACULTY PROGRAM IN CHEMISTRY AND MATHEMATICS

See page 389 in the Chemistry section for complete program information.

FACULTY PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE (54 credits)
27 credits in Mathematics and 27 credits in Computer Science

Required Courses (48 credits)
MATH 222 (3) Calculus 3
MATH 223 (3) Linear Algebra
MATH 315 (3) Ordinary Differential Equations
MATH 317 (3) Numerical Analysis
MATH 323 (3) Probability Theory
MATH 324 (3) Statistics
MATH 343 (3) Discrete Mathematics & Applied Algebra
COMP 202 (3) Introduction to Computing 1
COMP 203 (3) Introduction to Computing 2
COMP 206 (3) Intro to Software Systems
COMP 251 (3) Data Structures and Algorithms
COMP 273 (3) Intro. to Computer Systems
COMP 302 (3) Programming Languages and Paradigms
COMP 310 (3) Comp. Systems and Organization
COMP 420 (3) Files and Databases
COMP 530 (3) Formal Languages

Complementary Courses (6 credits)
selected from:
MATH 240 (3) Discrete Structures & Computing
MATH 314 (3) Advanced Calculus
MATH 318 (3) Mathematical Logic
MATH 327 (3) Matrix Numerical Analysis
MATH 328 (3) Computability & Mathematical Linguistics
MATH 407 (3) Dynamic Programming
MATH 417 (3) Mathematical Programming

FACULTY PROGRAM IN MATHEMATICS, STATISTICS AND COMPUTER SCIENCE (54 credits)

Required Courses (30 credits)
COMP 202 (3) Introduction to Computing 1
COMP 203 (3) Introduction to Computing 2
COMP 206 (3) Intro to Software Systems
COMP 251 (3) Data Structures and Algorithms
MATH 222 (3) Calculus 3
MATH 223 (3) Linear Algebra
MATH 315 (3) Ordinary Differential Equations
MATH 323 (3) Probability Theory
MATH 324 (3) Statistics
MATH 423 (3) Regression and Analysis of Variance

Complementary Courses (24 credits)
at least 6 credits selected from:
MATH 314 (3) Advanced Calculus
MATH 317 (3) Numerical Analysis
MATH 318 (3) Mathematical Logic
MATH 319 (3) Partial Differential Equations
MATH 327 (3) Matrix Numerical Analysis
MATH 328 (3) Computability & Mathematical Linguistics
MATH 343 (3) Discrete Mathematics & Applied Algebra
MATH 407 (3) Dynamic Programming
MATH 417 (3) Mathematical Programming
at least 6 credits in Statistics selected from:
MATH 329 (3) Theory of Interest
MATH 447 (3) Stochastic Processes
MATH 523 (4) Generalized Linear Models
MATH 525 (4) Sampling Theory and Applications
at least 6 credits in Computer Science selected from:
COMP 273 (3) Intro. to Computer Systems
COMP 302 (3) Programming Languages and Paradigms
COMP 310 (3) Comp. Systems and Organization
COMP 420 (3) Files and Databases

FACULTY PROGRAM IN MATHEMATICS, CHEMISTRY AND PHYSICS (56 credits)

Required Courses (47 credits)
CHEM 201 (3) Modern Inorganic Chemistry 1
or CHEM 281 (3) Inorganic Chemistry 1
CHEM 204 (3) Physical Chem./Biol. Sci. 1
or CHEM 213 (3) Physical Chemistry 1
CHEM 212 (4) Organic Chemistry 1
CHEM 214 (3) Physical Chem./Biol. Sci. 2
CHEM 222 (4) Organic Chemistry 2
MATH 222 (3) Calculus 3
MATH 223 (3) Linear Algebra
MATH 314 (3) Advanced Calculus
MATH 315 (3) Ordinary Differential Equations
MATH 319 (3) Partial Differential Equations
PHYS 230 (3) Dynamics of Simple Systems
PHYS 232 (3) Heat and Waves
PHYS 241 (3) Signal Processing
PHYS 340 (3) Electricity and Magnetism
COMP 202 (3) Introduction to Computing 1

Complementary Courses (9 credits)
3 credits in Physics, 200 level or higher
6 credits in Mathematics, Chemistry or Physics, chosen in consultation with the adviser.

MAJOR PROGRAM IN MATHEMATICS (54 credits)

Students entering the Major program are normally expected to have completed MATH 133, MATH 140 and MATH 141 or their equivalents. Otherwise they will be required to make up any deficiencies in these courses over and above the 54 credits of required courses.

Major students who have done well in MATH 242 and MATH 235 are urged to consider, in consultation with their adviser and the instructors concerned, entering the Honours stream by registering for MATH 251 and MATH 255.

Guidelines for Selection of Courses in the Major Program

The following informal guidelines should be discussed with the student's adviser. Where appropriate, Honours courses may be substituted for equivalent Major courses. Students planning to pursue graduate studies are encouraged to make such substitutions.

Students interested in computer science are advised to choose courses from the following MATH 317, MATH 318, MATH 327, MATH 328, MATH 343, MATH 407, MATH 417 and to complete the Computer Science Minor.

Students interested in probability and statistics are advised to take MATH 324, MATH 407, MATH 423, MATH 447, MATH 523, MATH 525.

Students interested in applied mathematics should take MATH 317, MATH 319, MATH 324, MATH 326, MATH 327, MATH 407, MATH 417.

Students considering a career in secondary school teaching are advised to take MATH 318, MATH 328, MATH 338, MATH 339, MATH 346, MATH 348.

Students interested in careers in business, industry or government are advised to select courses from the following list: MATH 317, MATH 319, MATH 327, MATH 329, MATH 330, MATH 407, MATH 417, MATH 423, MATH 447, MATH 523, MATH 525.

Required Courses (27 credits)
MATH 222 (3) Calculus 3
MATH 235 (3) Algebra 1
MATH 236 (3) Linear Algebra 1
MATH 242 (3) Analysis 1
MATH 243 (3) Real Analysis
MATH 314 (3) Advanced Calculus
MATH 315 (3) Ordinary Differential Equations
MATH 316 (3) Functions of a Complex Variable
or MATH 249 (3) Advanced Calculus
MATH 323 (3) Probability Theory

Complementary Courses (27 credits)
21 credits selected from the following list, with at least 6 credits selected from:
MATH 317 (3) Numerical Analysis
MATH 324 (3) Statistics
MATH 343 (3) Discrete Mathematics & Applied Algebra
the remainder of the 21 credits to be selected from:
MATH 318 (3) Mathematical Logic
MATH 319 (3) Partial Differential Equations
MATH 320 (3) Differential Geometry
MATH 326 (3) Nonlinear Dynamics and Chaos
MATH 327 (3) Matrix Numerical Analysis
MATH 328 (3) Computability & Mathematical Linguistics
MATH 329 (3) Theory of Interest
MATH 338 (3) History and Philosophy of Mathematics
MATH 339 (3) Topics in the Foundations of Mathematics
MATH 346 (3) Number Theory
MATH 348 (3) Topics in Geometry
MATH 407 (3) Dynamic Programming
MATH 417 (3) Mathematical Programming
MATH 423 (3) Regression and Analysis of Variance
MATH 447 (3) Stochastic Processes
MATH 523 (4) Generalized Linear Models
MATH 525 (4) Sampling Theory and Applications
6 additional credits in Mathematics or related disciplines selected in consultation with the adviser.

JOINT MAJOR PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE (72 credits)

Required courses (48 credits)
MATH 222 (3) Calculus 3
MATH 235 (3) Algebra 1
MATH 236 (3) Linear Algebra 1
MATH 242 (3) Analysis 1
MATH 315 (3) Ordinary Differential Equations
MATH 317 (3) Numerical Analysis
MATH 318 (3) Mathematical Logic
MATH 323 (3) Probability Theory
COMP 206 (3) Intro to Software Systems
COMP 250* (3) Introduction to Computer Science
COMP 251 (3) Data Structures and Algorithms
COMP 273 (3) Intro. to Computer Systems
COMP 302 (3) Programming Languages and Paradigms
COMP 310 (3) Comp. Systems and Organization
COMP 330 (3) Theoretical Aspects of Computer Science
COMP 360 (3) Algorithm Design Techniques

* Students with no basic knowledge of any high level programming language (e.g. Fortran, Basic, Pascal, C, C++, Java) may take COMP 202 and have it count as a complementary course in Computer Science.

Complementary Courses (24 credits)
12 credits from the set of courses recommended for a Major or Honours Program in Mathematics, excluding MATH 240 and MATH 340.
12 credits from the set of courses recommended for a Major or Honours Program in Computer Science.

JOINT MAJOR PROGRAM IN PHYSIOLOGY AND MATHEMATICS See page 436 in the Physiology section for complete program information.

HONOURS PROGRAMS

The minimum requirement for entry into the Honours program is that the student has completed with high standing the following courses: MATH 133, MATH 140, MATH 141, or their equivalents. In addition, a student who has not completed the equivalent of MATH 222 must take it in the first term without receiving credits towards the credits required in the Honours program.

Students who transfer to Honours in Mathematics from other programs will have credits for previous courses assigned, as appropriate, by the Department.

To remain in an Honours program and to be awarded the Honours degree, the student must maintain a 3.00 GPA in the required and complementary Mathematics courses of the program, as well as an overall CGPA of 3.00.

HONOURS PROGRAM IN MATHEMATICS (60 credits)

Required Courses (42 credits)
MATH 235 (3) Algebra 1
MATH 242 (3) Analysis 1
MATH 248 (3) Advanced Calculus 1
MATH 251 (3) Algebra 2
MATH 255 (3) Analysis 2
MATH 325 (3) Ordinary Differential Equations
MATH 354 (3) Analysis 3
MATH 355 (3) Analysis 4
MATH 356 (3) Probability
MATH 357 (3) Statistics
MATH 370 (3) Algebra 3
MATH 371 (3) Algebra 4
MATH 380 (3) Differential Geometry
MATH 466 (3) Complex Analysis

Complementary Courses (18 credits)
MATH 375 (3) Differential Equations
or MATH 574 (4) Ordinary Differential Equations
and 15 credits to be selected from the following:
COMP 250* (3) Introduction to Computer Science
COMP 252 (3) Algorithms and Data Structures
*COMP 250 may be preceded by COMP 202
further Honours Mathematics courses, of which MATH 470 is encouraged;
non-Honours Mathematics courses (other than MATH 242, MATH 235), for which no Honours equivalent exists (these count for half of their credits);
certain Honours level courses in other departments; with credit weight determined by the Department of Mathematics and Statistics.

HONOURS PROGRAM IN APPLIED MATHEMATICS (68 credits)
[Program revisions are under consideration for September 2002. Go to http://www.mcgill.ca (Course Calendars) in July for details.]

Aside from seeking to develop a sound basis in Applied Mathematics, one of the objectives of the program is to kindle the students' interest in possible areas of application. The extra-mural courses are included to ensure that the student has some appreciation of the scope of Applied Mathematics and is familiar with at least one of the diversity of areas in which applications can be found.

Required Courses (39 credits)
MATH 235 (3) Algebra 1
MATH 242 (3) Analysis 1
MATH 248 (3) Advanced Calculus 1
MATH 251 (3) Algebra 2
MATH 255 (3) Analysis 2
MATH 325 (3) Ordinary Differential Equations
MATH 356 (3) Probability
MATH 357 (3) Statistics
MATH 375 (3) Differential Equations
MATH 387 (3) Numerical Analysis
MATH 466 (3) Complex Analysis
or MATH 249 (3) Advanced Calculus 2
COMP 252 (3) Algorithms and Data Structures
COMP 250* (3) Introduction to Computer Science
*COMP 250 may be preceded by COMP 202

Complementary Courses (29 credits)
at least 6 credits selected from:
MATH 354 (3) Analysis 3

MATH 355 (3) Analysis 4
MATH 370 (3) Algebra 3
MATH 371 (3) Algebra 4
MATH 380 (3) Differential Geometry

at least 9 credits selected from:
MATH 376 (3) Chaos and Nonlinear Dynamics
MATH 397 (3) Matrix Numerical Analysis
MATH 470 (3) Honours Project
MATH 487 (3) Mathematical Programming
MATH 523 (4) Generalized Linear Models
MATH 525 (4) Sampling Theory and Applications
MATH 555 (4) Fluid Dynamics
MATH 556 (4) Mathematical Statistics 1
MATH 557 (4) Mathematical Statistics 2
MATH 560 (4) Optimization
MATH 561 (4) Analytical Mechanics
MATH 574 (4) Ordinary Differential Equations
MATH 575 (4) Partial Differential Equations
MATH 578 (4) Numerical Analysis
MATH 579 (4) Numerical Differential Equations
MATH 585 (4) Integral Equations and Transforms
MATH 586 (4) Applied Partial Differential Equations

and the following, for which **half credit only** may be counted:
MATH 407 (3) Dynamic Programming
MATH 423 (3) Regression and Analysis of Variance
MATH 447 (3) Stochastic Processes

12 credits of extra-mural courses:
chosen in consultation with the student's adviser from approved courses in other departments. A list of such courses is available from the Department of Mathematics and Statistics. Student initiative is encouraged in suggesting other courses that fulfill the intentions of this section as described above. Such suggestions must receive departmental approval. They must be in a field related to Applied Mathematics such as Atmospheric and Oceanic Science, Biology, Biochemistry, Chemistry, Computer Science, Earth and Planetary Science, Economics, Engineering, Management, Physics, Physiology and Psychology. At least 6 credits must be chosen from a single department other than Computer Science.

HONOURS PROGRAM IN PROBABILITY AND STATISTICS (63 credits)

All Honours students are encouraged to take MATH 325, MATH 387, MATH 423 and MATH 447.

Students primarily interested in probability should include courses MATH 325, MATH 375 and MATH 447 in their program.

Students primarily interested in statistics should include MATH 423, MATH 447, MATH 523,MATH 524 and MATH 525 in their program.

Required Courses (46 credits)
MATH 235 (3) Algebra 1
MATH 242 (3) Analysis 1
MATH 248 (3) Advanced Calculus 1
MATH 249 (3) Advanced Calculus 2
or MATH 466(3) Complex Analysis
MATH 251 (3) Algebra 1
MATH 255 (3) Analysis 2
MATH 354 (3) Analysis 3
MATH 356 (3) Probability
MATH 357 (3) Statistics
MATH 556 (4) Mathematical Statistics 1
MATH 557 (4) Mathematical Statistics 2
MATH 587 (4) Advanced Probability Theory 1
MATH 589 (4) Advanced Probability Theory 2
COMP 250* (3) Introduction to Computer Science
*COMP 250 may be preceded by COMP 202

Complementary Courses (17 credits)
selected from:
MATH 325 (3) Ordinary Differential Equations
MATH 355 (3) Analysis 4
MATH 375 (3) Differential Equations 2
MATH 387 (3) Numerical Analysis
MATH 397 (3) Matrix Numerical Analysis
MATH 470 (3) Honours Project
MATH 523 (4) Generalized Linear Models
MATH 524 (4) Nonparametric Statistics
MATH 525 (4) Sampling Theory and Applications

and the following, for which **half credit only** may be counted:
MATH 423 (3) Regression and Analysis of Variance
MATH 447 (3) Stochastic Processes

JOINT HONOURS PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE (72 credits)

Students must consult an Honours adviser in both departments.

Required Courses (39 credits)
MATH 235 (3) Algebra 1
MATH 242 (3) Analysis 1
MATH 248 (3) Advanced Calculus 1
MATH 251 (3) Algebra 2
MATH 255 (3) Analysis 2
COMP 206 (3) Intro to Software Systems
COMP 250* (3) Introduction to Computer Science
COMP 252 (3) Algorithms and Data Structures
COMP 273 (3) Intro. to Computer Systems
COMP 302 (3) Programming Languages and Paradigms
COMP 310 (3) Comp. Systems and Organization
COMP 330 (3) Theoretical Aspects of Computer Science
COMP 362 (3) Honours Algorithm Design
* Students with no basic knowledge of any high level programming language (e.g. Fortran, Basic, Pascal, C, C++, Java) are advised to take COMP 202 before COMP 250. In this case COMP 202 counts as an elective.

Complementary Courses (33 credits)
21 credits in Mathematics,
at least 12 credits selected from:
MATH 354 (3) Analysis 3
MATH 355 (3) Analysis 4
MATH 356* (3) Probability
MATH 370 (3) Algebra 3
MATH 371 (3) Algebra 4
MATH 387 (3) Numberical Analysis
The remaining credits selected from honours courses given by the Department of Mathematics and Statistics.
*Students with appropriate background in probability may substitute MATH 587 for MATH 356 and must then also register for MATH 355.

12 credits in Computer Science, selected from:
COMP 303 (4) Advanced Programming Techniques
COMP 304 (3) Object-Oriented Design
COMP 335 (3) Software Engineering Methods
400-level and 500-level Computer Science courses with the exception of COMP 431.

JOINT HONOURS PROGRAM IN MATHEMATICS AND PHYSICS See page 431 in the Physics section for complete program information.

INTERNSHIP PROGRAMS – INTERNSHIP YEAR FOR ENGINEERING AND SCIENCE (IYES)

The following programs are also available with an Internship component. For more information, please see section 2.9 in the Faculty of Engineering section.

Major in Mathematics
Honours in Mathematics
Honours in Applied Mathematics
Honours in Probability & Statistics
Joint Majors in Mathematics & Computer Science
Joint Honours in Mathematics & Computer Science

COURSE DESCRIPTIONS

Please note: courses may have been rescheduled or new courses added after this Calendar went to press. Students preparing to register are advised to consult the 2002-2003 Class Schedule on the Web, http://www.mcgill.ca/minerva-students for the most up-to-date information.

The Class Schedule includes the term(s), days, and times when courses will be offered, as well as class locations and names of instructors.

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

The course credit weight is given in parentheses after the title. Term(s) offered (Fall, Winter, Summer) may appear after the credit weight to indicate when a course would normally be taught. Please check the Class Schedule to confirm this information.

MATH has replaced 189 as the prefix for Mathematics and Statistics courses.

All courses have limited enrolment.

● Denotes courses not offered in 2002-03.

★ Denotes courses offered only in alternate years.

Note A: MATH 133, MATH 139, MATH 140, MATH 141, MATH 150 and MATH 151 are not open to students who have taken or are taking MATH 130 or MATH 131 (Mathematics for Management 1 and 2, for descriptions see page 301), except by permission of the Department of Mathematics and Statistics.

MATH 112 FUNDAMENTALS OF MATHEMATICS. (3) (Fall) (Not open to students who have taken CEGEP course 201-101) (Open only to those students who are deficient in a pre-calculus background) Equations and inequalities, graphs, relations and functions, exponential and logarithmic functions, trigonometric functions and their use, mathematical induction, binomial theorem, complex numbers.

MATH 133 VECTORS, MATRICES AND GEOMETRY. (3) (Fall and Winter and Summer) (Prerequisite: a course in functions) (Not open to students who have taken MATH 221 or CEGEP objective 00UQ or equivalent.) (Not open to students who have taken or are taking MATH 130 or MATH 131, except by permission of the Department of Mathematics and Statistics) Systems of linear equations, matrices, inverses, determinants; geometric vectors in three dimensions, dot product, cross product, lines and planes; introduction to vector spaces, linear dependence and independence, bases; quadratic loci in two and three dimensions.

MATH 139 CALCULUS. (4) (Fall and Winter) (3 hours lecture; 2 hours tutorial) (Prerequisite: a course in functions) (Requires Departmental Approval) (Not open to students who have taken MATH 120 or CEGEP objective 00UN or equivalent. This course is intended for students with no previous knowledge of Calculus; it is not open to students who have had one term of College level Calculus) (Students continue in MATH 141) (Each Tutorial section is enrolment limited) (Not open to students who have taken or are taking MATH 130 or MATH 131, except by permission of the Department of Mathematics and Statistics) Review of functions and graphs. Limits, continuity, derivative. Differentiation of elementary functions. Antidifferentiation. Applications.

MATH 140 CALCULUS 1. (3) (Fall and Winter and Summer) (3 hours lecture, 1 hour tutorial) (Prerequisite: High School Calculus) (Not open to students who have taken MATH 120, MATH 122, MATH 139 or CEGEP objective 00UN or equivalent) (Not open to students who have taken or are taking MATH 130 or MATH 131, except by permission of the Department of Mathematics and Statistics) (Each Tutorial section is enrolment limited) Review of functions and graphs. Limits, continuity, derivative. Differentiation of elementary functions. Antidifferentiation. Applications.

MATH 141 CALCULUS 2. (4) (Fall and Winter and Summer) (3 hours lecture; 2 hours tutorial) (Not open to students who have taken MATH 121 or CEGEP objective 00UP or equivalent) (Prerequisites: MATH 139 or MATH 140 or MATH 150) (Not open to students who have taken or are taking MATH 130 or MATH 131, except by permission of the Department of Mathematics and Statistics) (Each Tutorial section is enrolment limited) The definite integral. Techniques of integration. Applications. Introduction to sequences and series.

MATH 150 CALCULUS A. (4) (Fall) (3 hours lecture, 2 hours tutorial) (Students with no prior exposure to vector geometry are advised to take MATH 133 concurrently. Intended for students with high school calculus who have not received six advanced placement credits) (Not open to students who have taken CEGEP objective 00UN or equivalent) (Not open to students who have taken or are taking MATH 130 or MATH 131, except by permission of the Department of Mathematics and Statistics) (MATH 150 and MATH 151 cover the material of MATH 139, MATH 140, MATH 141, MATH 222) Functions, limits and continuity, differentiation, L'Hospital's rule, applications, Taylor polynomials, parametric curves, functions of several variables.

MATH 151 CALCULUS B. (4) (Winter) (3 hours lecture; 2 hours tutorial) (Prerequisite: MATH 150) (Not open to students who have taken CEGEP objective 00UP or equivalent) (Not open to students who have taken or are taking MATH 130 or MATH 131, except by permission of the Department of Mathematics and Statistics) (Each Tutorial section is enrolment limited) Integration, methods and applications, infinite sequences and series, power series, arc length and curvature, multiple integration.

● **MATH 199 FYS: CHAOS, FRACTALS AND COMPLEXITY.** (3) (Open only to newly admitted students in U0 or U1, who may take only one FYS. Students who register for more than one will be obliged to withdraw from all but one of them.) (Maximum 25)

MATH 203 PRINCIPLES OF STATISTICS 1. (3) (Fall and Winter) (No calculus prerequisites) (This course is intended for students in all disciplines and is not open to students in Mathematics programs; or to students who have taken or are taking MATH 324) (Credit for other statistics courses may preclude credit for this course and conversely) Examples of statistical data and the use of graphical means to summarize the data. Basic distributions arising in the natural and behavioural sciences. The logical meaning of a test of significance and a confidence interval. Tests of significance and confidence intervals in the one and two sample setting (means, variances and proportions).

MATH 204 PRINCIPLES OF STATISTICS 2. (3) (Winter) (Prerequisite: MATH 203 or equivalent. No calculus prerequisites) (This course is intended for students in all disciplines and is not open to students in Mathematics programs; or to students who have taken or are taking MATH 324) (Credit for other statistics courses may preclude credit for this course and conversely) The concept of degrees of freedom and the analysis of variability. Planning of experiments. Experimental designs. Polynomial and multiple regressions. Statistical computer packages (no previous computing experience is needed). General statistical procedures requiring few assumptions about the probability model.

● **MATH 211 PRACTICAL METHODS OF MATHEMATICS.** (3) (Prerequisite: MATH 111 or CEGEP 101 or consent of instructor) (Not open to students in the Faculty of Science, students in Mathematics or Computer Science programs or students who have taken or are taking any of MATH 240, MATH 343, MATH 363 or any statistics course)

MATH 222 CALCULUS 3. (3) (Fall and Winter and Summer) (Prerequisite: MATH 141. Familiarity with vector geometry or Corequisite: MATH 133) (Not open to students who have taken CEGEP course 201-303 or MATH 150, MATH 151 or MATH 227) Taylor series, Taylor's theorem in one and several variables. Review of vector geometry. Partial differentiation, directional derivative. Extreme of functions of 2 or 3 variables. Parametric curves and arc length. Polar and spherical coordinates. Multiple integrals.

MATH 223 LINEAR ALGEBRA. (3) (Fall and Winter and Summer) (Prerequisite: MATH 133 or equivalent) (Not open to students in Mathematics programs nor to students who have taken or are taking MATH 236, MATH 247 or MATH 251. It is open to students in Faculty Programs) Review of matrix algebra, determinants and systems of linear equations. Vector spaces, linear operators and

their matrix representations, orthogonality. Eigenvalues and eigenvectors, diagonalization of Hermitian matrices. Applications.

MATH 235 BASIC ALGEBRA. (3) (Fall) (3 hours lecture; 1 hour tutorial) (Prerequisite: MATH 133 or equivalent) Sets and relations. Rings and fields. Integers, rationals, real and complex numbers; modular arithmetic. Polynomials over a field. Divisibility theory for integers and polynomials. Linear equations over a field. Introduction to vector spaces.

MATH 236 LINEAR ALGEBRA. (3) (Winter) (Prerequisite: MATH 235) Continuation of the topics of MATH 235. Linear mappings. Matrix representation of linear mappings. Determinants. Eigenvectors and eigenvalues. Diagonalizable operators. Cayley-Hamilton theorem. Bilinear and quadratic forms. Inner product spaces, orthogonal diagonalization of symmetric matrices. Canonical forms.

MATH 240 DISCRETE STRUCTURES AND COMPUTING. (3) (Fall) (Corequisites: MATH 133 and MATH 222. For Major and Honours students in Computer Science only. Others only with the instructor's permission) Abstractly defined mathematical structures. Mathematical induction. Sets, relations and functions. Combinatorics; graphs; recurrences; generating functions. Lattices, Boolean algebras.

MATH 242 ANALYSIS 1. (3) (Fall) (Prerequisite: MATH 141) A rigorous presentation of sequences and of real numbers and basic properties of continuous and differentiable functions on the real line.

MATH 243 REAL ANALYSIS. (3) (Winter) (Prerequisite: MATH 242) Infinite series; series of functions; power series. The Riemann integral in one variable. A rigorous development of the elementary functions.

MATH 247 LINEAR ALGEBRA. (3) (Winter) (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) (Fall) (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) (Winter) (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 251 ALGEBRA 2. (3) (Winter) (Prerequisites: MATH 235 or permission of the Department) (Not open to students who are taking or have taken MATH 247) Linear maps and their matrix representation. Determinants. Canonical forms. Duality. Bilinear and quadratic forms. Real and complex inner product spaces. Diagonalization of self-adjoint operators.

MATH 255 ANALYSIS 2. (3) (Winter) (Prerequisites: MATH 242 or permission of the Department) Series of functions including power series. Riemann integration in one variable. Elementary functions.

MATH 314 ADVANCED CALCULUS. (3) (Fall and Winter and Summer) (Prerequisites: MATH 133, MATH 222) (Not open to students who have taken or are taking MATH 248) Derivative as a matrix. Chain rule. Implicit functions. Constrained maxima and minima. Jacobians. Multiple integration. Line and surface integrals. Theorems of Green, Stokes and Gauss.

MATH 315 ORDINARY DIFFERENTIAL EQUATIONS. (3) (Fall and Winter and Summer) (Prerequisite: MATH 222. Corequisite MATH 133) (Not open to students who have taken or are taking MATH 325) First order ordinary differential equations including elementary numerical methods. Linear differential equations. Laplace transforms. Series solutions.

MATH 316 FUNCTIONS OF A COMPLEX VARIABLE. (3) (Fall) (Prerequisites: MATH 314 and MATH 243) (Not open to students who have taken or are taking MATH 249) Algebra of complex numbers, Cauchy-Riemann equations, complex integral, Cauchy's theorems. Taylor and Laurent series, residue theory and applications.

MATH 317 NUMERICAL ANALYSIS. (3) (Fall) (Prerequisites: MATH 222, COMP 202 or equivalents) Error analysis. Interpolation. Numerical solutions of equations by iteration. Numerical integration. Introduction to numerical solutions of differential equations. Programming assumed. Some lab work necessary.

MATH 318 MATHEMATICAL LOGIC. (3) (Fall) (Not open to students who are taking or have taken PHIL 210) Propositional calculus, truth-tables, switching circuits, natural deduction, first order predicate calculus, axiomatic theories, set theory.

MATH 319 PARTIAL DIFFERENTIAL EQUATIONS. (3) (Winter) (Prerequisites: MATH 223 or MATH 236, MATH 314, MATH 315) First order equations, geometric theory; second order equations, classification; Laplace, wave and heat equations, Sturm-Liouville theory, Fourier series, boundary and initial value problems.

● ★ **MATH 320 DIFFERENTIAL GEOMETRY.** (3) (Fall) (Prerequisites: MATH 236 or MATH 223 or MATH 247, and MATH 314 or MATH 248)

MATH 323 PROBABILITY THEORY. (3) (Fall and Winter) (Prerequisites: MATH 141 or equivalent. Intended for students in Science, Engineering and related disciplines, who have had differential and integral calculus) (Not open to students who have taken or are taking MATH 356) Sample space, events. Conditional probability, independence. Bayes' theorem with applications. Random variables, univariate distributions. Mathematical expectation, moment generating function. The binominal, Poisson, exponential, normal and other distributions. Joint distributions, transformation of variables. The weak law of large numbers. Sampling distributions, chi-squared, student-t, F variables. The central limit theorem.

MATH 324 STATISTICS. (3) (Fall and Winter) (Prerequisite: MATH 323 or equivalent) (Not open to students who have taken or are taking MATH 357) (Credit for other statistics courses may preclude credit for this course and conversely) The notion of a random sample. Sampling distributions, with reference to those related to the normal; chi-squared, F and t (review). Point estimation. Hypothesis testing, the notion of power function. Likelihood-ratio tests. Contingency tables, goodness-of-fit. Some nonparametric procedures. Regression and the method of least squares, analysis of variance, one-way and two-way classifications.

MATH 325 ORDINARY DIFFERENTIAL EQUATIONS. (3) (Fall and Winter) (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 326 NONLINEAR DYNAMICS AND CHAOS.** (3) (Fall) (Prerequisites: MATH 222, MATH 223) (Not open to students who have taken or are taking MATH 376)

MATH 327 MATRIX NUMERICAL ANALYSIS. (3) (Winter) (Prerequisites: MATH 223 or MATH 236. Corequisite: MATH 317) Numerical methods for solving systems of linear algebraic equations, matrix inversion and eigenvalue problems. Topics from least

squares approximation, spline approximation and boundary value problems.

● ★ **MATH 328 COMPUTABILITY AND MATHEMATICAL LINGUISTICS.** (3) (Winter)

MATH 329 THEORY OF INTEREST. (3) (Winter) (Prerequisite: MATH 141) Simple and compound interest, annuities certain, amortization schedules, bonds, depreciation.

MATH 330 MATHEMATICAL FINANCE. (3) (Fall) (Prerequisites: MATH 222, MATH 323 or equivalent) Introduction to concepts of price and hedge derivative securities. The following concepts will be studied in both discrete and continuous time: filtrations, martingales, the change-of-measure technique, hedging, pricing, absence of arbitrage opportunities and the Fundamental Theorem of Asset Pricing.

● **MATH 333 ANALYSIS.** (3)

MATH 338 HISTORY AND PHILOSOPHY OF MATHEMATICS. (3) (Fall) Egyptian, Babylonian, Greek, Indian and Arab contributions to mathematics are studied together with some modern developments they give rise to, for example, the problem of trisecting the angle. European mathematics from the Renaissance to the 18th century is discussed in some detail.

● ★ **MATH 339 FOUNDATIONS OF MATHEMATICS.** (3) (Winter) (Prerequisites: MATH 235, MATH 318)

MATH 340 ABSTRACT ALGEBRA AND COMPUTING. (3) (Winter) (Prerequisites: MATH 240, MATH 223 (or MATH 236)) (For Major and Honours students in Computer Science only. Others only with the instructor's permission) Basic number theory: divisibility, Euclid's algorithm, congruences, Fermat's "little" theorem, primality testing, factorization. Commutative rings: basic definitions, (integers), gaussian integers, polynomial rings, euclidean rings, finite fields. Groups: symmetry groups, permutation groups. Additional topics.

MATH 343 DISCRETE MATHEMATICS AND APPLIED ALGEBRA. (3) (Winter) (Prerequisites: MATH 236, COMP 202) Basic combinatorics, introductory graph theory, matching, elementary group theory and symmetry, directed graphs and networks, modular arithmetic and its applications.

★ **MATH 346 NUMBER THEORY.** (3) (Winter) (Prerequisite: MATH 235 or consent of instructor) Divisibility. Congruences. Quadratic reciprocity. Diophantine equations. Arithmetical functions.

MATH 348 TOPICS IN GEOMETRY. (3) (Fall and Summer) (Prerequisite: Previous course in Mathematics) Selected topics - the particular selection may vary from year to year. Topics include: isometries in the plane, symmetry groups of frieze and ornamental patterns, equidecomposibility, non-Euclidean geometry and problems in discrete geometry.

MATH 354 ANALYSIS 3. (3) (Fall) (Prerequisite: MATH 255 or equivalent) Introduction to metric spaces. Multivariable differential calculus, implicit and inverse function theorems.

MATH 355 ANALYSIS 4. (3) (Winter) (Prerequisite: MATH 255 or equivalent) Lebesgue measure on Rn and integration, convergence theorems, Fubini's theorem. Further topics in metric spaces. Introduction to Lp spaces, Fourier series.

MATH 356 PROBABILITY. (3) (Fall) (Prerequisite: MATH 255 or MATH 243) (Not open to students who have taken or are taking MATH 323) Basic combinatorial probability. Introductory distribution theory of univariate and multivariate distributions with special reference to the Binomial, Poisson, Gamma and Normal distributions. Characteristic functions. Weak law of large numbers. Central limit theorem.

MATH 357 STATISTICS. (3) (Winter) (Prerequisite: MATH 356 or equivalent) (Not open to students who have taken or are taking MATH 324) Data analysis. Estimation and hypothesis testing. Power of tests. Likelihood ratio criterion. The chi-squared goodness of fit test. Introduction to regression analysis and analysis of variance.

MATH 370 ALGEBRA 3. (3) (Fall) (Prerequisite: MATH 251) Introduction to monoids, groups, permutation groups; the isomorphism theorems for groups; the theorems of Cayley, Lagrange and Sylow; structure of groups of low order. Introduction to ring theory; integral domains, fields, quotient field of an integral domain; polynomial rings; unique factorization domains.

MATH 371 ALGEBRA 4. (3) (Winter) (Prerequisite: MATH 370) Introduction to modules and algebras; finitely generated modules over a principal ideal domain. Field extensions; finite fields; Galois groups; the fundamental theorem of Galois theory; application to the classical problem of solvability by radicals.

MATH 375 DIFFERENTIAL EQUATIONS. (3) (Fall) (Prerequisites: MATH 247 or MATH 251 or equivalent, MATH 248 or equivalent, MATH 325) First order partial differential equations, geometric theory, classification of second order linear equations, Sturm-Liouville problems, orthogonal functions and Fourier series, eigenfunction expansions, separation of variables for heat, wave and Laplace equations, Green's function methods, uniqueness theorems.

● ★ **MATH 376 CHAOS AND NONLINEAR DYNAMICS.** (3) (Fall) (Prerequisites: MATH 222, MATH 223) (Intended primarily for Honours students. Not open to students who have taken or are taking MATH 326)

★ **MATH 377 NUMBER THEORY.** (3) (Winter) (Prerequisite: Enrolment in Mathematics Honours program or consent of instructor) This course consists of the lectures of MATH 346 together with a special project or projects assigned after consultation between the instructor and student.

MATH 380 DIFFERENTIAL GEOMETRY. (3) (Winter) (Prerequisites: MATH 251 or MATH 247, and MATH 248 or MATH 314) In addition to the topics of MATH 320, topics in the global theory of plane and space curves, and in the global theory of surfaces are presented. These include: total curvature and the Fary-Milnor theorem on knotted curves, abstract surfaces as 2-d manifolds, the Euler characteristic, the Gauss-Bonnet theorem for surfaces.

● ★ **MATH 387 NUMERICAL ANALYSIS.** (3) (Fall) (Prerequisites: MATH 222 and COMP 202 or COMP 250 or equivalent, or consent of instructor) (Intended primarily for Honours students)

● **MATH 397 MATRIX NUMERICAL ANALYSIS.** (3) (Prerequisites: MATH 251, MATH 387 or consent of instructor)

★ **MATH 407 DYNAMIC PROGRAMMING.** (3) (Winter) (Prerequisites: COMP 202; MATH 223 or MATH 236, MATH 314, MATH 315 and MATH 323) Sequential decision problems, resource allocation, transportation problems, equipment replacement, integer programming, network analysis, inventory systems, project scheduling, queuing theory calculus of variations, markovian decision processes, stochastic path problems, reliability, discrete and continuous control processes.

MATH 417 MATHEMATICAL PROGRAMMING. (3) (Fall) (Prerequisites: COMP 202, and MATH 223 or MATH 236, and MATH 314 or equivalent) An introductory course in optimization by linear algebra, and calculus methods. Linear programming (convex polyhedra, simplex method, duality, multi-criteria problems), integer programming, and some topics in nonlinear programming (convex functions, optimality conditions, numerical methods). Representative applications to various disciplines.

MATH 420 INDEPENDENT STUDY IN MATHEMATICS. (3) (Fall and Winter and Summer) (Requires Departmental Approval) (Please see regulations concerning "Project Courses" under Faculty Degree Requirements) Reading projects permitting independent study under the guidance of a staff member specializing in a subject where no appropriate course is available. Arrangements must be made with an instructor and the Chair before registration.

MATH 423 REGRESSION AND ANALYSIS OF VARIANCE. (3) (Fall) (Prerequisites: MATH 324, and MATH 223 or MATH 236) Least-squares estimators and their properties. Analysis of variance. Linear models with general covariance. Multivariate normal and chi-squared distributions; quadratic forms. General linear hypothesis: F-test and t-test. Prediction and confidence intervals. Transformations and residual plot. Balanced designs.

● ★ **MATH 437 MATHEMATICAL METHODS IN BIOLOGY.** (3) (Fall) (Prerequisites: MATH 315 or MATH 325, and MATH 323 or MATH 356, a CEGEP or higher level computer programming course)

● ★ **MATH 447 STOCHASTIC PROCESSES.** (3) (Winter) (Prerequisite: MATH 323)

MATH 466 COMPLEX ANALYSIS. (3) (Fall) (Prerequisite: MATH 354) Functions of a complex variable, Cauchy-Riemann equations, Cauchy's theorem and its consequences. Uniform convergence on compacta. Taylor and Laurent series, open mapping theorem, Rouché's theorem and the argument principle. Calculus of residues. Fractional linear transformations.

MATH 470 HONOURS PROJECT. (3) (Fall and Winter and Summer) (Requires Departmental Approval) (Prerequisites: appropriate second year honours courses with approval of coordinator) (Please see regulations concerning "Project Courses" under Faculty Degree Requirements) The student will be assigned a project supervisor and a project topic at the beginning of the semester. The project will consist of a written report including a literature survey and will be tested by an oral examination.

MATH 480 INDEPENDENT STUDY IN MATHEMATICS. (3) (Fall and Winter and Summer) (Please see regulations concerning "Project Courses" under Faculty Degree Requirements) (Requires Departmental Approval) Reading projects permitting independent study under the guidance of a staff member specializing in a subject where no appropriate course is available. Arrangements must be made with an instructor and the Chair before registration.

MATH 487 MATHEMATICAL PROGRAMMING. (3) (Fall) (Prerequisites: MATH 248, MATH 251 and COMP 202 or MATH 250 or equivalent) Intended primarily for honours students. This course consists of the lectures of MATH 417 together with a special project or projects assigned after consultation between the instructor and the student.

★ **MATH 488 SET THEORY.** (3) (Fall) (Prerequisites: MATH 251 or MATH 255 or permission of instructor) Axioms of set theory. Operations on sets. Ordinal and cardinal numbers. Well-orderings, transfinite induction and recursion. Consequences of the axiom of choice. Boolean algebras. Cardinal arithmetic. Topics include: Linear orderings, trees. Infinite combinatorics, partition calculus. Set-theoretic aspects of point-set topology. Descriptive set-theory. Stationary sets. Set-theoretic principles going beyond the basic axiom system.

MATH 523 GENERALIZED LINEAR MODELS. (4) (Winter) (Prerequisite: MATH 423 or EPIB 697) (Not open to students who have taken MATH 426) Modern discrete data analysis. Exponential families, orthogonality, link functions. Inference and model selection using analysis of deviance. Shrinkage (Bayesian, frequentist viewpoints). Smoothing. Residuals. Quasi-likelihood. Sliced inverse regression. Continency tables: logistic regression, log-linear models. Censored data. Applications to current problems in medicine, biological and physical sciences. GLIM, S, software.

MATH 524 NONPARAMETRIC STATISTICS. (4) (Fall) (Prerequisite: MATH 324 or equivalent) (Not open to students who have taken MATH 424) Distribution free procedures for 2-sample problem: Wilcoxon rank sum, Siegel-Tukey, Smirnov tests. Shift model: power and estimation. Single sample procedures: Sign, Wilcoxon signed rank tests. Nonparametric ANOVA: Kruskal-Wallis, Friedman tests. Association: Spearman's rank correlation, Kendall's tau. Goodness of fit: Pearson's chi-square, likelihood ratio, Kolmogorov-Smirnov tests. Statistical software packages used.

MATH 525 SAMPLING THEORY AND APPLICATIONS. (4) (Winter) (Prerequisite: MATH 324 or equivalent) (Not open to students who have taken MATH 425) Simple random sampling, domains, ratio and regression estimators, superpopulation models, stratified sampling, optimal stratification, cluster sampling, sampling with unequal probabilities, multistage sampling, complex surveys, nonresponse.

● **MATH 555 FLUID DYNAMICS.** (4) (prerequisites: MATH 315 and MATH 319 or equivalent)

MATH 556 MATHEMATICAL STATISTICS 1. (4) (Fall) (Prerequisite: MATH 357 or equivalent) Probability and distribution theory (univariate and multivariate). Exponential families. Laws of large numbers and central limit theorem.

MATH 557 MATHEMATICAL STATISTICS 2. (4) (Winter) (Prerequisite: MATH 556) Sampling theory (including large-sample theory). Likelihood functions and information matrices. Hypothesis testing, estimation theory. Regression and correlation theory.

MATH 560 OPTIMIZATION. (4) (Winter) (Prerequisite: Undergraduate background in analysis and linear algebra, with instructor's approval) Classical optimization in n variables. Convex sets and functions, optimality conditions for single-objective and multi-objective nonlinear optimization problems with and without constraints. Duality theories and their economic interpretations. Optimization with functionals. Connections with calculus of variations and optimal control. Stability of mathematical models. Selected numberical methods.

● **MATH 561 ANALYTICAL MECHANICS.** (4) (Prerequisites: MATH 354 and MATH 380 or instructor's approval)

MATH 564 ADVANCED REAL ANALYSIS 1. (4) (Fall) (Prerequisites: MATH 354, MATH 355 or equivalents) Review of theory of measure and integration; product measures, Fubini's theorem; Lp spaces; basic principles of Banach spaces; Riesz representation theorem for C(X); Hilbert spaces; part of the material of 189-565 may be covered as well.

MATH 565 ADVANCED REAL ANALYSIS 2. (4) (Winter) (Prerequisite: MATH 564) Continuation of topics from MATH 564. Signed measures, Hahn and Jordan decompositions. Radon-Nikodym theorems, complex measures, differentiation in Rn, Fourier series and integrals, additional topics.

● **MATH 566 ADVANCED COMPLEX ANALYSIS.** (4) (Winter) (Prerequisites: MATH 466, MATH 564)

MATH 570 HIGHER ALGEBRA 1. (4) (Fall) (Prerequisite: MATH 371 or equivalent) Review of group theory; free groups and free products of groups. Sylow theorems. The category of R-modules; chain conditions, tensor products, flat, projective and injective modules. Basic commutative algebra; prime ideals and localization, Hilbert Nullstellensatz, integral extensions. Dedekind domains. Part of the material of MATH 571 may be covered as well.

MATH 571 HIGHER ALGEBRA 2. (4) (Winter) (Prerequisites: MATH 570 or consent of instructor) Completion of the topics of MATH 570. Rudiments of algebraic number theory. A deeper study of field extensions; Galois theory, separable and regular extensions. Semi-simple rings and modules. Representations of finite groups.

● **MATH 574 ORDINARY DIFFERENTIAL EQUATIONS.** (4) (Prerequisites: MATH 325, MATH 354)

● **MATH 575 PARTIAL DIFFERENTIAL EQUATIONS.** (4) (Prerequisite: MATH 375)

MATH 576 GEOMETRY AND TOPOLOGY 1. (4) (Fall) (Prerequisite: MATH 354) Basic point-set topology, including connectedness, compactness, product spaces, separation axioms, metric spaces. The fundamental group and covering spaces. Simplicial complexes. Singular and simplicial homology. Part of the material of MATH 577 may be covered as well.

MATH 577 GEOMETRY AND TOPOLOGY 2. (4) (Winter) (Prerequisite: MATH 576) Continuation of the topics of MATH 576. Manifolds and differential forms. De Rham's theorem. Riemannian geometry. Connections and curvatures 2-Manifolds and imbedded surfaces.

MATH 578 NUMERICAL ANALYSIS 1. (4) (Fall) (Prerequisites: A first course in numerical analysis with programming and a background in real and complex analysis, with Instructor's approval) Errors in computation, vector and matrix norms. Iteration methods for roots in Rn and the complex plane. Interpolation including osculating and spline interpolation. Numerical differentiation and integration including Romberg and Gaussian methods and the Peano theorem. Matrix calculations with condition numbers and error bounds. Band matrices, eigenvalue calculations and applications to boundary value problems.

MATH 579 NUMERICAL DIFFERENTIAL EQUATIONS. (4) (Winter) (Prerequisites: a background in ordinary and partial differential equations as well as numerical analysis, with instructor's approval) Basic error analysis. Numerical solution of initial and boundary value problems for ordinary differential equations; simple, multiple shooting methods and finite difference methods. Finite difference methods for partial differential equations: parabolic, hyperbolic and elliptical equations, consistency, convergence and stability of numerical schemes. Explicit and implicit methods, alternating direction explicit and alternating direction implicit methods.

MATH 585 INTEGRAL EQUATIONS AND TRANSFORMS. (4) (Winter) Integral transforms. Introduction to the theory of Hilbert spaces. Fredholm and Volterra integral equations; exact and approximate solutions. Equations with Hermitian kernels. Hilbert Schmidt theorem and consequences. Representation formulas for the solutions of initial and boundary value problems. Green's functions. Applications.

MATH 586 APPLIED PARTIAL DIFFERENTIAL EQUATIONS. (4) (Fall or Winter) (Prerequisites MATH 316, MATH 375 or equivalent) Linear and nonlinear partial differential equations of applied mathematics. Classification and appropriate partial initial and/or boundary conditions for elliptic, hyperbolic and parabolic equations. Method of characteristics for first-order systems and quasi linear equations. Transform methods. Introduction to generalized functions. Special techniques for finding exact solutions of nonlinear equations.

MATH 587 ADVANCED PROBABILITY THEORY 1. (4) (Fall) (Prerequisite: MATH 356 or equivalent and approval of instructor) Probability spaces. Random variables and their expectations. Convergence of random variables in Lp. Independence and conditional expectation. Introduction to Martingales. Limit theorems including Kolmogorov's Strong Law of Large Numbers.

MATH 589 ADVANCED PROBABILITY THEORY 2. (4) (Winter) (Prerequisites: MATH 587 or equivalent) Characteristic functions: elementary properties, inversion formula, uniqueness, convolution and continuity theorems. Weak convergence. Central limit theorem. Additional topic(s) chosen (at discretion of instructor) from: Martingale Theory; Brownian moiton, stochastic calculus.

MATH 591 MATHEMATICAL LOGIC 1. (4) (Winter) (Prerequisites: MATH 488 or equivalent or consent of instructor) Propositional logic and first order logic, completeness, compactness and Löwenheim-Skolem theorems. Introduction to axiomatic set theory. Some of the following topics: introduction to model theory, Herbrand's and Gentzen's theories, Lindström's characterization of first order logic.

● **MATH 592 MATHEMATICAL LOGIC 2.** (4) (Winter) (Prerequisites: MATH 488 or equivalent or consent of instructor)

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Microbiology & Immunology: Lawrence Kleiman
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Microbiology is the study of microorganisms such as bacteria, viruses, unicellular eukaryotes, and parasites. Microorganisms play an important role in human and animal disease, food production (bread, cheese, wine), decay and spoilage, contamination and purification of water and soil. Microbiologists study these tiny, self-replicating machines to understand the basic principles of life: growth, metabolism, cell division, control of gene expression, response to environmental stimuli. Microbiologists are also concerned with controlling or harnessing microorganisms for the benefit of people, by isolating antibiotics or producing vaccines to protect against disease, and by developing and perfecting microorganisms for industrial uses.

Immunology is the study of the molecular and cellular basis of host resistance and immunity to external agents such as pathogenic microorganisms. Immunologists study the mechanisms by which the body recognizes foreign antigens, generates appropriate antibodies to an enormously diverse spectrum of antigens, and sequesters and kills invading microorganisms. Their discoveries lead to vaccination against disease, transfusions and organ transplants, allergies, cancer, autoimmune diseases and immune-deficiency diseases such as AIDS. Antibodies may soon be used in conjunction with antibiotics or chemical agents as specific "magic bullets" to diagnose disease and attack microbes and cancers.

The disciplines of microbiology and immunology are natural partners in research, and both fields use the modern methods of cell biology, molecular biology and genetics to study basic life processes. The members of the Department of Microbiology and Immunology perform research on microbial physiology and genetics, microbial pathogenesis, molecular virology, cellular and molecular immunology, and parasitology. Students registered in

the Department therefore are exposed to these related areas and receive an excellent background in basic biology and chemistry as well as in the more applied areas of biotechnology and medicine.

Many opportunities exist for careers in basic or applied microbiology and immunology, medical microbiology, environmental microbiology, and biotechnology. They include positions in industry (pharmaceutical and biotechnology), hospitals, universities, and government (environment, public health, and energy). A degree in microbiology also provides an excellent basis for entering professional and postgraduate programs in medicine, dentistry, the veterinary sciences, research, and education.

Notes on admission to Microbiology and Immunology programs. Please note that enrolment to Microbiology and Immunology programs is limited to a total of 120 students per year. Students seeking admission to the Faculty, Majors and Honours programs must have completed BIOL 111, BIOL 112, CHEM 110 or CHEM 111, CHEM 120 or CHEM 121, MATH 112, MATH 139 or MATH 140, MATH 141, PHYS 101 and PHYS 102 or their equivalent with an overall average of at least of 65% (B-). Students transferring from other programs may be admitted with a B- average up to the maximum program capacity of 120 students. Applicants not admitted will be placed on a waiting list and will be considered should vacancies occur. Application deadline for U0 or transfer students from other departments and faculties is April 20. Students who want to transfer to Microbiology and Immunology should consider taking MIMM 211 as a complementary course.

An Undergraduate Handbook, containing detailed course descriptions, a listing of faculty research interests, and information on careers in microbiology and immunology, is available from the Student Affairs Office in room 511 of the Lyman Duff Building and on the web at: http://www.microimm.mcgill.ca.

All students (U1, U2, U3) must meet with an adviser prior to registration. For an appointment, telephone (514) 398-3915.

FACULTY PROGRAM IN MICROBIOLOGY AND IMMUNOLOGY (57 credits)

The Faculty Program is intended to offer a basic education in microbiology and immunology to undergraduate students who wish greater flexibility to choose a substantial number of courses from other departments or faculties within the University.

U1 Required Courses (18 credits)

MIMM 211	(3)	Biology of Microorganisms
MIMM 212	(2)	Laboratory in Microbiology
BIOL 200	(3)	Molecular Biology
BIOL 201	(3)	Cell Biology and Metabolism
or BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOL 202	(3)	Basic Genetics
CHEM 212	(4)	Organic Chemistry 1

U1, U2 or U3 Required Course (3 credits)

BIOL 373	(3)	Biostatistical Analysis
or MATH 203	(3)	Principles of Statistics 1
or PSYC 204	(3)	Introduction to Psychological Statistics

U2 Required Courses (15 credits)

MIMM 314	(3)	Immunology
MIMM 323	(3)	Microbial Physiology
MIMM 324	(3)	Fundamental Virology
MIMM 386D1	(3)	Laboratory in Microbiology and Immunology
MIMM 386D2	(3)	Laboratory in Microbiology and Immunology

U3 Complementary Courses (6 credits)
6 credits selected from:

MIMM 387	(3)	Applied Microbiology and Immunology
MIMM 413	(3)	Parasitology
MIMM 414	(3)	Advanced Immunology
MIMM 465	(3)	Bacterial Pathogenesis and Host Defences
MIMM 466	(3)	Viral Pathogenesis and Host Defences
MIMM 509	(3)	Seminars on Inflammatory Processes

U1, U2 or U3 Complementary Courses (15 credits)
15 credits selected from:

BIOL 300	(3)	Molecular Biology of the Gene
BIOL 314	(3)	Molecular Biology of Oncogenes
CHEM 203	(3)	Survey of Physical Chemistry
or CHEM 204	(3)	Intro. to Physical Chemistry/Biol.Science
CHEM 222	(4)	Organic Chemistry 2
CHEM 302	(3)	Organic Chemistry 3
BIOT 505	(3)	Selected Topics in Biotechnology
ANAT 261	(4)	Introduction to Dynamic Histology
ANAT 262	(3)	Intro. Molecular and Cellular Biology
ANAT 365	(3)	Cell Biology of the Secretory Processes
ANAT 458	(3)	Membranes & Cellular Signalling
or BIOC 458	(3)	Membranes & Cellular Signalling
BIOC 311	(3)	Metabolic Biochemistry
BIOC 312	(3)	Biochemistry of Macromolecules
BIOC 450	(3)	Protein Structure and Function
BIOC 454	(3)	Nucleic Acids
BIOC 458	(3)	Membranes & Cellular Signalling
EXMD 504	(3)	Biology of Cancer
MIMM 387	(3)	Applied Microbiology and Immunology
MIMM 413	(3)	Parasitology
MIMM 414	(3)	Advanced Immunology
MIMM 465	(3)	Bacterial Pathogenesis and Host Defences
MIMM 466	(3)	Viral Pathogenesis and Host Defences
MIMM 509	(3)	Seminars on Inflammatory Processes
PATH 300	(3)	Human Disease
PHAR 300	(3)	Drug Action
PHAR 301	(3)	Drugs and Diseases
PHGY 209	(3)	Mammalian Physiology 1 (Class Schedule conflict with MIMM 324, if taken should be in U1 or U3)
PHGY 210	(3)	Mammalian Physiology 2

MAJOR PROGRAM IN MICROBIOLOGY AND IMMUNOLOGY \ (67 credits)

The Major Program is designed for students who want to acquire a substantial background in microbiology and immunology and related disciplines (chemistry, biology, biochemistry) which will prepare them for professional schools, graduate education, or entry into jobs in industry or research institutes.

U1 Required Courses (25 credits)
as for the Faculty Program, plus:

CHEM 222	(4)	Organic Chemistry 2
CHEM 203	(3)	Survey of Physical Chemistry
or CHEM 204	(3)	Physical Chem./Biol. Sc. 1

U1, U2 or U3 Required Statistics Courses (3 credits)
as for the Faculty Program

U2 Required Courses (21 credits)
as for the Faculty program, plus

BIOC 311	(3)	Metabolic Biochemistry
BIOC 312	(3)	Biochemistry of Macromolecules

U3 Required Courses (9 credits)

MIMM 413	(3)	Parasitology
MIMM 465	(3)	Bacterial Pathogenesis and Host Defences
MIMM 466	(3)	Viral Pathogenesis and Host Defences

Complementary Courses (9 credits)
9 credits selected from:

BIOL 300	(3)	Molecular Biology of the Gene
BIOL 314	(3)	Molecular Biology of Oncogenes
CHEM 302	(3)	Organic Chemistry 3
BIOT 505	(3)	Selected Topics in Biotechnology
ANAT 261	(4)	Introduction to Dynamic Histology
ANAT 262	(3)	Intro. Molecular and Cellular Biology
ANAT 458	(3)	Membranes & Cellular Signaling
or BIOC 458	(3)	Membranes & Cellular Signaling
ANAT 365	(3)	Cell Biology of the Secretory Process
BIOC 450	(3)	Protein Structure and Function

BIOC 454	(3)	Nucleic Acids
EXMD 504	(3)	Biology of Cancer
MIMM 387	(3)	Applied Microbiology and Immunology
MIMM 414	(3)	Advanced Immunology
MIMM 509	(3)	Seminars in Inflammatory Processes
PATH 300	(3)	Human Disease
PHAR 300	(3)	Drug Action
PHAR 301	(3)	Drugs and Diseases
PHGY 209	(3)	Mammalian Physiology 1 (Class Schedule conflict with MIMM 324, if taken should be in U1 or U3)
PHGY 210	(3)	Mammalian Physiology 2

HONOURS PROGRAM IN MICROBIOLOGY AND IMMUNOLOGY (73 required credits)

The Honours Program is designed to offer, in addition to the substantial background given by the Major Program, a significant research experience in a laboratory within the Department during the U3 year. Students are prepared for this independent research project by following an advanced laboratory course in U2. This Program is intended to prepare students for graduate study in microbiology and immunology or related fields, but could also be chosen by students intending to enter medical research after medical school, or intending to enter the job market in a laboratory research environment.

Students intending to apply to Honours must follow the Major program in U1 and U2 and must obtain a CGPA of at least 3.30 at the end of their U2 year. For graduation in Honours, students must pass all required courses with a C or better, and achieve a sessional GPA of at least 3.10 in the U3 year.

U1 Required Courses (25 credits)
as for the Major Program

U1, U2 or U3 Required Statistics Courses (3 credits)
as for the Faculty Program

U2 Required Courses (21 credits)
as for the Major program

U3 Required Courses (21 credits)
as for the Major Program, plus:

MIMM 502D1	(6)	Honours Research
MIMM 502D2	(6)	Honours Research

Complementary Courses (3 credits)
3 credits selected from:

BIOL 520	(3)	Gene Activity in Development
BIOT 505	(3)	Selected Topics in Biotechnology
ANAT 458	(3)	Membranes & Cellular Signalling
or BIOC 458	(3)	Membranes & Cellular Signalling
BIOC 404	(3)	Biophysical Chemistry
BIOC 450	(3)	Protein Structure and Function
BIOC 454	(3)	Nucleic Acids
BIOC 455	(3)	Neurochemistry
MIMM 414	(3)	Advanced Immunology
MIMM 509	(3)	Seminars in Inflammatory Processes
PHAR 562	(3)	General Pharmacology 1
PHAR 563	(3)	General Pharmacology 2

INTERDEPARTMENTAL HONOURS PROGRAM IN IMMUNOLOGY

The Departments of Biochemistry, Microbiology and Immunology and Physiology offer an interdepartmental Honours program in Immunology. Students interested in immunology may choose between this Honours program and the Honours program of the Department of Microbiology and Immunology.

Details of this program may be found in section 12.13 or by consulting Professor Baines in the Department of Microbiology and Immunology, Room 404, telephone (514) 398-4443 or 3928 or mgbaines@microimm.mcgill.ca

COURSE DESCRIPTIONS

Please note: courses may have been rescheduled or new courses added after this Calendar went to press. Students preparing to register are advised to consult the 2002-2003 Class Schedule on the Web, http://www.mcgill.ca/minerva-students for the most up-to-date information.

The Class Schedule includes the term(s), days, and times when courses will be offered, as well as class locations and names of instructors.

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

The course credit weight is given in parentheses after the title. Term(s) offered (Fall, Winter, Summer) may appear after the credit weight to indicate when a course would normally be taught. Please check the Class Schedule to confirm this information.

MIMM has replaced 528 as the prefix for Microbiology and Immunology courses.

All courses have limited enrolment.

● Denotes courses not offered in 2002-03.

MIMM 211 BIOLOGY OF MICROORGANISMS. (3) (Fall) (3 hours of lecture) (Corequisite: BIOL 200) A general treatment of microbiology bearing specifically on the biological properties of microorganisms. Emphasis will be on procaryotic cells. Basic principles of immunology and microbial genetics are also introduced.

MIMM 212 LABORATORY IN MICROBIOLOGY. (2) (Fall) (3 hours of laboratory, 1 hour of conference) (Corequisite: MIMM 211) This laboratory course is designed to complement MIMM 211. Sessions introduce general techniques peculiar to the handling of microorganisms.

MIMM 314 IMMUNOBIOLOGY. (3) (Winter) (3 hours of lecture) (Prerequisite: BIOL 200 and BIOL 201 or BIOC 212) An introduction to the immune system, antigens, antibodies and lymphocytes. The course will cover the cellular and molecular basis of lymphocyte development and mechanisms of lymphocyte activation in immune responses.

MIMM 323 MICROBIAL PHYSIOLOGY. (3) (Fall) (3 hours of lecture) (Prerequisite: MIMM 211) An introduction to the composition and structure of microbial cells, the biochemical activities associated with cellular metabolism and how these activities are regulated and coordinated. The course will have a molecular and genetic approach to the study of microbial physiology.

MIMM 324 FUNDAMENTAL VIROLOGY. (3) (Fall) (3 hours of lecture) (Prerequisites: MIMM 211, BIOL 200, BIOL 201 or BIOC 212) A study of the fundamental properties of viruses and their interactions with host cells. Bacteriophages, DNA- and RNA-containing animal viruses, and retroviruses are covered. Emphasis will be on phenomena occurring at the molecular level and on the regulated control of gene expression in virus-infected cells.

MIMM 386D1 LABORATORY IN MICROBIOLOGY AND IMMUNOLOGY. (3) (Fall) (1 hour lecture, 6 hours laboratory, 1 hour follow-up) (Prerequisites: MIMM 211, MIMM 212. Corequisites: MIMM 314, MIMM 323, MIMM 324) (Students must also register for MIMM 386D2) (No credit will be given for this course unless both MIMM 386D1 and MIMM 386D2 are successfully completed in consecutive terms) A series of illustrative exercises in bacterial classification, bacterial and viral molecular genetics and immunological techniques. The objective is to provide a practical introduction to microbiological and immunological research and technology.

MIMM 386D2 LABORATORY IN MICROBIOLOGY AND IMMUNOLOGY. (3) (Winter) (Prerequisite: MIMM 386D1) (No credit will be given for this course unless both MIMM 386D1 and MIMM 386D2 are successfully completed in consecutive terms) See MIMM 386D1 for course description.

MIMM 387 APPLIED MICROBIOLOGY AND IMMUNOLOGY. (3) (Winter) (Prerequisite: MIMM 211) The ability to select and manipulate genetic material has lead to unprecedented interest in the industrial applications of procaryotic and eucaryotic cells. Beginning in the 1970s the introduction of and subsequent refinements to

recombinant DNA technology and hybridoma technology transformed the horizons of the biopharmaceutical world. This course will highlight the important events that link basic research to clinical/commercial application of new drugs and chemicals.

MIMM 413 PARASITOLOGY. (3) (Winter) (Prerequisite: MIMM 314 or equivalent - ANAT 261 is strongly recommended) A study of the biology, immunological aspects of host-parasite interactions, pathogenicity, epidemiology and molecular biological aspects of selected parasites of medical importance. Laboratory will consist of a lecture on techniques, demonstrations and practical work.

MIMM 414 ADVANCED IMMUNOLOGY. (3) (Fall) (3 hour lecture) (Prerequisite: MIMM 314) An advanced course serving as a logical extension of MIMM 314. The course will integrate molecular, cellular and biochemical events involved in the ontogeny of the lymphoid system and its activation in the immune response. The course will provide the student with an up-to-date understanding of a rapidly moving field.

MIMM 465 BACTERIAL PATHOGENESIS AND HOST DEFENCES. (3) (Fall) (3 hours of lecture) (Prerequisites: MIMM 211, MIMM 314, MIMM 323, or the permission of the instructor) Organized by the McGill Centre for the Study of Host Resistance. This course focuses on the interplay of the host and the pathogen. The cellular and molecular basis of the host defense mechanism against infections will be considered in relationship to the virulence factors and evasion strategies used by bacteria to cause disease.

MIMM 466 VIRAL PATHOGENESIS AND HOST DEFENCES. (3) (Winter) (3 hours of lecture) (Prerequisites: MIMM 211, MIMM 324, MIMM 314) A study of the biological and molecular aspects of viral pathogenesis with emphasis on the human pathogenic viruses including the retroviruses HIV and HTLV-1; herpes viruses; papilloma viruses; hepatitis viruses; and new emerging human viral diseases. These viruses will be discussed in terms of virus multiplication, gene expression virus-induced cytopathic effects and host immune response to infection.

- **MIMM 486D1 LABORATORY METHODS.** (1)
- **MIMM 486D2 LABORATORY METHODS.** (1)

MIMM 502D1 HONOURS RESEARCH PROJECT. (6) (Fall) (More than 15 hours per week for an independent research project) (U3 Honours students and Majors students are eligible. Required CGPA: 3.30 or higher) (Please see regulations concerning "Project Courses") (Students must also register for MIMM 502D2) (No credit will be given for this course unless both MIMM 502D1 and MIMM 502D2 are successfully completed in consecutive terms) An information meeting about the course is held annually in February for students who intend to apply for registration. Subject to the availability of space and resources, professors in the Department of Microbiology and Immunology provide research opportunities for registrants in this course. Students present their research findings in a seminar and a final written report is required. Because this is a 12 credit course, students are expected to devote at least 40% of their academic effort towards their research.

MIMM 502D2 HONOURS RESEARCH PROJECT. (6) (Winter) (Prerequisite: MIMM 502D1) (No credit will be given for this course unless both MIMM 502D1 and MIMM 502D2 are successfully completed in consecutive terms) See MIMM 502D1 for course description.

MIMM 509 SEMINAR ON INFLAMMATORY PROCESSES. (3) (Winter) (3 hours of seminar) (Prerequisite: MIMM 314. Corequisite: PHGY 513 or MIMM 414) (This course will be given in conjunction with the Division of Experimental Medicine) This course concentrates on the non-specific aspects of the immune response, an area which is not adequately covered by the other immunology courses presented at the university. Interactions between guest researchers (from McGill and other universities) and students will be furthered.

12.18 Music

Strathcona Music Building
555 Sherbrooke Street West
Montreal, QC H3A 1E3

Telephone: (514) 398-4535
Fax: (514) 398-8061
Website: http://www.music.mcgill.ca

Department of Theory — TBA *(Chair)*

Department of Performance — G. Foote *(Chair)*

Adviser (B.A./B.Sc. Music programs) —
B. Minorgan (514) 398-4535, ext. 6333

SCIENCE MINOR IN MUSIC TECHNOLOGY (24 credits)
[Program registration done by Student Affairs Office]

Enrolment in the Minor in Music Technology program is highly restricted. Application forms will be available from the Department of Theory Office of the Faculty of Music (Room E220, Strathcona Music Building, 555 Sherbrooke Street West) from February 1, 2002 and must be completed and returned to that office by May 15, 2002. No late applications will be accepted and no students will be admitted to the Minor in January.

Students will be selected on the basis of their previous background or experience in music technology and/or sound recording, their computer programming skills, their expressed interest in the program, and their Cumulative Grade Point Average. Successful applicants will be notified June 1, 2002.

A B.Sc. with a Major in Computer Science and Music Technology is currently under development. Students interested in such a program are invited to contact Professor Gerald Ratzer in the School of Computer Science regarding the program, or Professor Philippe Depalle in the Faculty of Music regarding the Music Technology component.

Required Courses (24 credits)

PHYS 224	(3)	Physics and Psychophysics of Music
PHYS 225	(3)	Musical Acoustics
MUHL 342	(3)	History of Electroacoustic Music
MUMT 202	(3)	Fundamentals of New Media
MUMT 203	(3)	Introduction to Digital Audio
MUMT 301	(3)	Music and the Internet
MUMT 302	(3)	New Media Production 1
MUMT 303	(3)	New Media Production 2

The **Science Minor in Music** is no longer accepting new students. Science students wishing to take a Minor program in Music are permitted to take the Arts Minor Concentration in Music (see Faculty of Arts section).

COURSES
All courses have limited enrolment.

The following courses are offered by the Faculty of Music as electives for students in the Faculties of Arts, Science, and Education. They are also open to students from other faculties. For a complete listing of the offerings of the Faculty, consult the Faculty of Music section. Music courses not listed below may be taken by qualified students from other faculties providing they obtain permission from the relevant department in the Faculty of Music and from the Associate Dean of their own faculty.

Students preparing to register are advised to consult the 2002-2003 Class Schedule on the Web, http://www.mcgill.ca/minerva-students for the most up-to-date information. The Class Schedule includes the term(s), days, and times when courses will be offered, as well as class locations and names of instructors.

The course credit weight is given in parentheses after the title. Music courses now are prefixed as follows: MUAR has replaced 210, MUTH has replaced 211, MUHL has replaced 215. For the complete list see the page 32.

All courses have limited enrolment.

● Denotes courses not offered in 2002-03.

LIST I

Courses in List I may not be credited toward the B.A. or B.Sc. Music programs. Students who have completed an MUTH course from List II or who have Matriculation Music or McGill Conservatory Theory Secondary V or its equivalent may not register for MUAR 201 or MUAR 202. Students who read music and have an instrumental or vocal background may proceed directly to courses at the 300 level.

MUAR 201 BASIC MATERIALS: WESTERN MUSIC. (3) (3 hours) A combination of elementary theory and ear training (sightsinging and aural recognition), and basic piano skills. Topics include: notation of pitch and rhythm, intervals, scales and modes, concept of key, triads and seventh chords, introductory melody and accompaniment writing.

MUAR 202 BASIC MATERIALS: WESTERN MUSIC 2. (3) (3 hours) (Prerequisite: MUAR 201 or permission of instructor) Integrated course in music theory with creative applications of acquired skills. Analysis and writing: concepts of melodic organization, elementary harmonic progressions, two-part contrapuntal techniques, fundamental formal procedures, examination of popular song and jazz. Development of individual skills: intermediate sightsinging, aural recognition, keyboard techniques, small group performance in class.

MUAR 211 THE ART OF LISTENING. (3) (3 hours) An introduction to the major forms and styles in Western music from the baroque to the present, with emphasis on guided listening in the classroom. The ability to read music is not a prerequisite.

● **MUAR 374 SPECIAL TOPICS IN MUSIC.** (3)

MUAR 384 ROMANTICISM AND THE PIANO. (3) (3 hours) (Prerequisite: MUAR 201 or MUAR 211 or permission of instructor) A survey of nineteenth-century European piano music: the piano virtuoso as cult figure, the social functions of the piano, women and the piano, and developing Romantic sensibilities as expressed in piano music throughout the century. Repertoire may include works by Beethoven, Chopin, Liszt, and Rachmaninoff, among others.

● **MUAR 385 MUSIC OF THE AVANT-GARDE.** (3) (3 hours) (Prerequisite: MUAR 201 or MUAR 211)

MUAR 387 THE OPERA. (3) (3 hours) (Prerequisite: MUAR 201 or MUAR 211) A survey of opera from c.1600 to the present. Opera as ritual, opera as spectacle, opera as catharsis, opera as business, opera and its literary models. The continuing relevance of the operatic experience today.

MUAR 389 THE SYMPHONY AND CONCERTO. (3) (3 hours) (Prerequisite: MUAR 201 or MUAR 211) An historical overview of two major genres in the current concert repertoire: baroque foundations, the Viennese achievement, Beethoven's influence, visionaries and nationalists after 1850, cross-currents in the twentieth century.

MUAR 392 POPULAR MUSIC AFTER 1945. (3) (3 hours) (Prerequisite: MUAR 201 or MUAR 211 or permission of instructor) An historical survey of major artists, genres, and styles in the most widespread traditions of postwar commercial music. The course will include practice in techniques of listening, discussion of the shaping institutions of commercial music, and consideration of the interaction of musical style and culture.

MUAR 393 INTRODUCTION TO JAZZ. (3) (3 hours) (Prerequisite: MUAR 201 or MUAR 211 or permission of instructor. Open only to non-Music majors) A survey of the development of jazz from its late 19th-century origins in America to the present day, with an introduction to musical concepts relevant to the genre and consideration of sociocultural issues.

List II

The courses in this list are intended for students who have at least high school matriculation music or the equivalent. Students who do not have the formal music prerequisites require the permission of the Chair of the Department of Theory to register for any of these courses.

For course pre/co-requisites, descriptions and availability of MUTH and MUHL courses, please check the Class Schedule.

MUHL 184 HISTORY SURVEY - MEDIEVAL, RENAISSANCE, BAROQUE. (3)

MUHL 185 HISTORY SURVEY - CLASSICAL, ROMANTIC, 20TH-C. (3)

MUHL 220 WOMEN IN MUSIC. (3)

Note: Students not in the B.A. or B.Sc. Music programs are not required to take the corequisites for the following MUTH (theory) courses. However, students intending later to enter either the B.A. Major Concentration or the B.Mus. program would then be required to sit placement tests in Musicianship and Keyboard Proficiency and may be required to take these courses.

MUTH 110 MELODY AND COUNTERPOINT. (3)

MUTH 111 ELEMENTARY HARMONY AND ANALYSIS. (3)

MUTH 210 TONAL THEORY AND ANALYSIS 1. (3)

MUTH 211 TONAL THEORY AND ANALYSIS 2. (3)

MUSIC TECHNOLOGY

MUMT 202 FUNDAMENTALS OF NEW MEDIA. (3) (3 hours) (Prerequisites: none) (Open only to students in Music Technology, including those in Minor Programs, and students in Sound Recording, and Composition) Combining theory and practice, the course covers the areas of MIDI, sound/image/MIDI sequencing, sampling, mixing, soundfile processing and editing, elementary music systems programming, and use of the Internet for sound/music/image.

MUMT 203 INTRODUCTION TO DIGITAL AUDIO. (3) (3 hours) (Prerequisite: MUMT 202) An introduction to the theory and practice of digital audio. Topics include: sampling theory; digital sound synthesis methods (additive, subtractive, summation series); sound processing (digital mixing, delay, filters, reverberation, sound localization); software-based samplers; real-time sound processing; interactive audio systems. Hands-on exercises are included.

MUMT 301 MUSIC AND THE INTERNET. (3) (3 hours) (Prerequisite: MUMT 201 OR MUMT 202) (Not open to students in B.Mus. Honours in Music Technology) Technologies and resources of the Internet (access tools, data formats and media) and Web authoring (HTML) for musicians; locating, retrieving and working with information; putting information online; tools for music research, music skills development, technology-enhanced learning, music productivity, and promotion of music and musicians. Evaluation of Internet music resources.

MUMT 302 NEW MEDIA PRODUCTION 1. (3) (3 hours) (Prerequisite: MUMT 201 OR MUMT 202) (Not open to students in B.Mus. Honours in Music Technology) Methods and techniques for producing and modifying musical and audiovisual content in new media applications. Media formats: audiovisual sequences (QuickTime), CD-ROMs and interactive CD-ROMs, DVD, surround sound audio. Also covered: software-based synthesis and sampling, techniques for image scanning, audio capture, content manipulation, media compression and format conversion.

MUMT 303 NEW MEDIA PRODUCTION 2. (3) (3 hours) (Prerequisite: MUMT 301) (Not open to students in B. Mus. Honours in Music Technology) A continuation of MUMT 302. Students produce new media objects of increasing complexity and scope, integrating several types of content.

The Faculty of Science is divided into four parts. All sections can be accessed from the Undergraduate Programs Calendar Front Page - click on the link at the bottom of the page.