11.12 Geography (183)

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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)*
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.)
B.K. Ray; B.E.S.(Wat.), M.A.(Tor.), Ph.D.(Queen's)
R.E. Sieber; B.Sc.(Mich. St.), M.P.A.(W. Mich.), Ph.D.(Rutgers)

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 91.

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) [MARS Program Code 6-450000]

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)

183-203	(3)	Environmental Systems
183-216	(3)	Geography of the World Economy
183-217	(3)	The Canadian City
183-302	(3)	Environmental Analysis and Management: Problems and Policy

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

B.Sc. MINOR IN GEOGRAPHICAL INFORMATION SYSTEMS (18 credits) [MARS Program Code 6-450300]

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)

183-201	(3)	Introduction to GIS I
183-306	(3)	GIS II
183-307	(3)	Socioeconomic Applications of GIS
183-308	(3)	Principles of Remote Sensing
183-506	(3)	Perspectives on GIS

Complementary Course (3 credits)
one course to be chosen from:

183-535	(3)	Remote Sensing Methods
183-551	(3)	Environmental Decisions
409-505	(3)	GIS in Planning
195-414	(3)	Applications of Remote Sensing
308-420	(3)	Files & Databases
308-557*	(3)	Fundamentals of Computer Graphics*

*Note prerequisites

B.Sc. MAJOR PROGRAM IN GEOGRAPHY (58 credits) [MARS Program Code 1-450000]

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

Required Courses (22 credits)

183-201	(3)	Geographic Information Systems I
183-203	(3)	Environmental Systems
183-216	(3)	Geography of the World Economy
183-217	(3)	The Canadian City
183-272	(3)	Landforms & Environmental Systems
183-302	(3)	Environmental Analysis and Management
183-351	(3)	Quantiative Methods
183-290	(1)	Local Geographical Excursion (In 2000 reserve Sept. 22-24)

Complementary Courses (36 credits)
3 credits of statistics chosen from:

166-350	(3)	Statistics in Social Research
177-373	(3)	Biostatistical Analysis
189-203	(3)	Principles of Statistics
204-204	(3)	Introduction to Psychological Statistics

3 credits from GIS techniques:
183-306 (3) Geographic Information Systems II
183-308 (3) Principles of Remote Sensing
12 credits from systematic physical geography:
183-305 (3) Soils and Environment
183-321 (3) Climatic Environments
183-322 (3) Environmental Hydrology
183-350 (3) Ecological Biogeography
183-372 (3) Running Water Environments
3 credits from field courses:
183-495 (3) Field Studies - Physical Geography
183-496 (3) Regional Geographical Excursion
183-497 (3) Coastal Marsh Plant Ecology
183-499 (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.

B.Sc. HONOURS PROGRAM IN GEOGRAPHY (67 credits)
[MARS Program Code 2-450000]

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 (31 credits)
22 credits of introductory courses
(see B.Sc. Major program in Geography)
9 credits of research and thesis courses:
183-381 (3) Evolution of Geography
183-491D,N (6) Honours Research and Reading

Complementary Courses (36 credits)
from the same list as for the B.Sc. Major Program in Geography.

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 11.19. Many Science students choose to take some of these courses.

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

● Denotes courses not offered in 2000-01.
▭ Denotes Limited Enrolment.

● ▭ **183-190A ENVIRONMENTAL PERSPECTIVES.** (1) (FYS – for first year, non-Geography students only, maximum 25.)

● ▭ **183-199A PEOPLE, PLACE AND ENVIRONMENT.** (3) (FYS – for first year students only, maximum 25. Closed to Geography Majors.)

183-200A GEOGRAPHICAL PERSPECTIVES ON WORLD ENVIRONMENTAL PROBLEMS. (3) (3 hours)

183-201A GEOGRAPHIC INFORMATION SYSTEMS I. (3) (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.
Professors Lewis and Ewing

183-203A ENVIRONMENTAL SYSTEMS. (3) (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.
Professors Chmura, Lapointe, Moore and Roulet

183-205B GLOBAL CHANGE: PAST, PRESENT AND FUTURE. (3) (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.
Professors Chmura and Moore

183-216A GEOGRAPHY OF THE WORLD ECONOMY. (3) (3 hours)

183-217B THE CANADIAN CITY. (3) (3 hours)

183-272B LANDFORMS & ENVIRONMENTAL SYSTEMS. (3) (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.
Staff

▭ **183-290A LOCAL GEOGRAPHICAL EXCURSION.** (1 credit) (Open to first-year Geography Major and Honours students only. Not open to students who have taken 183-199.) Introduction to landscape interpretation and geographical site analysis in physical and human geography. A three-day fall excursion with preparatory and concluding seminars. September 22-24, 2000.
Staff

183-300B HUMAN ECOLOGY IN GEOGRAPHY. (3) (3 hours) (Prerequisite: 183-203 or 151-202 or 177-111)

183-301A GEOGRAPHY OF NUNAVUT. (3) (3 hours)

183-302B ENVIRONMENTAL ANALYSIS AND MANAGEMENT: PROBLEMS AND POLICY. (3) (3 hours) (Prerequisite: 183-203 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 related environmental management. Study of the use of Canadian biological resources and of the impact of industrial processes. Students develop dossiers and assess applied research methods.
Professor Meredith

183-305A SOILS AND ENVIRONMENT. (3) (2 hours and laboratory) (Prerequisite: 183-203 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).
Professor Moore

183-306B GEOGRAPHIC INFORMATION SYSTEMS II. (3) (2 hours and laboratory) (Prerequisite: 183-201) 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.
Professor Lewis

183-307B SOCIOECONOMIC APPLICATIONS OF GIS. (3) (2 hours and laboratory) (Prerequisites: 183-201, 189-203 or equivalent)

183-308A PRINCIPLES OF REMOTE SENSING. (3) (3 hours and laboratory periods) (Restriction: Not open to students who have taken or are taking 195-308.) 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.
Professors Lewis and Fabry

183-309A GEOGRAPHY OF CANADA. (3) (3 hours)

183-311B CANADA – A GEO-ECONOMIC PERSPECTIVE. (3) (3 hours) (Prerequisite 183-216 or permission of the instructor.)

183-315A URBAN TRANSPORTATION GEOGRAPHY. (3) (3 hours) (Prerequisite 183-217 or permission of instructor.)

183-316B POLITICAL GEOGRAPHY. (3) (3 hours)

● **183-321B CLIMATIC ENVIRONMENTS.** (3) (3 hours) (Prerequisite: 183-203 or 195-210 or permission of the instructor.)

183-322B ENVIRONMENTAL HYDROLOGY. (3) (3 hours) (Prerequisite: 183-203 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. **Professor Roulet**

183-323B GEOGRAPHY OF EUROPE'S NORTH. (3) (3 hours)

183-331A URBAN SOCIAL GEOGRAPHY. (3) (3 hours) (Prerequisite: 183-216 or 217 or permission of instructor.)

183-350A ECOLOGICAL BIOGEOGRAPHY. (3) (3 hours) (Prerequisite: 183-302 or 177-205) 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. **Professor Chmura**

183-351A QUANTITATIVE METHODS. (3) (3 hours) (Prerequisite: Mathematics 189-203 or permission of instructor.) (Note: Credit for other statistics courses may preclude credit for this course and conversely. See "Course Overlap" on page 345.) Multiple regression and correlation, logit models, discrete choice models, gravity models, facility location algorithms, survey design, population projection. **Professor Ewing**

183-370A PROTECTED AREAS. (3) (3 hours) (Prerequisite: 177-208 or 183-203 or 344-205.)

183-372A RUNNING WATER ENVIRONMENTS. (3) (3 hours) (Prerequisites: 183-203 and 183-272, or 170-200 and 170-202) 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. **Professor Lapointe**

183-381A EVOLUTION OF GEOGRAPHY. (3) (3 hours)

● ▭ **183-398T FIELD STUDIES IN HUMAN GEOGRAPHY.** (3) (3 hours) (Prerequisite: Any introductory human geography course; or by permission of the instructor.)

● **183-404B ENVIRONMENTAL MANAGEMENT.** (3) (3 hours) (Prerequisite: 183-302 or permission of instructor.)

183-407B CONTEMPORARY ISSUES IN GEOGRAPHY. (3) (3 hours)

● **183-408B GEOGRAPHY OF UNEQUAL DEVELOPMENT.** (3) (3 hours) (Prerequisite: 183-216 or permission of instructor.)

183-410B GEOGRAPHY OF UNDERDEVELOPMENT: CURRENT PROBLEMS. (3) (3 hours) (Prerequisite: 183-216 or permission of instructor.)

● **183-424A PLACE, PEOPLE & CULTURE: EUROPE.** (6) (6 hours) (Prerequisite: 6 credits from any of History, Art History, Anthropology, Philosophy, Political Science, Sociology or permission of instructor)

183-470C WETLANDS. (3) (3 hours and field trips) (Prerequisites: one from 183-305, 183-322, 372-210, 336-217; and one from 183-350, 177-208/308, 367-460, 367-358) An examination of the structure, function and utility of wetlands. Topics include the fluxes of energy and water, wetland biogeochemistry, plant ecology in freshwater and coastal wetlands and wetland use, conservation and restoration. Field trip(s) will illustrate issues covered in class. **Professors Chmura, Moore, Roulet and Waterway**

183-490A,B,G,T INDEPENDENT STUDIES IN GEOGRAPHY. (3) (Open to U3 Geography Major students only.) (Please see regulations concerning Project Courses, section 2.6.2 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. **Staff**

183-491D,N HONOURS RESEARCH AND READING. (6) (Prerequisite: 183-381) (For U3 B.A. and B.Sc. Honours and Joint Honours Geography students.) Supervised reading, research and preparation of an undergraduate thesis under the direction of a member of staff. **Professor Müller-Wille and Staff**

183-492D,N JOINT HONOURS RESEARCH AND READING. (3) (Only for those U3 Joint Honours students in Geography who opt to enrol in a parallel course in another department.)

▭ **183-494A URBAN FIELD STUDIES.** (3) (Prerequisites: 200-level courses in GIS, statistics, and urban geography, and 183-331B)

183-495C FIELD STUDIES - PHYSICAL GEOGRAPHY. L(3) (2-week field school) (Prerequisites: 6 credits from the following list of Systematic Physical Geography courses: 183-305, 183-321, 183-322, 183-350, 183-372) 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. **Professor Lapointe and Staff**

● ▭ **183-496B REGIONAL GEOGRAPHICAL EXCURSION.** (3) (Prerequisites: 183-290 and permission of instructor.)

● ▭ **183-497T FIELD STUDIES IN GEOGRAPHY: COASTAL MARSH PLANT ECOLOGY.** (3) (Prerequisite: 183-350 or 183-305 or 177-208/308)

183-498B 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: 144-218, 189-203 or equivalents.) Focus on understanding of inter-relations between humans and neotropical environments represented in Panama. Study of contemporary rural landscapes, their origins, development and change. Impacts of economic growth and inequality, social organization, and politics on natural resource use and environmental degradation. Site visits and field exercises in peasant/colonist, Amerindian, and plantation communities. **Professors Coomes and Johns**

▭ **183-499T SUBARCTIC FIELD STUDIES IN GEOGRAPHY: SCHEFFERVILLE.** (3) (Prerequisite: 183-203 or 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 2000 at the McGill Subarctic Research Station, Schefferville, during ten days in late August. Preregistration in Department required by March 15. MARS registration by first week in July. **Professor Pollard**

183-500A GEOGRAPHY OF REGIONAL IDENTITY. (3) (3 hours) (Restriction: Graduate students and final year undergraduates and/or those who have taken 183-408A.)

183-501A MODELLING ENVIRONMENTAL SYSTEMS. (3) (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: 189-139 or 189-140, 189-141, and 189-203, 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. **Professor Roulet**

183-502A GEOGRAPHY OF NORTHERN DEVELOPMENT. (3) (3 hours) (Prerequisite: 183-301 or 436, or permission of instructor.)

● **183-504A INDUSTRIAL RESTRUCTURING – THE GEOGRAPHIC IMPLICATIONS.** (3) (Prerequisites: 183-311 or permission of instructor.)

183-505B GLOBAL BIOGEOCHEMISTRY. (3) (2 hours and research) (Prerequisite: 183-305 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. **Professors Moore and Roulet**

183-506A PERSPECTIVES ON GEOGRAPHIC INFORMATION ANALYSIS. (3) (2 hours and laboratory) (Prerequisite: 183-201 and 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. **Professor Sieber**

183-510B HUMID TROPICAL ENVIRONMENTS. (3) (3 hours) (Prerequisite: 183-203 or equivalent and written permission of the instructor.)

● **183-513A BEHAVIOURAL GEOGRAPHY.** (3) (3 hours) (Prerequisite: a course in introductory statistics.)

● **183-522B ADVANCED ENVIRONMENTAL HYDROLOGY.** (3) (2 hours and 1 tutorial) (Prerequisite: 183-322, or permission of instructor.)

● **183-523B ADVANCED CLIMATOLOGY.** (3) (3 hours) (Prerequisite: a previous course in climatology or meteorology, and written permission of the instructor.)

183-535B REMOTE SENSING METHODS & INTERPRETATION. (3) (3 hours) (Prerequisite: 183-308 and written permission of instructor.) Basic photogrammetry and interpretation procedures for aircraft and space craft photography and imagery. **Professor Lewis and Staff**

● **183-536B PERIGLACIAL AND PERMAFROST ENVIRONMENTS.** (3) (3 hours) (Prerequisite: 183-272 and any 300-level geomorphology course approved by instructor.)

183-537B ADVANCED FLUVIAL GEOMORPHOLOGY. (3) (Prerequisites: permission of instructor.) An examination of current advances in fluvial geomorphology: sediment entrainment and transport, alluviation and river channel evolution. **Professor Lapointe**

183-550A QUATERNARY PALEOECOLOGY. (3) (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. **Professor Chmura**

183-551A ENVIRONMENTAL DECISIONS. (3) (2 hours seminar, 1 hour tutorial) (Prerequisites: 183-302, 182-451, 183-306 or equivalents)

11.13 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 (528-314B, 507-503A, 528-414A, 552-419D, 552-513A) 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) [MARS Program Code 2-590500]

U1 Required Courses (20 credits)

177-200A	(3)	Molecular Biology
177-201B	(3)	Cell Biology and Metabolism
or 507-212B	(3)	Molecular Mechanisms of Cell Function
180-212A,B	(4)	Organic Chemistry I
180-222A,B	(4)	Organic Chemistry II
180-203A	(3)	Survey of Physical Chemistry
or 180-204A,B	(3)	Physical Chem./Biol. Sci. I
552-209A	(3)	Mammalian Physiology I

U1, U2 or U3 Required Course (3 credits)

177-373A	(3)	Biostatistical Analysis
or 189-203A	(3)	Principles of Statistics I
or 204-204A,B	(3)	Introduction to Psychological Statistics

U1 Complementary Courses (6 credits)

Selected from:

528-211A	(3)	Biology of Microorganisms
528-212A	(2)	Laboratory in Microbiology
177-202B	(3)	Basic Genetics
177-205B	(3)	Biology of Organisms
177-304A	(3)	Evolution
504-214A	(3)	Systematic Human Anatomy
504-261A*	(4)	Introduction to Dynamic Histology

*students must take this course in U1 or U2

U2 Required Courses (15 credits)

507-311A	(3)	Metabolic Biochemistry
507-312B	(3)	Biochemistry of Macromolecules
528-314B	(3)	Immunology
507-300D	(6)	Laboratory in Biochemistry
or 528-386D	(6)	Laboratory in Microbiology

U2 Complementary Courses (9 credits)

one of:

504-261A	(4)	Introduction to Dynamic Histology
528-211A	(3)	Biology of Microorganisms
552-210B	(3)	Mammalian Physiology II

plus 6 credits selected from:

177-314A	(3)	Molecular Biology of Oncogenes
177-300A	(3)	Molecular Biology of the Gene
552-210B	(3)	Mammalian Physiology II
180-302A,B	(3)	Organic Chemistry III
189-133A,B	(3)	Vectors, Matrices and Geometry
189-222A,B	(3)	Calculus III
189-315A,B	(3)	Ordinary Differential Equations
or 177-309A	(3)	Mathematical Models in Biology
528-323A	(3)	Microbial Physiology
528-324A	(3)	Fundamental Virology

546-300B (3) Human Disease
549-300A (3) Drug Action
549-301B (3) Drugs and Disease
552-311A (3) Intermediate Physiology I
552-312B (3) Intermediate Physiology II
552-313B (3) Intermediate Physiology III

U3 Required Courses (15 credits)
528-414A (3) Advanced Immunology
507-503B (3) Immunochemistry
552-419D (6) Project & Seminar in Immunology
552-513B (3) Cellular Immunology

U3 Complementary Courses (9 credits)
9 credits selected from:
177-314A (3) Molecular Biology of Oncogenes
507-454A (3) Nucleic Acids
507-404B (3) Biophysical Chemistry
507-450A (3) Protein Structure and Function
or 504-458B (3) Membranes & Cellular Signalling
552-311A (3) Intermediate Physiology I
552-312B (3) Intermediate Physiology II
552-313B (3) Intermediate Physiology III
552-531B (3) Topics in Applied Immunology
552-552B (3) Cellular & Molecular Physiology
189-315A,B (3) Ordinary Differential Equations
528-324A (3) Fundamental Virology
528-413B (3) Parasitology
528-465A (3) Bacterial Pathogenesis and Host Defences
528-466B (3) Viral Pathogenesis and Host Defences
528-509B (3) Seminars on Inflammatory Processes

11.14 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.

Enrolment in this program is restricted. Application forms and advising appointments will be available from February 12, 2001 and applications are considered on a first-come, first-served basis. The first 25 applicants who qualify will be accepted. At the time of application, a CGPA greater than 2.50 is required and at least one course toward the Minor program must have been completed with a grade of C or better.

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 who were registered in 1996-97 or earlier should consult the Minor advisor in the Student Affairs Office regarding their program requirements.

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)
280-211 (3) Introduction to Financial Accounting
280-293 (3) Managerial Economics
189-203 (3) Principles of Statistics I
or its equivalent as authorized by the Faculty of Science.
Students majoring in certain programs, for example in Mathematics, cannot take 189-203 but must take 189-324 instead. (Note: Credit for other statistics courses may preclude credit for this course and conversely. See "Course Overlap" on page 345.)

Complementary Courses (15 credits)
3 credits from:
280-213 (3) Introduction to Management Accounting
280-341 (3) Finance I
280-382 (3) International Business

3 credits from:
280-222 (3) Organizational Behaviour
280-320 (3) Managing Human Resources
280-352 (3) Marketing Management I

3 credits from:
280-360 (3) Social Context of Business
280-373 (3) Operations Research
280-423 (3) Organizational Policy

6 credits from:
any approved 300- or 400-level Management courses for which the prerequisites, if any, have been met.

11.15 Mathematics and Statistics (189)

Burnside Hall, Room 1005
805 Sherbrooke Street West
Montreal, QC H3A 2K6
Telephone: (514) 398-3800
Fax: (514) 398-3899
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Chair — Kohur GowriSankaran

Emeritus Professors
Joachim Lambek; M.Sc., Ph.D.(McG.), F.R.S.C.
(Peter Redpath Emeritus Professor of Pure Mathematics)
William O.J. Moser; B.Sc.(Manit.), M.A.(Minn.), Ph.D.(Tor.)

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.)
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.)
Arak M. Mathai; M.Sc.(Kerala), M.A., Ph.D.(Tor.)
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.)
Kwok Kuen Tam; M.A., Ph.D.(Tor.)
Keith J. Worsley; B.Sc., M.Sc., Ph.D.(Auckland)
Sanjo Zlobec; M.Sc.(Zagreb), Ph.D.(Northwestern)

Associate Professors
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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.)
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)
Jian-Ju Xu; B.Sc., M.Sc.(Beijing), M.Sc., Ph.D.(Renss.)

Assistant Professors
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Eyal Z. Goren; B.A., M.S., Ph.D.(Hebrew)
John A. Toth; B.Sc., M.Sc.(McM.), Ph.D.(M.I.T.)

Associate Members
Luc P. Devroye *(Computer Science),* P.R.L. Dutilleul *(Plant Science),* Leon Glass *(Physiology),* Jean-Louis Goffin *(Management),* 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
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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)

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 2.8 for further information on IYES.

MINOR PROGRAM IN MATHEMATICS (24 credits)
[MARS Program Code 6-630000]

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 189-323. 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)

189-222	(3)	Calculus III
189-223*	(3)	Linear Algebra
189-315	(3)	Ordinary Differential Equations I

*189-223 may be replaced by 189-235 and 189-236. 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 189-323 strongly recommended; alternatively up to 6 credits may be allowed for appropriate courses from other departments.

MINOR PROGRAM IN STATISTICS (24 credits)
[MARS Program Code 6-630200]

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 fulfil 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)

189-222	(3)	Calculus III
189-223*	(3)	Linear Algebra
189-323	(3)	Probability Theory
or 189-356	(3)	Probability
189-324	(3)	Statistics
or 189-357	(3)	Statistics
189-423	(3)	Regression and Analysis of Variance

*189-223 may be replaced by 189-235 and 189-236. In this case the complementary credit requirement is reduced by three.

Complementary Courses (9 credits)
selected from:

189-425	(3)	Sampling Theory and Applications
189-447	(3)	Stochastic Processes
189-523	(4)	Generalized Linear Models
189-556	(4)	Mathematical Statistics I
189-557	(4)	Mathematical Statistics II
166-504	(3)	Quantitative Methods of Social Research I
166-505	(3)	Quantitative Methods of Social Research II
180-593	(3)	Statistical Thermodynamics
183-351	(3)	Quantitative Methods
198-362	(3)	Statistical Mechanics
198-559	(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 362 in the Biology section for complete program information.

FACULTY PROGRAM IN CHEMISTRY AND MATHEMATICS
See page 371 in the Chemistry section for complete program information.

FACULTY PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE (54 credits) [MARS Program Code 4-632500]
27 credits in Mathematics and 27 credits in Computer Science

Required Courses (48 credits)

189-222	(3)	Calculus III
189-223*	(3)	Linear Algebra
189-315	(3)	Ordinary Differential Equations I
189-317	(3)	Numerical Analysis
189-323	(3)	Probability Theory
189-324	(3)	Statistics
189-343	(3)	Discrete Mathematics & Applied Algebra
or 189-240	(3)	Discrete Structures & Computing
308-202**	(3)	Introduction to Computing I
308-203**	(3)	Introduction to Computing II
308-251	(3)	Data Structures and Algorithms
308-273	(3)	Introduction to Computer Systems
308-302	(3)	Programming Languages and Paradigms
308-305	(3)	Computer System Architecture
308-310	(3)	Computer Systems and Organization
308-420	(3)	Files and Databases
308-530	(3)	Formal Languages

*189-223 may be replaced by 189-235 and 189-236. In this case the complementary credit requirement is reduced by three.
**308-202 and 308-203 may be replaced by 308-250 with an additional three credits at the 300 level.

Complementary Courses (6 credits)
selected from:

189-314	(3)	Advanced Calculus
189-318	(3)	Mathematical Logic
189-327	(3)	Matrix Numerical Analysis
189-328	(3)	Computability & Mathematical Linguistics
189-407	(3)	Dynamic Programming
189-417	(3)	Mathematical Programming

FACULTY PROGRAM IN MATHEMATICS, STATISTICS AND COMPUTER SCIENCE (54 credits)
[MARS Program Code 4-635100]

Required Courses (30 credits)

189-222	(3)	Calculus III
189-223*	(3)	Linear Algebra
189-315	(3)	Ordinary Differential Equations I
189-323	(3)	Probability Theory
189-324	(3)	Statistics
189-423	(3)	Regression and Analysis of Variance
308-202**	(3)	Introduction to Computing I
308-203**	(3)	Introduction to Computing II
308-251	(3)	Data Structures and Algorithms
308-273	(3)	Introduction to Computer Systems

*189-223 may be replaced by 189-235 and 189-236. In this case the complementary credit requirement is reduced by three.
**308-202 and 308-203 may be replaced by 308-250 with an additional three credits at the 300 level.

Complementary Courses (24 credits)
at least 6 credits selected from:

189-314	(3)	Advanced Calculus
189-317	(3)	Numerical Analysis
189-318	(3)	Mathematical Logic
189-319	(3)	Partial Differential Equations
189-327	(3)	Matrix Numerical Analysis
189-328	(3)	Computability & Mathematical Linguistics
189-343	(3)	Discrete Mathematics & Applied Algebra
189-407	(3)	Dynamic Programming
189-417	(3)	Mathematical Programming

at least 6 credits in Statistics selected from:

189-329	(3)	Theory of Interest
189-425	(3)	Sampling Theory and Applications
189-447	(3)	Stochastic Processes
189-523	(4)	Generalized Linear Models

at least 6 credits in Computer Science selected from:

308-302	(3)	Programming Languages and Paradigms
308-305	(3)	Computer System Architecture
308-310	(3)	Computer Systems and Organization
308-420	(3)	Files and Databases
308-530	(3)	Formal Languages

FACULTY PROGRAM IN MATHEMATICS, CHEMISTRY AND PHYSICS (56 credits) [MARS Program Code 4-631200]
(Revision Awaiting University Approval)

Required Courses (47 credits)

180-201	(3)	Modern Inorganic Chemistry I
or 180-281	(3)	Inorganic Chemistry I
180-204	(3)	Physical Chem./Biol. Sci. I
or 180-213	(3)	Physical Chemistry I
180-212	(4)	Organic Chemistry I
180-214	(3)	Physical Chem./Biol. Sci. II
180-222	(4)	Organic Chemistry II
189-222	(3)	Calculus III
189-223	(3)	Linear Algebra
189-314	(3)	Advanced Calculus
189-315	(3)	Ordinary Differential Equations I
189-319	(3)	Partial Differential Equations I
198-230	(3)	Dynamics of Simple Systems
198-232	(3)	Heat and Waves
198-241	(3)	Signal Processing
198-340	(3)	Electricity and Magnetism
308-202	(3)	Introduction to Computing I

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)
[MARS Program Code 1-630000]

Students entering the Major program are normally expected to have completed 189-133, 189-140 and 189-141 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 189-242 and 189-235 are urged to consider, in consultation with their advisor and the instructors concerned, entering the Honours stream by registering for 189-251 and 189-255.

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 189-317, 189-318, 189-327, 189-328, 189-343, 189-407, 189-417 and to complete the Computer Science Minor.

Students interested in probability and statistics are advised to take 189-324, 189-407, 189-423, 189-425, 189-447, 189-523. Students interested in applied mathematics should take 189-317, 189-319, 189-322, 189-324, 189-327, 189-407, 189-417.

Students considering a career in secondary school teaching are advised to take 189-318, 189-328, 189-338, 189-339, 189-346, 189-348.

Students interested in careers in business, industry or government are advised to select courses from the following list: 189-317, 189-319, 189-327, 189-329, 189-407, 189-417, 189-423, 189-425, 189-447, 189-523.

Required Courses (27 credits)
189-222 (3) Calculus III
189-235 (3) Algebra I
189-236 (3) Linear Algebra I
189-242 (3) Analysis I
189-243 (3) Real Analysis
189-314 (3) Advanced Calculus
189-315 (3) Ordinary Differential Equations I
189-316 (3) Functions of a Complex Variable
or 189-249 (3) Advanced Calculus
189-323 (3) Probability Theory

Complementary Courses (27 credits)
21 credits selected from the following list, with at least 6 credits selected from:
189-317 (3) Numerical Analysis
189-324 (3) Statistics
189-343 (3) Discrete Mathematics & Applied Algebra
the remainder of the 21 credits to be selected from:
189-318 (3) Mathematical Logic
189-319 (3) Partial Differential Equations
189-320 (3) Differential Geometry
189-322 (3) Dynamical Systems, Fractals and Chaos
189-327 (3) Matrix Numerical Analysis
189-328 (3) Computability & Mathematical Linguistics
189-329 (3) Theory of Interest
189-338 (3) History and Philosophy of Mathematics
189-339 (3) Topics in the Foundations of Mathematics
189-346 (3) Number Theory
189-348 (3) Topics in Geometry
189-407 (3) Dynamic Programming
189-417 (3) Mathematical Programming
189-423 (3) Regression and Analysis of Variance
189-425 (3) Sampling Theory and Applications
189-447 (3) Stochastic Processes
189-523 (4) Generalized Linear Models
6 additional credits in Mathematics or related disciplines selected in consultation with the adviser.

JOINT MAJOR PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE (72 credits)
[MARS Program Code 1-632500]

Required courses (48 credits)
189-222 (3) Calculus III
189-235 (3) Algebra I
189-236 (3) Linear Algebra I
189-242 (3) Analysis I
189-315 (3) Ordinary Differential Equations I
189-317 (3) Numerical Analysis
189-318 (3) Mathematical Logic
189-323 (3) Probability Theory
308-250* (3) Introduction to Computer Science
308-251 (3) Data Structures and Algorithms
308-273 (3) Introduction to Computer Systems
308-302 (3) Programming Languages and Paradigms
308-305 (3) Computer System Architecture
308-310 (3) Computer Systems and Organization
308-330 (3) Theoretical Aspects of Computer Science
308-360 (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 308-202 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.

12 credits from the set of courses recommended for a Major or Honours Program in Computer Science.

Students will not receive credit for 189-240.

JOINT MAJOR PROGRAM IN PHYSIOLOGY AND MATHEMATICS See page 413 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: 189-133, 189-140, 189-141, or their equivalents. In addition, a student who has not completed the equivalent of 189-222 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)
[MARS Program Code 2-630000]

Required Courses (45 credits)
189-235 (3) Algebra I
189-242 (3) Analysis I
189-248 (3) Advanced Calculus I
189-251 (3) Algebra II
189-255 (3) Analysis II
189-325 (3) Ordinary Differential Equations
189-354 (3) Analysis III
189-355 (3) Analysis IV
189-356 (3) Probability
189-357 (3) Statistics
189-370 (3) Algebra III
189-371 (3) Algebra IV
189-380 (3) Differential Geometry
189-375 (3) Differential Equations II
or 189-574 (4) Ordinary Differential Equations
189-466 (3) Complex Analysis

Complementary Courses (15 credits)
15 credits to be selected from the following:
308-250* (3) Introduction to Computer Science
308-251 (3) Data Structures and Algorithms
*308-250 may be preceded by 308-202

further Honours Mathematics courses, of which 189-470 is encouraged;

non-Honours Mathematics courses (other than 189-242, 189-235), 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) [MARS Program Code 2-630300]

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)
189-235 (3) Algebra I
189-242 (3) Analysis I
189-248 (3) Advanced Calculus I
189-251 (3) Algebra II
189-255 (3) Analysis II
189-325 (3) Ordinary Differential Equations
189-356 (3) Probability
189-357 (3) Statistics
189-375 (3) Differential Equations II
189-387 (3) Numerical Analysis
189-466 (3) Complex Analysis
or 189-249 (3) Advanced Calculus II
308-251 (3) Data Structures and Algorithms
308-250* (3) Introduction to Computer Science
*308-250 may be preceded by 308-202

Complementary Courses (29 credits)
at least 6 credits selected from:
189-354 (3) Analysis III
189-355 (3) Analysis IV
189-370 (3) Algebra III
189-371 (3) Algebra IV
189-380 (3) Differential Geometry
at least 9 credits selected from:
189-382 (3) Dynamical Systems, Fractals and Chaos
189-397 (3) Matrix Numerical Analysis
189-470 (3) Honours Project
189-487 (3) Mathematical Programming
189-523 (4) Generalized Linear Models
189-555 (4) Fluid Dynamics
189-556 (4) Mathematical Statistics I
189-557 (4) Mathematical Statistics II
189-560 (4) Optimization
189-561 (4) Analytical Mechanics
189-574 (4) Ordinary Differential Equations
189-575 (4) Partial Differential Equations
189-579 (4) Numerical Differential Equations
189-585 (4) Integral Equations and Transforms
189-586 (4) Applied Partial Differential Equations

and the following, for which **half credit only** may be counted:
189-407 (3) Dynamic Programming
189-423 (3) Regression and Analysis of Variance
189-425 (3) Sampling Theory and Applications
189-447 (3) Stochastic Processes

12 credits of extra-mural courses:
chosen in consultation with the student's advisor 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 fulfil 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) [MARS Program Code 2-630400]

All Honours students are encouraged to take 189-325, 189-387, 189-423 and 189-447.

Students primarily interested in probability should include courses 189-325, 189-375 and 189-447 in their program.

Students primarily interested in statistics should include 189-423, 189-425, 189-447, 189-523 and 189-524 in their program.

Required Courses (46 credits)
189-235 (3) Algebra I
189-242 (3) Analysis I
189-248 (3) Advanced Calculus I
189-249 (3) Advanced Calculus II
or 189-466 (3) Complex Analysis
189-251 (3) Algebra I
189-255 (3) Analysis II
189-354 (3) Analysis III
189-356 (3) Probability
189-357 (3) Statistics
189-556 (4) Mathematical Statistics I
189-557 (4) Mathematical Statistics II
189-587 (4) Advanced Probability Theory I
189-589 (4) Advanced Probability Theory II
308-250* (3) Introduction to Computer Science
*308-250 may be preceded by 308-202

Complementary Courses (17 credits)
selected from:
189-325 (3) Ordinary Differential Equations
189-355 (3) Analysis IV
189-375 (3) Differential Equations II
189-387 (3) Numerical Analysis
189-397 (3) Matrix Numerical Analysis
189-470 (3) Honours Project
189-523 (4) Generalized Linear Models
189-524 (4) Nonparametric Statistics

and the following, for which **half credit only** may be counted:
189-423 (3) Regression and Analysis of Variance
189-425 (3) Sampling Theory and Applications
189-447 (3) Stochastic Processes

JOINT HONOURS PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE (72 credits)
[MARS Program Code 3-632500]

Students must consult an Honours advisor in both departments.

Required Courses (39 credits)
189-235 (3) Algebra I
189-242 (3) Analysis I
189-248 (3) Advanced Calculus I
189-251 (3) Algebra II
189-255 (3) Analysis II
308-250* (3) Introduction to Computer Science
308-251 (3) Data Structures and Algorithms
308-273 (3) Introduction to Computer Systems
308-302 (3) Programming Languages and Paradigms
308-305 (3) Computer System Architecture
308-310 (3) Computer Systems and Organization
308-330 (3) Theoretical Aspects of Computer Science
308-506 (3) Advanced Analysis of Algorithms
* Students with no basic knowledge of any high level programming language (e.g. Fortran, Basic, Pascal, C, C++, Java) are advised to take 308-202 before 308-250. In this case 308-202 counts as an elective.

Complementary Courses (33 credits)
21 credits in Mathematics,
at least 12 credits selected from:
189-354 (3) Analysis III

189-355 (3) Analysis IV
189-356* (3) Probability
189-370 (3) Algebra III
189-371 (3) Algebra IV
189-387 (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 189-587 for 189-356 and must then also register for 189-355.

12 credits in Computer Science, selected from:
308-335 (3) Software Engineering Methods

400-level and 500-level Computer Science courses with the exception of 308-431 and 308-506.

JOINT HONOURS PROGRAM IN MATHEMATICS AND PHYSICS See page 408 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 2.8 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

Note: When this Calendar went to press final information was not yet available on which courses at the 400 and 500 levels would be given in 2000-01. Consult the Department of Mathematics and Statistics for up-to-date information on these courses.

The names appearing after the course descriptions are those of instructors who were associated with the courses during the 1999-2000 academic year.

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

● Denotes courses not offered in 2000-01.
★ Denotes courses offered only in alternate years.

189-112A,B FUNDAMENTALS OF MATHEMATICS. (3) (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. **Staff**

189-133A,B VECTORS, MATRICES AND GEOMETRY. (3) (Prerequisite: a course in functions.) (Not open to students who have taken 189-221 or CEGEP course 201-105.) 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. **Staff**

189-139A,B CALCULUS. (4) (3 hours lecture; 2 hours tutorial) (Prerequisite: a course in functions.) (Not open to students who have taken 189-120 or CEGEP course 201-103. 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 189-141.) Review of functions and graphs. Limits, continuity, derivative. Differentiation of elementary functions. Antidifferentiation. Applications. Password required.
Note: Each Tutorial section is enrolment limited. **Staff**

189-140A,B CALCULUS I. (3) (3 hours lecture, 1 hour tutorial) (Prerequisite: High School Calculus.) (Not open to students who have taken 189-120, 189-122, 189-139 or CEGEP course 201-103.) Review of functions and graphs. Limits, continuity, derivative. Differentiation of elementary functions. Antidifferentiation. Applications. (Revisions Awaiting University Approval) **Staff**

189-141A,B CALCULUS II. (4) (3 hours lecture; 2 hours tutorial) (Not open to students who have taken 189-121 or CEGEP course 201-203) (Prerequisites: 189-139 or 189-140 or 189-150) The definite integral. Techniques of integration. Applications. Introduction to sequences and series.
Note: Each Tutorial section is enrolment limited. **Staff**

189-150A CALCULUS A. (4) (3 hours lecture, 2 hours tutorial) (Students with no prior exposure to vector geometry are advised to take 189-133 concurrently. Intended for students with high school calculus who have not received six advanced placement credits.) (Not open to students who have taken CEGEP course 201-103.) (189-150 and 189-151 cover the material of 189-139, 189-140, 189-141, 189-222.) Functions, limits and continuity, differentiation, L'Hospital's rule, applications, Taylor polynomials, parametric curves, functions of several variables.
Note: Each Tutorial section is enrolment limited.
Professor GowriSankaran

189-151B CALCULUS B. (4) (3 hours lecture; 2 hours tutorial) (Prerequisite: 189-150.) (Not open to students who have taken CEGEP course 201-203.) Integration, methods and applications, infinite sequences and series, power series, arc length and curvature, multiple integration.
Note: Each Tutorial section is enrolment limited.
Professor GowriSankaran

● ▭ **189-199A CHAOS, FRACTALS AND COMPLEXITY.** (3) (FYS - for first year students only, maximum 25)

189-203A,B PRINCIPLES OF STATISTICS I. (3) (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 189-324.) (Note: Credit for other statistics courses may preclude credit for this course and conversely. See "Course Overlap" on page 345.) 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).
Professors Wolfson and Worsley

189-204B PRINCIPLES OF STATISTICS II. (3) (Prerequisite: 189-203 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 189-324.) (Note: Credit for other statistics courses may preclude credit for this course and conversely. See "Course Overlap" on page 345.) 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. **Staff**

● **189-211B PRACTICAL METHODS OF MATHEMATICS.** (3) (Prerequisite: 189-111 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 189-240, 189-343, 189-363 or any statistics course.)

189-222A,B CALCULUS III. (3) (Prerequisite: 189-141. Familiarity with vector geometry or Corequisite: 189-133) (Not open to students who have taken CEGEP course 201-303 or 189-150, 189-151 or 189-227.) 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. **Staff**

189-223A,B LINEAR ALGEBRA. (3) (Prerequisite: 189-133 or equivalent.) (Not open to students in Mathematics programs nor to students who have taken or are taking 189-236, 189-247 or 189-

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. **Staff**

189-235A ALGEBRA I. (3) (3 hours lecture; 1 hour tutorial) (Prerequisite: 189-133 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. **Professor Loveys**

189-236B LINEAR ALGEBRA I. (3) (Prerequisite: 189-235) Continuation of the topics of 189-235. 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. **Staff**

189-240A DISCRETE STRUCTURES AND COMPUTING. (3) (Corequisites: 189-133 and 189-222. 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. **Professor Brown**

189-242A ANALYSIS I. (3) (Prerequisite: 189-141) A rigorous presentation of sequences and of real numbers and basic properties of continuous and differentiable functions on the real line. **Professor Drury**

189-243B REAL ANALYSIS. (3) (Prerequisite: 189-242) Infinite series; series of functions; power series. The Riemann integral in one variable. A rigorous development of the elementary functions. **Staff**

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

189-248A ADVANCED CALCULUS I. (3) (Prerequisites: 189-133 and 189-222 or consent of Department. Intended for Honours Mathematics, Physics and Engineering students.) (Not open to students who have taken or are taking 189-314.) Partial derivatives; implicit functions; Jacobians; 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. **Professor Roth**

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

189-251B ALGEBRA II. (3) (Prerequisites: 189-235 or permission of the Department.) (Not open to students who are taking or have taken 189-247B.) 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. **Professor Loveys**

189-255B ANALYSIS II. (3) (Prerequisites: 189-242 or permission of the Department.) Series of functions including power series. Riemann integration in one variable. Elementary functions. **Professor Drury**

189-314A,B ADVANCED CALCULUS. (3) (Prerequisites: 189-133, 189-222.) (Not open to students who have taken or are taking 189-248.) 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. **Staff**

189-315A,B ORDINARY DIFFERENTIAL EQUATIONS. (3) (Prerequisite: 189-222. Corequisite 189-133.) (Not open to students who have taken or are taking 189-325.) First order ordinary differential equations including elementary numerical methods. Linear differential equations. Laplace transforms. Series solutions. **Staff**

189-316A FUNCTIONS OF A COMPLEX VARIABLE. (3) (Prerequisites: 189-314 and 189-243.) (Not open to students who have taken or are taking 189-249.) Algebra of complex numbers, Cauchy-Riemann equations, complex integral, Cauchy's theorems. Taylor and Laurent series, residue theory and applications.

189-317A NUMERICAL ANALYSIS. (3) (Prerequisites: 189-222, 308-202 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. **Professor Xu**

189-318A MATHEMATICAL LOGIC. (3) (Not open to students who are taking or have taken 107-210.) Propositional calculus, truth-tables, switching circuits, natural deduction, first order predicate calculus, axiomatic theories, set theory. **Professor Bunge**

189-319B PARTIAL DIFFERENTIAL EQUATIONS. (3) (Prerequisites: 189-223 or 189-236, 189-314, 189-315) First order equations, geometric theory; second order equations, classification; Laplace, wave and heat equations, Sturm-Liouville theory, Fourier series, boundary and initial value problems. **Professor Lawruk**

★**189-320A DIFFERENTIAL GEOMETRY.** (3) (Prerequisites: 189-236 or 189-223 or 189-247, and 189-314 or 189-248) Review of Euclidean geometry. Local theory of plane and space curves: the Frenet formulas. Local theory of surfaces: the first and second fundamental forms, the shape operator, the mean and Gaussian curvatures, surfaces of revolution with prescribed curvature, ruled and developable surfaces. Geodesic curves on surfaces of revolution. The Gauss-Codazzi equations, rigidity. **Staff**

● ★**189-322A DYNAMICAL SYSTEMS, FRACTALS AND CHAOS.** (3) (Prerequisites: 189-133, 189-222; a programming language or consent of instructor.) (Not open to students who have taken 189-422.)

189-323A,B PROBABILITY THEORY. (3) (Prerequisites: 189-141 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 189-356.) 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. **Staff**

189-324A,B STATISTICS. (3) (Prerequisite: 189-323 or equivalent.) (Not open to students who have taken or are taking 189-357.) (Note: Credit for other statistics courses may preclude credit for this course and conversely. See "Course Overlap" on page 345.) 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. **Staff**

189-325A,B ORDINARY DIFFERENTIAL EQUATIONS. (3) (Prerequisite: 189-222. Intended for Honours Mathematics, Physics and Engineering programs.) (Not open to students who have taken 189-261, 189-315.) First and second order equations, linear equations, applications, series solutions, elementary numerical methods, Laplace transforms. **Professor Maslowe**

189-327B MATRIX NUMERICAL ANALYSIS. (3) (Prerequisites: 189-223 or 189-236. Corequisite: 189-317) 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. **Staff**

● ★**189-328B COMPUTABILITY AND MATHEMATICAL LINGUISTICS.** (3)

189-329B THEORY OF INTEREST. (3) (Prerequisite: 189-141) Simple and compound interest, annuities certain, amortization schedules, bonds, depreciation. **Professor Sancho**

189-338A HISTORY AND PHILOSOPHY OF MATHEMATICS. (3) 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. **Professor Makkai**

● ★**189-339B TOPICS IN THE FOUNDATIONS OF MATHEMATICS.** (3) (Prerequisites: 189-235, 189-318)

189-340B ABSTRACT ALGEBRA AND COMPUTING. (3) (Prerequisites: 189-240, 189-223 (or -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. **Professor Brown**

189-343B DISCRETE MATHEMATICS AND APPLIED ALGEBRA. (3) (Prerequisites: 189-236, 308-202) Basic combinatorics, introductory graph theory, matching, elementary group theory and symmetry, directed graphs and networks, modular arithmetic and its applications. **Professor Kharlmapovich**

★**189-346B NUMBER THEORY.** (3) (Prerequisite: 189-235 or consent of instructor.) Divisibility. Congruences. Quadratic reciprocity. Diophantine equations. Arithmetical functions. **Staff**

189-348A TOPICS IN GEOMETRY. (3) (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. **Professor Kharlampovich**

189-354A ANALYSIS III. (3) (Prerequisite: 189-255 or equivalent) Introduction to metric spaces. Multivariable differential calculus, implicit and inverse function theorems. **Professor Klemes**

189-355B ANALYSIS IV. (3) (Prerequisite: 189-255 or equivalent) Lebesgue measure on R^n and integration, convergence theorems, Fubini's theorem. Further topics in metric spaces. Introduction to L^p spaces, Fourier series. **Professor Klemes**

189-356A PROBABILITY. (3) (Prerequisites: 189-255 or -243) (Not open to students who have taken or are taking 189-323.) 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. **Professor Wolfson**

189-357B STATISTICS. (3) (Prerequisite: 189-356 or equivalent) (Not open to students who have taken or are taking 189-324.) 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. **Professor Wolfson**

189-370A ALGEBRA III. (3) (Prerequisite: 189-251) 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. **Professor Russell**

189-371B ALGEBRA IV. (3) (Prerequisite: 189-370) 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. **Professor Russell**

189-375A DIFFERENTIAL EQUATIONS. (3) (Prerequisite: 189-325) 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. **Professor Roth**

★**189-377B NUMBER THEORY.** (3) (Prerequisite: Enrolment in Mathematics Honours program or consent of instructor.) This course consists of the lectures of 189-346B together with a special project or projects assigned after consultation between the instructor and student. **Staff**

189-380B DIFFERENTIAL GEOMETRY. (3) (Prerequisites: 189-251 or 189-247, and 189-248 or 189-314) In addition to the topics of 189-320, 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. **Professor Kamran**

● ★**189-382A DYNAMICAL SYSTEMS, FRACTALS AND CHAOS.** (3) (Prerequisites: 189-133, 189-222; a programming language or consent of instructor.) (Not open to students who have taken 189-422.)

189-387A NUMERICAL ANALYSIS. (3) (Prerequisites: 189-222 and 308-202 or 308-250 or equivalent, or consent of instructor.) (Intended primarily for Honours students.) This course consists of the lectures of 189-317 together with a special project or projects assigned after consultation between the instructor and student. **Professor Xu**

189-397B MATRIX NUMERICAL ANALYSIS. (3) (Prerequisites: 189-251, 189-387 or consent of instructor.) The course consists of the lectures of 189-327 plus additional work involving theoretical assignments and/or a project. The final examination for this course may be different from that of 189-327. **Staff**

★**189-407B DYNAMIC PROGRAMMING.** (3) (Prerequisites: 308-202; 189-223 or 189-236, 189-314, 189-315 and 189-323) 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.

189-417A MATHEMATICAL PROGRAMMING. (3) (Prerequisites: 308-202, and 189-223 or 189-236, and 189-314 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. **Professor Zlobec**

189-420A,B INDEPENDENT STUDIES IN MATHEMATICS. (3) (Please see regulations concerning Project Courses, section 2.6.2 in the Faculty Degree Requirements section.) 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. Password required.

189-423A REGRESSION AND ANALYSIS OF VARIANCE. (3) (Prerequisites: 189-324, and 189-223 or 189-236) 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. **Professor Styan**

189-425B SAMPLING THEORY AND APPLICATIONS. (3) (Prerequisites: 189-324 or equivalent.) Basic sampling designs and estimators; simple random, stratified, systematic, and cluster sampling; sampling with unequal probabilities; ratio and regression techniques. **Professor Worsley**

● **★189-437B MATHEMATICAL METHODS IN BIOLOGY.** (3) (Prerequisites: 189-315 or 189-325, and 189-323 or 189-356, a CEGEP or higher level computer programming course.)

● **★189-447B STOCHASTIC PROCESSES.** (3) (Prerequisites: 189-323)

189-466A COMPLEX ANALYSIS. (3) (Prerequisite: 189-354) 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. **Professor Koosis**

189-470A,B HONOURS PROJECT. (3) (Prerequisites: appropriate second year honours courses with approval of coordinator.) (Please see regulations concerning Project Courses, section 2.6.2 in the Faculty Degree Requirements section.) 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. Password required.

189-480A,B INDEPENDENT STUDIES IN MATHEMATICS. (3) (Please see regulations concerning Project Courses, section 2.6.2 in the Faculty Degree Requirements section.) 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. Password required.

189-487A MATHEMATICAL PROGRAMMING. (3) (Prerequisites: 189-248, 189-251 and 308-202 or 189-250 or equivalent.) Intended primarily for honours students. This course consists of the lectures of 189-417 together with a special project or projects assigned after consultation between the instructor and the student. **Professor Zlobec**

● **★189-488A SET THEORY.** (3) (Prerequisites: 189-251 or 189-255 or permission of instructor.)

189-523B GENERALIZED LINEAR MODELS. (4) (Prerequisite: 189-423 or 513-697.) (Not open to students who have taken 189-426.) 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. Contingency tables: logistic regression, log-linear models. Censored data. Applications to current problems in medicine, biological and physical sciences. GLIM, S, software. **Professor Worsley**

189-524A NONPARAMETRIC STATISTICS. (4) (Prerequisite: 189-324 or equivalent.) (Not open to students who have taken 189-424.) 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.

189-555A FLUID DYNAMICS. (4) (Prerequisites: 189-315 and 189-319 or equivalent) Kinematics. Dynamics of general fluids. Inviscid fluids, Navier-Stokes equations. Exact solutions of Navier-Stokes equations. Low and high Reynolds number flow.

189-556A MATHEMATICAL STATISTICS I. (4) (Prerequisite: 189-357 or equivalent) Probability and distribution theory (univariate and multivariate). Exponential families. Laws of large numbers and central limit theorem. **Professor Mathai**

189-557B MATHEMATICAL STATISTICS II. (4) (Prerequisite: 189-556) Sampling theory (including large-sample theory). Likelihood functions and information matrices. Hypothesis testing, estimation theory Regression and correlation theory.

189-560A OPTIMIZATION. (4) (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. **Professor Zlobec**

189-561A ANALYTICAL MECHANICS. (4) (Prerequisites: 189-354 and 189-380 or instructor's approval.) Basic differential geometry. Lagrangian formulation: Euler-Lagrange equations, Noether's theorem, applications. Hamiltonian formalism: symplectic forms and Legendre transformation, symmetry and conserved quantities, completely integrable systems, Poisson brackets. **Professor Toth**

189-564A ADVANCED REAL ANALYSIS I. (4) (Prerequisites: 189-354, 189-355 or equivalents.) Review of theory of measure and integration; product measures, Fubini's theorem; L^p spaces; basic principles of Banach spaces; Riesz representation theorem for C(X); Hilbert spaces; part of the material of 189-565B may be covered as well. **Professor Taylor**

189-565B ADVANCED REAL ANALYSIS II. (4) (Prerequisite: 189-564) Continuation of topics from 189-564. Signed measures, Hahn and Jordan decompositions. Radon-Nikodym theorems, complex measures, differentiation in R^n, Fourier series and integrals, additional topics.

189-566B ADVANCED COMPLEX ANALYSIS. (4) (Prerequisites: 189-466A, 189-564A) Simple connectivity, use of logarithms; argument, conservation of domain and maximum principles; analytic continuation, monodromy theorem; conformal mapping; normal families, Riemann mapping theorem; harmonic functions, Dirichlet problem; introduction to functions of several complex variables. **Professor Havin**

189-570A HIGHER ALGEBRA I. (4) (Prerequisite: 189-371 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 189-571B may be covered as well. **Professor Darmon**

189-571B HIGHER ALGEBRA II. (4) (Prerequisites: 189-570 or consent of instructor.) Completion of the topics of 189-570. 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. **Professor Darmon**

189-574A ORDINARY DIFFERENTIAL EQUATIONS. (4) (Prerequisites: 189-325, 189-354) Existence, uniqueness, smoothness, and dependence on initial conditions of solutions of systems of ordinary differential equations. Dynamical systems. Stable and unstable manifold theorem, Hartman-Grobman Theorem. Classification of equilibria. Liapunov functions. Limit sets, limit cycles and the Poincaré-Bendixson Theorem. The van der Pol equation. Strange attractors and Hopf bifurcation. Applications.

189-575B PARTIAL DIFFERENTIAL EQUATIONS. (4) (Prerequisite: 189-375) A continuation of topics introduced in 189-375.

189-576A GEOMETRY AND TOPOLOGY I. (4) (Prerequisite: 189-354) 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 189-577B may be covered as well. **Staff**

189-577B GEOMETRY AND TOPOLOGY II. (4) (Prerequisite: 189-576) Continuation of the topics of 189-576A. Manifolds and differential forms. De Rham's theorem. Riemannian geometry. Connections and curvatures 2-Manifolds and imbedded surfaces. **Professor Kamran**

189-578A NUMERICAL ANALYSIS. (4) (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 R^n 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. **Professor Gander**

189-579B NUMERICAL DIFFERENTIAL EQUATIONS. (4) (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. **Professor Gander**

189-585B INTEGRAL EQUATIONS AND TRANSFORMS. (4) 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. **Professor Maslowe**

189-586A APPLIED PARTIAL DIFFERENTIAL EQUATIONS. (4) (Prerequisites 189-316, 189-375 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. **Professor Maslowe**

189-587A ADVANCED PROBABILITY THEORY I. (4) (Prerequisite: 189-356 or equivalent and approval of instructor.) Probability spaces. Random variables and their expectations. Convergence of random variables in L^p. Independence and conditional expectation. Introduction to Martingales. Limit theorems including Kolmogorov's Strong Law of Large Numbers. **Professor Anderson**

189-589B ADVANCED PROBABILITY THEORY II. (4) (Prerequisites: 189-587 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.

189-591A MATHEMATICAL LOGIC I. (4) (Prerequisites: 189-488 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. **Staff**

● **189-592B MATHEMATICAL LOGIC II.** (4) (Prerequisites: 189-488 or equivalent or consent of instructor.)

11.16 Microbiology and Immunology (528)

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Chair — Greg J. Matlashewski

Professors
Nicholas H. Acheson; A.B.(Harv.), Ph.D.(Rockefeller)
Zafer Ali-Khan; B.Sc.(Bilar), M.Sc.(Karachi), Ph.D.(Tulane)
James W. Coulton; B.Sc.(Tor.), M.Sc.(Calg.), Ph.D.(W.Ont.)
Michael S. Dubow, B.Sc.(SUNY), M.A., Ph.D.(Ind.)
John Hiscott; B.Sc., M.Sc.,(W.Ont.), Ph.D.(N.Y.)
Jack Mendelson; M.Sc.(Roch.), M.D.,C.M.(McG.), F.R.C.P.(C.)
Robert A. Murgita; B.Sc.(Me.), M.S.(Vt.), Ph.D.(McG.)
Michael J.H. Ratcliffe; B.A.(Glas.), Ph.D.(Imp.Coll.)
Hugh G. Robson; B.Sc., M.D., C.M.(McG.), F.R.C.P.(C.)
Mark A. Wainberg; B.Sc.(McG.), M.Sc., Ph.D.(Col.)

Associate Professors
Malcolm G. Baines; B.Sc., M.Sc., Ph.D.(Queen's)
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Andre Dascal; D.C.S.(McG.), M.D.(Montr.)
Greg J. Matlashewski; B.Sc.(C'dia), Ph.D.(Ott.)
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David Portnoy; B.Sc.(Sir G.Wms.), M.D.(Liège)
Joseph Portnoy; B.Sc., M.D.C.M., M.Sc.(McG.)
Pierre René; B.A., M.D.(Sher.)

Associate Members
Institute of Parisitology: Gaeton Faubert, Paula Ribeiro
Division of Exp. Medicine: Clement Couture
Microbiology & Immunology: Lawrence Kleiman
Medicine: Vivian Loo, J.Dick Maclean, Mark A. Miller, Marianna Newkirk, C. Kirk Osterland, Roger G.E. Palfree, Joyce E. Rauch, Bernard Turcotte, Brian J. Ward
Neurology & Neurosurgery: Jack Antel
Oncology: Antonis E. Koromilas, Stephane Richard
Surgery: Nicholas V. Christou, A. Robin Poole

Adjunct Professors
Albert Descoteaux: B.Sc., M.Sc.(Montr.), Ph.D.(McG.)
Patrick Hugo; B.Sc., M.Sc., Ph.D.(McG.)
George Kukolj; B.Sc., Ph.D.(McG.)
Peter Lau; Ph.D.(Ottawa)
Clement Rioux; B.Sc., M.Sc.(Laval), Ph.D.(Guelph)
Rafick-P. Sekaly; B.A.(Stanislas), B.Sc., M.Sc.(Montr.), Ph.D.(Lausanne)

Affiliated Centre:
Centre for Host Resistance, Montreal General Hospital, 1650 Cedar Avenue, Montreal, QC H3G 1A4. Telephone: (514) 398-8038. Director: E. Skamane

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 177-111A, 177-112B, 180-110B or 180-111B, 180-120A or 180-121A, 189-112A/B, 189-139A/B or 189-140A/B,198-101A/B and 198-102A/B 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 528-211A 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) [MARS Program Code 4-662800]

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)

528-211A	(3)	Biology of Microorganisms
528-212A	(2)	Laboratory in Microbiology
177-200A	(3)	Molecular Biology
177-201B	(3)	Cell Biology and Metabolism
or 507-212B	(3)	Molecular Mechanisms of Cell Function
177-202B	(3)	Basic Genetics
180-212A,B	(4)	Organic Chemistry I

U1, U2 or U3 Required Course (3 credits)

177-373A	(3)	Biostatistical Analysis
or 189-203A	(3)	Principles of Statistics I
or 204-204A,B	(3)	Introduction to Psychological Statistics

U2 Required Courses (15 credits)

528-314B	(3)	Immunology
528-323A	(3)	Microbial Physiology
528-324A	(3)	Fundamental Virology
528-386D	(6)	Laboratory in Microbiology & Immunology

U3 Complementary Courses (6 credits)

6 credits selected from:

528-387B	(3)	Applied Microbiology and Immunology
528-413B	(3)	Parasitology
528-414A	(3)	Advanced Immunology
528-465A	(3)	Bacterial Pathogenesis and Host Defences
528-466B	(3)	Viral Pathogenesis and Host Defences
528-509B	(3)	Seminars on Inflammatory Processes

U1, U2 or U3 Complementary Courses (15 credits)

15 credits selected from:

177-300A	(3)	Molecular Biology of the Gene
177-314A	(3)	Molecular Biology of Oncogenes
180-203A	(3)	Survey of Physical Chemistry
or 180-204A,B	(3)	Intro. to Physical Chemistry/Biol.Science
180-222A,B	(4)	Organic Chemistry II
180-302A	(3)	Organic Chemistry III
202-505B	(3)	Selected Topics in Biotechnology
504-261A	(4)	Introduction to Dynamic Histology
504-262B	(3)	Intro. Molecular and Cellular Biology
504-365A	(3)	Cell Biology of the Secretory Processes
504-458B	(3)	Membranes & Cellular Signalling
or 507-458B	(3)	Membranes & Cellular Signalling
507-311A	(3)	Metabolic Biochemistry
507-312B	(3)	Biochemistry of Macromolecules
507-450A	(3)	Protein Structure and Function
507-454A	(3)	Nucleic Acids
507-458B	(3)	Membranes & Cellular Signalling
516-504A	(3)	Biology of Cancer
528-387B	(3)	Applied Microbiology and Immunology
528-413B	(3)	Parasitology
528-414A	(3)	Advanced Immunology
528-465A	(3)	Bacterial Pathogenesis and Host Defences
528-466B	(3)	Viral Pathogenesis and Host Defences
528-509B	(3)	Seminars on Inflammatory Processes
546-300B	(3)	Human Disease
546-300B	(3)	Human Disease
549-300A	(3)	Drug Action
549-300A	(3)	Drug Action
549-301B	(3)	Drugs and Diseases
552-209A	(3)	Mammalian Physiology I (timetable conflict with 528-324A, if taken should be in U1 or U3)
552-210B	(3)	Mammalian Physiology II

MAJOR PROGRAM IN MICROBIOLOGY AND IMMUNOLOGY (67 credits) [MARS Program Code 1-662800]

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:

180-222A,B	(4)	Organic Chemistry II
180-203A	(3)	Survey of Physical Chemistry
or 180-204A,B	(3)	Physical Chem./Biol. Sc. I

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

507-311A	(3)	Metabolic Biochemistry
507-312B	(3)	Biochemistry of Macromolecules

U3 Required Courses (9 credits)
528-413B (3) Parasitology
528-465A (3) Bacterial Pathogenesis and Host Defences
528-466B (3) Viral Pathogenesis and Host Defences

Complementary Courses (9 credits)
9 credits selected from:
177-300A (3) Molecular Biology of the Gene
177-314A (3) Molecular Biology of Oncogenes
180-302A (3) Organic Chemistry III
202-505B (3) Selected Topics in Biotechnology
504-261A (4) Introduction to Dynamic Histology
504-262B (3) Intro. Molecular and Cellular Biology
504-458B (3) Membranes & Cellular Signaling
or 507-458B (3) Membranes & Cellular Signaling
504-365A (3) Cell Biology of the Secretory Process
507-311A (3) Metabolic Biochemistry
507-312B (3) Biochemistry of Macromolecules
507-450A (3) Protein Structure and Function
507-454A (3) Nucleic Acids
516-504A (3) Biology of Cancer
528-387B (3) Applied Microbiology and Immunology
528-414A (3) Advanced Immunology
528-509B (3) Seminars in Inflammatory Processes
546-300B (3) Human Disease
549-300A (3) Drug Action
549-301B (3) Drugs and Diseases
552-209A (3) Mammalian Physiology I
(timetable conflict with 528-324A, if taken should be in U1 or U3)
552-210B (3) Mammalian Physiology II

HONOURS PROGRAM IN MICROBIOLOGY AND IMMUNOLOGY (73 required credits)
[MARS Program Code 2-662800]

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:
528-502D (12) Honours Research

Complementary Courses (3 credits)
3 credits selected from:
177-420B (3) Gene Activity in Development
202-505B (3) Selected Topics in Biotechnology
504-458B (3) Membranes & Cellular Signalling
or 507-458B (3) Membranes & Cellular Signalling
507-404B (3) Biophysical Chemistry
507-450A (3) Protein Structure and Function
507-454A (3) Nucleic Acids
507-455B (3) Neurochemistry
528-414A (3) Advanced Immunology
528-509B (3) Seminars in Inflammatory Processes
549-562A (3) General Pharmacology I
549-563B (3) General Pharmacology II

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 11.13 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

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

528-211A BIOLOGY OF MICROORGANISMS. (3) (3 hours of lecture) (Corequisite: 177-200A) 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. **TBA**

528-212A LABORATORY IN MICROBIOLOGY. (2) (3 hours of laboratory, 1 hour of conference) (Corequisite: 528-211A) This laboratory course is designed to complement 528-211A. Sessions introduce general techniques peculiar to the handling of microorganisms. **TBA**

528-314B IMMUNOLOGY. (3) (3 hours of lecture) (Prerequisite: 177-200A and 177-201B or 507-212B) 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. **Professor Ratcliffe**

528-323A MICROBIAL PHYSIOLOGY. (3) (3 hours of lecture) (Prerequisites: 528-211A) 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. **Professor Coulton**

528-324A FUNDAMENTAL VIROLOGY. (3) (3 hours of lecture) (Prerequisites: 528-211A, 177-200A, 177-201B or 507-212B) 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. **Professor Acheson**

528-386D LABORATORY IN MICROBIOLOGY & IMMUNOLOGY. (6) (1 hour lecture, 6 hours laboratory, 1 hour follow-up) (Prerequisites: 528-211A, 528-212A. Corequisites: 528-314B, 528-323A, 528-324A) 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. **Professor Baines**

528-387B APPLIED MICROBIOLOGY AND IMMUNOLOGY. (3) (Prerequisite: 528-211A) 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. **Professor Murgita**

528-413B PARASITOLOGY. (3) (Prerequisite: 528-314B or equivalent – 504-261A is strongly recommended) A study of the biology, immunological aspects of host-parasite interactions, pathogenicity, epidemiology and molecular biological aspects of selected par-

asites of medical importance. Laboratory will consist of a lecture on techniques, demonstrations and practical work.
Professor Ali-Khan

528-414A ADVANCED IMMUNOLOGY. (3) (3 hour lecture) (Prerequisite: 528-314B) An advanced course serving as a logical extension of 528-314B. 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. **Professor Ratcliffe**

528-465A BACTERIAL PATHOGENESIS AND HOST DEFENCES. (3) (3 hours of lecture) (Prerequisites: 528-211A, 528-314B, 528-323A, 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. **TBA**

528-466B VIRAL PATHOGENESIS AND HOST DEFENCES. (3) (3 hours of lecture) (Prerequisites: 528-211A, 528-324A, 528-314B) 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. **Professor Hiscott**

528-502D HONOURS RESEARCH PROJECT. (12) (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, section 2.6.2 in the Faculty Degree Requirements section.) 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. **Professor Coulton**

▭ **528-509B SEMINARS ON INFLAMMATORY PROCESSES.** (3) (3 hours of seminar) (Prerequisite: 528-314B. Corequisite: 552-513A or 528-414A) 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. This course will be given in conjunction with the Division of Experimental Medicine.
Professor Newkirk

11.17 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 — W. Woszczyk *(Chair)*

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

Advisor (B.A./B.Sc. Music programs) —
S. Huebner (514) 398-4535, ext. 5639

SCIENCE MINOR IN MUSIC PROGRAM (24 credits)
[MARS Program Code 6-666500]

Required Courses (9 credits)

210-285D	(3)	Introduction to Musical Styles
211-210A or B	(3)	Tonal Theory and Analysis I*
211-211A or B	(3)	Tonal Theory and Analysis II*

* Students must take a diagnostic placement examination before registering for this course. If the appropriate level is not achieved on the examination, students will be required to register for Melody and Counterpoint 211-110A (3 credits) and/or Elementary Harmony and Analysis 211-111B (3 credits). These courses may *not* be counted toward the 24-credit Music Minor program.

Complementary Courses (15 credits)
Music History, Literature or Performance Practice (3 credits)
a course with a 214- prefix at the 300 level – see list of courses in the Faculty of Music section; an historical performance practice course with a 215-prefix may be taken with Departmental permission.

Music Courses (12 credits)
12 credits from courses with a 211- or 214- prefix at the 300 level, or any other course from the following list of additional courses .

Complementary Course List

198-224A	(3)	Physics and Psychophysics of Music
198-225B	(3)	Musical Acoustics
211-301A	(3)	Modal Counterpoint I
211-302B	(3)	Modal Counterpoint II
211-303A	(3)	Tonal Counterpoint I
211-304B	(3)	Tonal Counterpoint II
211-310A	(3)	Mid & Late 19th-C.Theory & Analysis
or 211-327D	(4)	19th-Century Analysis
211-311B	(3)	20th-Century Theory and Analysis
or 211-427D	(4)	20th-Century Analysis
211-522D	(6)	Advanced Counterpoint
211-523D	(6)	Advanced Harmony
211-528A or B	(3)	Schenkerian Techniques
213-230D	(4)	The Art of Composition
213-260A	(2)	Instruments of the Orchestra
213-261B	(2)	Elementary Orchestration
214-220A or B	(3)	Women in Music
214-3xx		Music History complementary (maximum of 3 credits)
216-201A or B	(3)	Introduction to Music Technologies
216-305A or B	(3)	Personal Computer Applications in Music
216-306A or B	(3)	Computer Programming for Musicians I
216-307A or B	(3)	Computer Programming for Musicians II
222-205A or B	(3)	Psychology of Music
222-207A or B	(3)	Sociology of Music
243-xxx		Ensembles (maximum of 4 credits; registration contingent upon ensemble audition)

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 Academic Affairs Office of the Faculty of Music (Room E222, Strathcona Music Building, 555 Sherbrooke Street West) from February 1, 2000 and must be completed and returned to that office by May 15, 2000. 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, 2000.

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)

198-224A	(3)	Physics and Psychophysics of Music
198-225B	(3)	Musical Acoustics

214-342A or B (3) History of Electroacoustic Music
216-202A (3) Fundamentals of New Media
216-203B (3) Introduction to Digital Audio
216-301A or B (3) Music and the Internet
216-302A (3) New Media Production I
216-303B (3) New Media Production II

COURSES

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.

Please consult the Faculty of Music for timetable information.

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

● Denotes courses not offered in 2000-01.
▭ Denotes courses with limited enrolment.

LIST I

No music prerequisites, other than those listed under a specific course, are required. **Courses in List I may not be credited toward the B.A. or B.Sc. Music programs.**

Students who have completed a course with a 211- teaching unit number from List II or who have Matriculation Music or McGill Conservatory Theory Secondary V or its equivalent may not register for 210-201 or 210-202.

▭ **210-201A,B BASIC MATERIALS OF WESTERN MUSIC I.** (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. **Ms. Lipszyc (Co-ordinator)**

▭ **210-202A,B BASIC MATERIALS OF WESTERN MUSIC II.** (3) (3 hours) (Prerequisite: 210-201A,B 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.

▭ **210-211A,B 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. **Professor Cumming (Co-ordinator)**

Not all of the following courses in List I will be offered in 2000-01; for an up-to-date listing, please consult the final 2000-01 Faculty of Music timetable.

Students who read music and have an instrumental or vocal background may proceed directly to courses at the 300 level.

210-374A OR B SPECIAL TOPICS IN MUSIC. (3) (3 hours) A course whose topics will correspond to special historical events and their associated musical, political, and cultural contexts.

● **210-384A OR B ROMANTICISM & THE PIANO.** (3) (3 hours) (Prerequisite: 210-201 or 210-211 or permission of instructor.)

210-385A MUSIC OF THE AVANT-GARDE. (3) (3 hours) (Prerequisite: 210-201 or 210-211) Explorations into post-1945 sound environments; new timbres (Berio and Crumb); "technological" music (electronic and computer music); minimalism (Glass); new aesthetics (Cage); the World Soundscape Project (Schafer); global trends (cross-cultural influences; the New Romanticism; multimedia; protest music). **Professor Levitz**

210-387A OR B THE OPERA. (3) (3 hours) (Prerequisite: 210-201 or 210-211) 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. **Professor Lawton**

210-389B THE SYMPHONY AND CONCERTO. (3) (3 hours) (Prerequisite: 210-201 or 210-211) 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.

▭ **210-392B POPULAR MUSIC AFTER 1945.** (3) (3 hours) (Prerequisite: 210-201 or 210-211 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. **Mr. Morrison**

▭ **210-393B INTRODUCTION TO JAZZ.** (3) (3 hours) (Prerequisite: 210-201 or 210-211 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. **Mr. Steprans**

For course descriptions, please consult the Faculty of Music section 8.3.

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.

THEORY

For course descriptions, please consult the Faculty of Music section 8.1.

Note: Students not in the B.A. or B.Sc. Music programs are not required to take the corequisites for the following 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.

211-110A MELODY AND COUNTERPOINT. (3) (4 hours) (Prerequisite: Matriculation Music or McGill Conservatory Theory Secondary V or its equivalent. Corequisites: 212-129 and -170 or permission of co-ordinator or instructor.) **Professor Schubert (Co-ordinator) and Staff**

211-111B ELEMENTARY HARMONY AND ANALYSIS. (3) (4 hours) (Prerequisite: 211-110. Corequisites: 212-131 and 212-171) **Professor Schubert (Co-ordinator) and Staff**

211-210A,B TONAL THEORY AND ANALYSIS I. (3) (3 hours) (Prerequisites: 211-110 and 111. Corequisite: 212-229. Prerequisite or corequisite: 212-171)**Professor Caplin (Co-ordinator) and Staff**

211-211A,B TONAL THEORY AND ANALYSIS II. (3) (3 hours) (Prerequisite: 211-210. Corequisite: 212-231. **Professor Caplin (Co-ordinator) and Staff**

Unless otherwise indicated the following courses are prerequisites to 300-, 400- and 500- level theory courses: 211-211 or 213-240 AND 212-231 AND 212-171.

211-310A MID & LATE 19TH-C. THEORY & ANALYSIS. (3) (3 hours) **Staff**

211-311B 20TH-CENTURY THEORY AND ANALYSIS. (3) (3 hours) (Prerequisite: 211-310) **Staff**

HISTORY

For course descriptions, please consult the Faculty of Music section 8.4.

214-184A HIST. SURVEY (MEDIEVAL, RENAISS., BAROQ.). (3) (3 hours) (Corequisites: 211-110 and 212-129 OR permission of instructor) **Professor Helmer**

214-185B HIST. SURVEY (CLASS., ROMANTIC, 20TH-C.). (3) (3 hours) (Corequisites: 211-111 and 212-131 OR permission of instructor) **Professor Huebner**

214-220B WOMEN IN MUSIC. (3) (3 hours) (Prerequisite: none) **Professor Levitz**

Unless otherwise indicated the following courses are prerequisites to 300- and 400- level history courses: 214-184 and 214-185 AND 211-211 or 213-240 AND 212-231.

Not all of the following courses will be offered in 2000-01; for an up-to-date listing, please consult the final 2000-01 Faculty of Music timetable.

214-342A OR B HISTORY OF ELECTROACOUSTIC MUSIC. (3) (3 hours) (Open to non-music students by permission of instructor.) Investigation of the repertoire and techniques of electroacoustic music and the historical developments at important centers for research and creative activities. The roles of electronic and computer technologies in commercial and concert music are examined. **Professor Ianza**

● **214-386B CHAMBER MUSIC LITERATURE.** (3) (3 hours)

214-387A OR B OPERA FROM MOZART TO PUCCINI. (3) (3 hours) **Professor Huebner**

● **214-389A OR B ORCHESTRAL LITERATURE.** (3) (3 hours)

214-390B THE GERMAN LIED. (3) (3 hours) **Dr. Evans**

214-395A OR B KEYBOARD LITERATURE BEFORE 1750. (3) (3 hours) **Professor Minorgan**

● **214-396B ERA OF THE MODERN PIANO.** (3) (3 hours)

214-397B CHORAL LITERATURE AFTER 1750. (3) (3 hours)

214-398A WIND ENSEMBLE LITERATURE AFTER 1750. (3) (3 hours) **Professor Gibson**

▭ **215-381A OR B TOPICS IN PERF. PRACTICE BEFORE 1800.** (3) (3 hours) **Professor Helmer**

▭ **216-202A 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. **Staff**

▭ **216-203B INTRODUCTION TO DIGITAL AUDIO.** (3) (3 hours) (Prerequisite: 216-202A) 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. **Staff**

216-301A OR B MUSIC AND THE INTERNET. (3) (3 hours) (Prerequisite: 216-201A OR 216-202A) (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. **Staff**

▭ **216-302A NEW MEDIA PRODUCTION I.** (3) (3 hours) (Prerequisite: 216-201A OR 216-202A) (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. **Staff**

▭ **216-303B NEW MEDIA PRODUCTION II.** (3) (3 hours) (Prerequisite: 216-301A) (Not open to students in B. Mus. Honours in Music Technology.) A continuation of 216-302A. Students produce new media objects of increasing complexity and scope, integrating several types of content. **Staff**

Music Ensembles

Science students in the Science Minor in Music Program may, with the permission of the instructor and the Associate Dean of their own Faculty, participate in one of the following ensembles in a given year. Auditions are held starting the week prior to the beginning of classes in September and continuing during that first week and, in the case of the McGill Symphony Orchestra (243-497A,B), in early January for the winter term. The schedule and requirements for these auditions are available at the end of June from the Department of Performance office (514) 398-4542. Normally both the A and B sections of an ensemble are taken in the same academic year.

The deadline for withdrawing from ensembles is the end of the second week of classes in any term.

For course descriptions, please consult the Faculty of Music section 8.9.

243-489A,B WOODWIND ENSEMBLES. (1 plus 1 credit) (2-3 hours) (Prerequisite: audition) **Professor Kestenberg (Co-ordinator)**

243-490A,B MCGILL WINDS. (2 plus 2 credits) (4-6 hours) (Prerequisite: audition) **Staff**

243-491A,B BRASS ENSEMBLES. (1 plus 1 credit) (2-3 hours) (Prerequisite: audition) **Professor Gibson (Co-ordinator)**

243-493A,B CHORAL ENSEMBLES. (2 plus 2 credits) (4 hours) (Prerequisite: audition) Students enroling in Choral Ensembles will be assigned to one of the following groups:
Section 01 Chamber Singers
Section 02 Concert Choir
Section 03 University Chorus
Section 04 Women's Chorale **Professor Edwards and Staff**

243-494A,B CONTEMPORARY MUSIC ENSEMBLE. (2 plus 2 credits) (4 hours) (Prerequisite: audition) **Professor Bouliane**

243-495A,B JAZZ ENSEMBLES. (2 plus 2 credits) (3-4 hours) (Prerequisite: audition) **Professor Foote and Mr. DiLauro**

243-496A,B OPERA STUDIO. (4 plus 4 credits) (3-6 hours) (Prerequisite: audition) **Professors Ross-Neill, Vernon and Staff**

243-497A,B ORCHESTRA. (2 plus 2 credits) (6-7 hours) (Prerequisite: audition. Corequisite for wind players: 243-478A,B)
N.B. Woodwind and brass players will take one hour per week of Repertoire Class as part of Orchestra. **Professor Vernon and Staff**

243-499A,B STRING ENSEMBLES. (1 plus 1 credit) (2-3 hours) (Prerequisite: audition) N.B. Guitar ensemble is restricted to Performance Majors only.
Section 01 Chamber Music
Section 02 Bass Ensemble
Section 03 Guitar Ensemble
Professor Saint-Cyr (Co-ordinator)