Immunology
504-261A Introduction to Dynamic Histology
507-503B Immunochemistry
552-513B Cellular Immunology
528-314B Immunology
528-414A Advanced Immunology

Management*
154-208 Microeconomics Analysis and Applications
280-211 Introduction to Financial Accounting
280-341 Finance 1
280-352 Marketing Management I
280-472 Operations Management
* These courses may not also be used for a Management Minor, nor for complementary, by Engineering students

Microbiology
528-323A Microbial Physiology
528-324A Fundamental Virology
528-413B Parasitology
528-465A Bacterial Pathogenesis and Host Defenses
528-466B Viral Pathogenesis and Host Defenses

Molecular Biology (Biology)
177-300A Molecular Biology of the Gene
177-314A Molecular Biology of Oncogenes
177-420B Gene Activity in Development
177-451A Molecular Biology: Cell Cycle
177-524A Topics in Molecular Biology

Molecular Biology (Biochemistry)
507-311A Metabolic Biochemistry
507-312B Biochemistry of Macromolecules
507-450A Protein Structure and Function
507-454A Nucleic Acids
507-455B Neurochemistry

Physiology
552-517B Artificial Internal Organs
552-518A Artificial Cells and Biotechnology
549-562A General Pharmacology I
549-563B General Pharmacology II
516-401B Physiology and Biochemistry of Endocrine Systems
516-502A Advanced Endocrinology, Part I
516-503B Advanced Endocrinology, Part II

Plant Biology
177-357A Plant Physiology
177-526B Plants and Extreme Environments

Pollution*
303-225B Environmental Engineering
303-430A Water Treatment and Pollution Control
303-526B Solid Waste Management
303-553B Stream Pollution and Control
302-471B Industrial Water Pollution Control
* These courses may not also be used for a Environmental Engineering Minor by Engineering students.

General:
306-310A,B Engineering Economy

COURSE DESCRIPTION

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

202-505A SELECTED TOPICS IN BIOTECHNOLOGY. (3) (Restricted to U3 students) Current methods and recent advances in biological, medical, agricultural and engineering aspects of biotechnology will be described and discussed. An extensive reading list will complement the lecture material. **Professor Prichard**

11.6 Chemistry (180)

Otto Maass Chemistry Building
801 Sherbrooke Street West
Montreal, QC H3A 2K6
Departmental Office: Room 322. Telephone: (514) 398-6999
Student Advisory Office: Room 309A. Telephone: (514) 398-6927
Website: http://www.mcgill.ca/chemistry

Chair — David N. Harpp

Emeritus Professors
John F. Harrod; B.Sc., Ph.D.(Birm.)
(Tomlinson Emeritus Professor of Chemistry)
Alan S. Hay; B.Sc., M.Sc.(Alta.), Ph.D.(Ill.), D.Sc.(Alta.), F.R.S., F.N.Y., Acad.Sci.*(Tomlinson Emeritus Professor of Chemistry)*
Mario Onyszchuk, B.Sc.(McG.), M.Sc.(W.Ont.), Ph.D.(McG.), Ph.D.(Cantab,)
Donald Patterson; M.Sc.(McG.), Doc. Hon. Causa(St-Etienne)
(Otto Maass Emeritus Professor of Chemistry)
Arthur S. Perlin; M.Sc., Ph.D.(McG.), F.R.S.C.
(E.B. Eddy Emeritus Professor of Industrial Chemistry)
William C. Purdy; B.A.(Amherst), Ph.D.(M.I.T.), F.C.I.C.
(William C. Macdonald Emeritus Professor of Chemistry)
Leon E. St-Pierre; B.Sc.(Alta.), Ph.D.(Notre Dame, Ind.), F.C.I.C.
Michael A. Whitehead; B.Sc., Ph.D. D.Sc.(Lond.), F.C.I.C.

Professors
Ian S. Butler; B.Sc., Ph.D.(Brist.), F.C.I.C., C.Chem., F.R.S.C.(U.K.)
Tak-Hang Chan; B.Sc.(Tor.), M.A., Ph.D.(Prin.), F.C.I.C., F.R.S.C.
Adi Eisenberg; B.S.(Worcester Polytech.), M.A., Ph.D.(Prin.), F.C.I.C. *(Otto Maass Professor of Chemistry)*
Byung Chan Eu; B.Sc.(Seoul), Ph.D.(Brown)
Patrick G. Farrell; B.Sc., Ph.D., D.Sc.(Exe.)
Denis F.R. Gilson; B.Sc.(Lond.), M.Sc., Ph.D.(U.B.C.), F.C.I.C.
David N. Harpp; A.B.(Middlebury), M.A.(Wesleyan), Ph.D.(N.Carolina), F.C.I.C.
James J. Hogan; B.S.(Renss.), Ph.D.(Chic.)
George Just; Ing.Chem.(E.T.H. Zürich), Ph.D.(W.Ont.), F.C.I.C.
(William C. Macdonald Professor of Chemistry)
Robert H. Marchessault; B.Sc.(Loyola), Ph.D.(McG.), D.Sc.(C'dia), F.R.S.C. *(E.B. Eddy Professor of Industrial Chemistry)*
David Ronis; B.Sc.(McG.), Ph.D.(M.I.T.)
Eric D. Salin; B.Sc.(Calif.), Ph.D.(Oreg.St.)
Bryan C. Sanctuary; B.Sc., Ph.D.(U.B.C.)
Alan G. Shaver; B.Sc.(Car.), Ph.D.(M.I.T.)

Associate Professors
Mark P. Andrews; B.Sc., M.Sc., Ph.D.(Tor.)
David H. Burns; B.Sc.(Puget Sound), Ph.D.(Wash)
Masad J. Damha; B.Sc., Ph.D.(McG.)
William C. Galley; B.Sc.(McG.), Ph.D.(Calif.)
Ashok K. Kakkar; Ph.D.(Wat.)
Romas Kazlauskas; B.Sc.(Clev.St.), Ph.D.(M.I.T.)
R. Bruce Lennox; B.Sc., M.Sc., Ph.D.(Tor.)
Joan F. Power; B.Sc., Ph.D.(C'dia)
Linda Reven; B.A.(Car.), Ph.D.(Ill.)

Assistant Professors
Parisa Ariya; B.Sc., Ph.D.(York)
Bruce Arndtsen; B.A.(Car.), Ph.D.(Stan.)
Christopher J. Barrett; B.Sc., M.Sc., Ph.D.(Queen's)
James Gleason; B.Sc.(McG.), Ph.D.(Virginia)
Hanadi Sleiman; B.Sc.(A.U.B.), Ph.D.(Stan.)

Faculty Lecturers
John Finkenbine; B.S.(Capital), Ph.D.(McG.)
Grazyna Wilczek; M.Sc., Doctorate Chem. Sci.(Warsaw)

Associate Members
James A. Finch *(Mining & Metallurical Engineering),*
Orval A. Mamer *(University Clinic),* Barry I. Posner *(Medicine)*

Adjunct Professors
G Ronald Brown; B.Sc.(Man.), Ph.D.(McG.)
Ariel Fenster; L.ès S., D.E.A.(Paris), Ph.D.(McG.)
Joseph A. Schwarcz; B.Sc., Ph.D.(McG.)

Youla Tsantrizos; B.Sc., Ph.D.(McG.)
Ivor Wharf; B.Sc., Ph.D.(Lond.), A.R.C.S., D.I.C.
Robert Zamboni; B.Sc., Ph.D.(McG.)

PAPRICAN Adjunct Professors
Dimitris Argyropoulos; B.Sc.(South Bank Poly.), Ph.D.(McG.)
Derek G. Gray; B.Sc.(Belf.), M.Sc., Ph.D.(Man.), F.C.I.C.
R. St. John Manley; B.Sc., Ph.D.(McG.), D.Sc.(Uppsala)
Theo G.M. van de Ven; Kand. Doc.(Utrecht), Ph.D.(McG.)

Chemistry is both a pure science, offering a challenging intellectual pursuit and an applied science whose technology is of fundamental importance to the economy and society. Modern chemists seek an understanding of the structure and properties of atoms and molecules to predict and interpret the properties and transformations of matter and the energy changes that accompany those transformations. Many of the concepts of physics and mathematics are basic to chemistry, while chemistry is of fundamental importance to many other disciplines such as the biological and medical sciences, geology, metallurgy, etc.

A degree in chemistry leads to a wide variety of professional vocations. The large science-based industries (petroleum refining, plastics, pharmaceuticals, etc.) all employ chemists in research, development and quality control. Many federal and provincial departments and agencies employ chemists in research and testing laboratories. Such positions are expected to increase with the currently growing concern for the environment and for consumer protection. A background in chemistry is also useful as a basis for advanced study in other related fields, such as medicine and the biological sciences. For a business career, a B.Sc. in Chemistry can profitably be combined with a master's degree in Business Administration, or a study of law for work as a patent lawyer or forensic scientist.

Chemistry courses at the university level are traditionally divided into four areas of specialization: 1) organic chemistry, dealing with the compounds of carbon; 2) inorganic chemistry, concerned with the chemistry and compounds of elements other than carbon; 3) analytical chemistry, which deals with the identification of substances and the quantitative measurement of their compositions; and 4) physical chemistry, which treats the physical laws and energetics governing chemical reactions. Naturally there is a great deal of overlap between these different areas, and the boundaries are becoming increasingly blurred. After a general course at the collegial level, courses in organic, inorganic, analytical and physical chemistry are offered through the university years. Since chemistry is an experimental science, laboratory classes accompany most undergraduate courses. In addition, courses are offered in polymer, nuclear, theoretical, radio- and biological chemistry to upper year undergraduates.

There are two main programs in chemistry, Honours and Major. The Honours program is intended primarily for students wishing to pursue graduate studies in chemistry. While the Major program is somewhat less specialized, it is still recognized as sufficient training for a career in chemistry. It can also lead to graduate studies although an additional qualifying year may be necessary. There are also a number of Faculty programs available. Interested students may inquire about these at the Student Advisory Office, Room 309A, Otto Maass Chemistry Building.

PRE-PROGRAM REQUIREMENTS

Students entering from the Freshman program must have included Mathematics 189-140/141, Chemistry 180-121/111 or -120/110, Biology 177-111, Physics 198-131/142, or their equivalents in their Freshman year. Québec students must have completed the DEC with appropriate science and mathematics courses.

REQUIRED COURSES IN CHEMISTRY PROGRAMS

The required courses in Chemistry programs consist of 57 credits in chemistry, physics and mathematics, listed below. The courses marked with an asterisk (*) are omitted from the program of students who have successfully completed them at the CEGEP level but the Chemistry courses must be replaced by courses in that discipline if students wish to be eligible for admission to the Ordre des chimistes du Québec. Students from outside Québec or transfer students should consult the academic advisor.

A computer science course, either 308-102 or 308-202, will be required during U1 for students who have no previous introduction to computer *programming.* Students are required to contact their advisor on this matter. Completion of Mathematics 189-222 and 189-315 during U1 is strongly recommended. Physics 198-242 should be completed during U-2.

Chemistry Majors and Honours Programs
Required Courses (57 credits)

180-212	(4)	Organic Chemistry I
180-213	(3)	Physical Chemistry I
180-222*	(4)	Organic Chemistry II
180-273	(1)	Chemical Kinetics
180-277	(4)	Classical Methods of Analysis
180-281	(3)	Inorganic Chemistry I
180-302	(3)	Organic Chemistry III
180-345	(3)	Molecular Properties & Structure I
180-355	(3)	Molecular Properties & Structure II
180-363	(2)	Physical Chemistry Lab
180-365	(2)	Statistical Mechanics
180-367	(3)	Instrumental Analysis I
180-377	(3)	Instrumental Analysis II
180-381	(3)	Chemistry of Transition Elements
180-392	(3)	Integrated Inorganic/organic Lab
180-393	(2)	Physical Chemistry Lab II
189-133*	(3)	Vectors, Matrices and Geometry
189-222*	(3)	Calculus III
189-315	(3)	Ordinary Differential Equations
198-242	(2)	Electricity & Magnetism

* asterisks denote courses with CEGEP equivalents

HONOURS PROGRAM IN CHEMISTRY (75 credits)
[MARS Program Code 2-172200]

Required Courses (57 credits)
57 credits as listed above

Complementary Courses (18 credits)
6 credits of research:

180-470*	(6)	Research Project
or 180-480	(3)	Research Project
and 180-490	(3)	Research Project

and 12 credits of additional Chemistry courses:
6 credits of which must be at the 300 level or higher, and
6 credits of which must be at the 400 level or higher

Note: Students may take up to 12 Research Project credits but **only** 6 of these may be used to fulfil the program requirement.

Attainment of the Honours degree requires a CGPA of at least 3.00.

* Awaiting University Approval

HONOURS WITH BIO-ORGANIC OPTION (79 credits)
[MARS Program Code 2-172205]

The Bio-organic Option of Honours in Chemistry consists of the requirements for Honours in Chemistry with replacement of 198-242 by 177-200 and 177-201, and replacement of the 6 complementary credits of Chemistry at the 300 level with 6 credits chosen from the following: 177-202, 177-301, 180-402, 528-211, 528-314, 528-323, 552-201, 552-202, 552-209A, 552-210B.

Attainment of the Honours degree requires a CGPA of at least 3.00.

HONOURS IN CHEMISTRY: ENVIRONMENTAL CHEMISTRY OPTION (78 credits) [MARS Program Code 2-172206]
(Revisions Awaiting University Approval)

The Environmental Chemistry Option of Honours in Chemistry consists of the requirements for Honours in Chemistry with replacement of 6 complementary credits of Chemistry at the 300 level or higher and 6 credits at the 400 level or higher by 180-219,

180-307, 180-419 plus 6 credits chosen from the following: 180-352, 180-511, 180-575, 180-597, 186-542, 195-220.

Attainment of the Honours degree requires a CGPA of at least 3.00.

HONOURS WITH MATERIALS OPTION (78 credits)
[MARS Program Code 2-172207]
(Revisions Awaiting University Approval)

The Materials Option of Honours in Chemistry consists of the requirements for Honours in Chemistry with replacement of the 6 credits at the 300 level or higher and the 6 credits at the 400 level or higher by 180-455 and 180-531, plus 9 credits chosen from the following: 180-543, 180-571, 180-585, 302-487, 306-260, 306-367.

Attainment of the Honours degree requires a CGPA of at least 3.00.

MAJOR PROGRAM IN CHEMISTRY [(63 credits)
MARS Program Code 1-172200]

Required Courses (57 credits)
57 credits as listed above

Complementary Courses (6 credits)
6 credits of additional Chemistry courses at the 300 level or higher.

Attainment of the Major degree requires a CGPA of 2.00.

MAJOR WITH BIO-ORGANIC OPTION (67 credits)
[MARS Program Code 1-172205]

The Bio-organic Option of Major in Chemistry is the Honours program with Bio-Organic Option less the 6 credit Research Project and the 6 complementary credits at the 400 level or higher.

Attainment of the Major degree requires a CGPA of 2.00.

MAJOR IN CHEMISTRY: ENVIRONMENTAL CHEMISTRY OPTION (66 credits) [MARS Program Code 1-172206]
(Revisions Awaiting University Approval)

The Environmental Chemistry Option of Major in Chemistry is the 57 credits of Required Courses, to which are added 180-219, 180-307, 180-419.

Attainment of the Major degree requires a CGPA of 2.00.

MAJOR WITH MATERIALS OPTION (66 credits)
[MARS Program Code 1-172207]
(Revisions Awaiting University Approval)

The Materials Option of Major in Chemistry is the 57 credits of Required Courses, to which are added 180-455, 180-531 plus 3 credits chosen from the following: 180-543, 180-571, 180-585, 302-487, 306-260, 306-367.

Attainment of the Major degree requires a CGPA of 2.00.

FACULTY PROGRAMS IN CHEMISTRY

Faculty programs in Chemistry are constructed from the U1 courses and the general courses of U2 and U3 intended for these students. Consult the Department of Chemistry Student Advisory Office for an adviser. A computer science course, either 308-102 or 308-202, will be required during U1 for students who have no previous introduction to computer programming.

FACULTY PROGRAM IN CHEMISTRY (53 credits)
[MARS Program Code 4-172200]

Chemistry 180-212, 222 or equivalent, 180-204 and 214, or 213 and 355, 201 or 281, 277, 301 or 381, 345, 367 and 377, 302. Mathematics 189-222, 315. Physics 198-242. Nine additional credits from any of the following: Chemistry 180-352, 363, 382, 355, 392, 393 and any 400-level courses in Chemistry for which the prerequisites are satisfied.

FACULTY PROGRAM IN CHEMISTRY AND BIOLOGICAL SCIENCES (54 credits) [MARS Program Code 4-172500]

Chemistry 180-222, 204, 214, 257D, 302, 352, 362, 382. Biology 177-200 and 201, 205, 301, 304. Physics 198-242. Physiology 552-209A, -210B. Computer Science 308-102 or 308-202. Plus 3 approved credits.

FACULTY PROGRAM IN CHEMISTRY AND MATHEMATICS (53 credits) [MARS Program Code 4-172900]

Chemistry 180-212, 222, 204 and 214 or 213 and 365, 281, 277, 345, 355. Physics 198-242. Mathematics 189-222, 223, 314, 315, 317, 319, 323, 324.

Please refer to page 390 in the Mathematics and Statistics section for the Faculty program in Mathematics, Chemistry and Physics.

MINOR PROGRAM IN CHEMISTRY
[MARS Program Code 6-172200]

A Minor in Chemistry which comprises 18 credits of chemistry courses taken at McGill, including 180-203, 180-212, 180-222, 180-281 and 180-257. Substitutions for these by more advanced courses may be made at the discretion of the advisor.

MINOR IN CHEMICAL ENGINEERING
[MARS Program Code 6-163800]

A Chemical Engineering Minor will be of interest to Chemistry students who wish to study the problems of process engineering and its related subjects. A student completing this Minor will be able to make the important link between molecular sciences and industrial processing. This Minor will not provide Professional Engineering accreditation. The Minor requires 24 credits as follows: 7 credits in 302-200A and 302-204B; at least one of 302-220B or 302-314A; at least 13 credits from the following: 189-314, 302-230B, 302-315B, 302-351B, 302-370A, 302-380A, 302-438B, 302-392A and 393B, 302-452B, 302-471A, 302-472A, 302-481A, 302-487A, and either 302-494A,B,D or 302-495A,B,D.

COURSE DESCRIPTIONS

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

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

180-110B GENERAL CHEMISTRY - BIOLOGICAL. (4) (3 lectures) (Prerequisites/corequisites: College level mathematics and physics or permission of instructor; 180-120 is not a prerequisite.) (Not open to students who have taken or are taking 180-111. See "Course Overlap" on page 345) A study of the fundamental principles of atomic structure, valence theory and periodic table.
Professor Sanctuary

Laboratory: (2½ hours) Illustrative experiments. Lab section for students continuing from 180-120 will be the same. New students will be assigned lab sections in OM 1 on the first day of classes.
NOTE: Each lab section is limited enrolment. **TBA**

180-111B GENERAL CHEMISTRY – PHYSICAL & ENGINEERING. (4) (3 lectures) (Prerequisites/corequisites: College level mathematics and physics, or permission of instructor: 180-121 is not a prerequisite.) (Not open to students who have taken or are taking 180-110. See "Course Overlap" on page 345) A study of the fundamental principles of atomic structure, valence theory and periodic table. **Professor Hogan**

Laboratory: (2½ hours) Illustrative experiments. Lab section for students continuing from 180-121 will be the same. New students will be assigned lab sections in OM 1 on the first day of classes.
NOTE: Each lab section is limited enrolment. **TBA**

180-112B GENERAL CHEMISTRY LABORATORY. (1) (2½ hours laboratory) (Open only to entering students who have the lecture equivalent of 180-110.) Illustrative experiments. Laboratory section of 180-110. Lab section for students continuing from 180-120 will be the same. New students will be issued lab sections in OM 1 on the first day of classes.
Note: Each lab section is limited enrolment. **TBA**

180-113B GENERAL CHEMISTRY LABORATORY. (1) (2½ hours laboratory) (Open only to entering students who have the lecture equivalent of 180-111.) Illustrative experiments for physical sciences

and engineering students (PSE). Lab section for students continuing from 180-121 will be the same. New students will be assigned lab sections in OM 1 on the first day of classes.
Note: Each lab section is limited enrolment. **TBA**

180-120A GENERAL CHEMISTRY – BIOLOGICAL. (4) (3 lectures) (Prerequisites/corequisites: College level mathematics and physics, or permission of instructor: 180-110 is not a prerequisite.) (Not open to students who have taken or are taking 180-121. See "Course Overlap" on page 345) A study of the fundamental principles of physical chemistry. Laboratory: (2½ hours) Illustrative experiments.
NOTE: Each lab section is limited enrolment.
Professor Sanctuary

180-121A GENERAL CHEMISTRY - PHYSICAL & ENGINEERING. (4) (3 lectures) (Prerequisites/corequisites: College level mathematics and physics, or permission of instructor: 180-111 is not a prerequisite.) (Not open to students who have taken or are taking 180-120. See "Course Overlap" on page 345) A study of the fundamental principles of physical chemistry. Laboratory: (2½ hours) Illustrative experiments.
NOTE: Each lab section is limited enrolment.
Professors Damha and Schwarcz

180-122A GENERAL CHEMISTRY LABORATORY. (1) (2½ hours laboratory) (Open only to entering students who have the lecture equivalent of 180-120.) Illustrative experiments. Laboratory section of 180-120.

180-123A GENERAL CHEMISTRY LABORATORY (PSE). (1) (2½ hours laboratory) (Open only to entering students who have the lecture equivalent of 180-121.) Illustrative experiments for physical sciences and engineering (PSE) students. Laboratory section of 180-121.

● **180-150B WORLD OF CHEM: FOOD.** (3) (3 lectures) (No prerequisites) (Science students may take for credit only two of: 180-150, -160, -170, -180. These courses can be taken independently of each other.)

● **180-160A WORLD OF CHEM: TECHNOLOGY.** (3) (3 lectures) (No prerequisites) (Science students may take for credit only two of: 180-150, -160, -170, -180. These courses can be taken independently of each other.)

180-170B WORLD OF CHEM: DRUGS. (3) (3 lectures) (No prerequisites) (Science students may take for credit only two of: 180-150, -160, -170, -180. These courses can be taken independently of each other.) Aspects of drugs including drug history, over the counter drugs (e.g. aspirin, cough remedies, allergy preparations), and street drugs. Significant attention will be paid to prescription drugs such as heart remedies and antibiotics. **Professors Harpp, Fenster and Schwarcz**

180-180A WORLD OF CHEM: ENVIRONMENT. (3) (3 lectures) (No prerequisites) (Science students may take for credit only two of: 180-150, -160, -170, -180. These courses can be taken independently of each other.) Water, air pollution, sick-building syndrome, the chemistry of the car, energy (fossil fuel, nuclear), household products, quackery (18th century to the internet), computers and cosmetics. (Awaiting Final Approval) **Professors Harpp, Fenster and Schwarcz**

180-199A WHY CHEMISTRY? (3) (2 lectures and 1 seminar) (FYS – for first year students only, maximum 25) A lecture/seminar course which is expected to deal with a) color, from gemstones to lasers; b) microscopes that see atoms – with demonstrations; c) the atmosphere: the greenhouse effect, and acid rain, and d) scientific ethics in research and publication. **Professors Schwarcz, Sleiman and Marchessault**

180-201A MODERN INORGANIC CHEMISTRY. (3) (3 lectures) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent. Not open to Honours or Majors in chemistry.) (Not open to students who have taken or plan to take 180-281.) Systematic survey of the chemistry of the main group elements and their compounds. Basic concepts of electronic structure, bonding and structure will be developed and applied to the understanding of common materials. Emphasis on elements such as oxygen, nitrogen, silicon and others in order to understand their role in our everyday lives.
Professor Andrews

180-203A SURVEY OF PHYSICAL CHEMISTRY. (3) (3 lectures) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent. Intended for students in biological science programs requiring only one course in physical chemistry.) (Not open to students who have taken or are taking 180-204 or 180-213.) A survey of the principles and methods of physical chemistry with emphasis on the use of biological examples. Topics will include thermodynamics, transport properties, kinetics, molecular structure and interactions, and spectroscopy. **Professor Galley**

180-204A,B,L PHYSICAL CHEM./BIOL. SCI. I. (3) (3 lectures) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent and one full course in calculus.) (Not open to students who have taken or are taking 180-203 or 180-213.) Similar to 180-213. Emphasis on the use of biological examples to illustrate the principles of physical chemistry. The relevance of physical chemistry to biology is stressed. **Professors Barrett (A) and Reven (B)**

180-212A,B,C ORGANIC CHEMISTRY I. (4) (3 lectures and Laboratory) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent courses. Not open to students who have taken Chemistry 202 at CEGEP.) A survey of reactions of aliphatic and aromatic compounds including modern concepts of bonding, mechanisms, conformational analysis, and stereochemistry.
NOTE: Each lab section is limited enrolment.
Professor Sleiman (A) and TBA (B) and Mr. Daoust

180-213B PHYSICAL CHEMISTRY I. (3) (3 lectures) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent; Mathematics 189-139 and 141 or equivalent.) (Not open to students who have taken or are taking 180-203 or 180-204.) Gas laws, kinetic theory. First law of thermodynamics, enthalpy, thermochemistry, bond energies. Second law of thermodynamics; the entropy and the free energy functions. Chemical and thermodynamic equilibrium states. Phase rule. Colligative properties of ideal solutions. Topics may include: chemical kinetics, electrochemistry and others.
Professor Ronis

180-214B PHYSICAL CHEM./BIOL. SCI. II. (3) (3 lectures) (Prerequisites: 180-213 or 180-204.) Emphasis is placed on the use of biological examples to illustrate the principles of physical chemistry. The relevance of physical chemistry to biology is stressed.
Professors Eisenberg and Galley

180-217A,B GENERAL ANALYTICAL CHEM. LAB. I. (1) (3 hours) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent.) Laboratory portion of an individualized program in analytical chemistry. **Professor Burns**

★**180-219B INTRO TO ATMOSPHERIC CHEM.** (3) (3 lectures) (Prerequisite: CEGEP DEC in Science or permission of instructor.) (Not open to students who have taken 195-219, 180-419, or 195-419.) (Offered in even years. Students should register in 195-219 in odd years.) An introduction to the basic topics in atmospheric chemistry. The fundamentals of the chemical composition of the atmosphere and its chemical reactions. selected topics such as smog chamber, acid rain, and ozone hole will be examined.
Professor Ariya

180-222A,B,T ORGANIC CHEMISTRY II. (4) (3 lectures and laboratory) (Prerequisite: 180-212. Not open to students who have taken Chemistry 302 at CEGEP.) Modern spectroscopic techniques for structure determination. The chemistry of alkyl halides, alcohols, ethers, carbonyl compounds and amines with special attention to mechanistic aspects. Special topics.
NOTE: Each lab section is limited enrolment.
Professors Harpp and Schwarcz (A) and Farrell (B) and Mr. Daoust

180-224A,B,C ORGANIC CHEMISTRY LABORATORY I. (1) (4 hours laboratory) (Open only to students who have the lecture equivalent of 180-212.) Illustrative experiments in organic chemistry. Laboratory section of 180-212. **Professor Farrell and Mr. Daoust**

180-237B GENERAL ANALYTICAL CHEM. LAB. II. (1) (3 hours) (Prerequisites: 180-217) Laboratory portion of an individualized program in analytical chemistry. **Professor Burns**

180-244A,B,T ORGANIC CHEMISTRY LABORATORY II. (1) (4 hours laboratory) (Prerequisite: 180-234 or equivalent) Laboratory section of 180-222. **Professor Farrell and Mr. Daoust**

180-257D ANALYTICAL CHEMISTRY. (4) (1 lecture, 1 homework tutorial and 4 hours laboratory) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent.) (Not open to students who have taken or are taking 180-277.) A survey of analytical chemistry including the theory and practice of representative gravimetric, volumetric and instrumental methods.
NOTE: Each lab section is limited enrolment. **Professor Burns**

180-273B CHEMICAL KINETICS. (1) (1 lecture) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent. For Honours and Major Chemistry students. Other students with permission of the lecturer.) Order, molecularity, reaction mechanisms and rate constants. Determination of order, effect of temperature on rate, activated state theory. Collision theory. Reactions in solution, homogeneous catalysis, upper atmosphere kinetics, drug kinetics.
Professor Eisenberg

180-277D CLASSICAL METHODS OF ANALYSIS. (4) (2 lectures and 4 hours laboratory) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent. For Chemistry Honours and Majors students only.) (Not open to students who have taken or are taking 180-257.) Qualitative and quantitative analysis. A survey of methods of analysis including theory and practice of semimicro qualitative analysis and representative gravimetric, volumetric and instrumental methods.
NOTE: Each lab section is limited enrolment. **Professor Burns**

180-281A INORGANIC CHEMISTRY I. (3) (3 lectures) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent. For Honours and Major Chemistry students.) (Not open to students who have taken or plan to take 180-201.) Basic concepts of electronic structure and molecular bonding will be developed and applied to the understanding of common materials. Acid-base chemistry. Survey of the chemistry of the main group elements. Introduction to coordination and organometallic chemistry. **Professor Andrews**

● **180-301B MODERN INORGANIC CHEMISTRY II.** (3) (3 lectures) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent.) (Not open to students who have taken or plan to take 180-381.)

180-302A,B ORGANIC CHEMISTRY III. (3) (3 lectures) (Prerequisites: 180-212 and 222.) Topics covered may include the following: aromatics and heterocyclics, carbanions, rearrangements, molecular orbital considerations, polymers and biomolecules.
Professors Farrell and Just

180-307A ENVIRONMENTAL ANALYSIS. (3) (2 lectures and laboratory with field trips) (Prerequisites: One course in analytical chemistry.) Description of current analytical practices in air and water pollution; critical evaluation of the reliability of the methods, with particular emphasis on interfering substances; rudiments of automated instrumentation; toxicological analysis as it relates to pollution. **Professors Salin and Farant**

180-345A MOLECULAR PROPERTIES & STRUCTURE I. (3) (3 lectures) (Prerequisite: 180-213, 189-315. For Chemistry Honours and Majors only.) An introduction to quantum chemistry covering the historical development, wave theory, methods of quantum mechanics, and applications of quantum chemistry. **Professor Eu**

180-350A EARTH, AIR, FIRE, WATER. (3) (3 lectures) (Prerequisites: 180-212 or equivalent and 180-204 or equivalent.) The elements of chemistry are found in a wide range of modern technological advances and environmental concerns. The course will deal with topics ranging from atmospheric chemistry, to receptor chemistry, to atomic microscopy, to ceramic materials.
Professor Hogan

180-352B STRUCTURAL ORGANIC CHEMISTRY. (3) (3 lectures) (Prerequisite: 180-302.) Modern methods of structure determination, employing spectroscopic techniques; stereochemistry.
Professor Kazlauskas

180-355B MOLECULAR PROPERTIES & STRUCTURE II. Spectroscopy (3) (3 lectures) (Prerequisite: 180-345.) A survey of the principles of electronic, vibrational and rotational spectroscopy. Magnetic resonance methods. **Professor Gilson**

180-362A,B ADVANCED ORGANIC CHEMISTRY LAB. (2) (4 hours) (Prerequisite or corequisite: 180-302) (Not open to Honours or Majors in Chemistry.) An advanced laboratory with experiments related to the theoretical principles and synthetic methods of modern organic chemistry. **Professor Farrell and Mr. Daoust**

▭ **180-363A,B PHYSICAL CHEMISTRY LAB.** (2) (3 hours) (Prerequisites: 180-213 and 180-273.) Selected experiments to illustrate physico-chemical principles.
NOTE: Each lab section is limited enrolment. **Professor Galley and Dr. Wilczek**

180-365B STATISTICAL MECHANICS. (2) (2 lectures) (Prerequisite: 180-345.) Molecular basis of thermodynamics with applications to ideal gases and simple solids. Topics to be covered will include: calculation of thermodynamic functions, chemical equilibrium constants, Einstein and Debye models of solids, absolute reaction rate theory, Debye-Hückel theory of strong electrolytes.
Professor Ronis

▭ **180-367A INSTRUMENTAL ANALYSIS I.** (3) (2 lectures and 4 hours of laboratory) (Prerequisite: 180-257 or 180-277) An introduction to modern methods of instrumental analysis emphasizing chromatography and electrochemical methods. Analytical methods to be examined in detail include gas liquid chromatography, high performance liquid chromatography flow injection analysis, and electrochemical methods. Laboratory exercises give the student practical exposure to these techniques.
NOTE: Each lab section is limited enrolment. **Professor Power and Dr. Wilczek**

180-371A,B,D INORGANIC CHEM. LAB. (2) (4 hours) (Prerequisite: 180-362; prerequisite/corequisite: 180-381) (Not open to students who have taken 180-392.) Modular format incorporating self-paced and selfguided instructions. In consultation with the instructors, a program of experimental modules is chosen covering projects related to theoretical principles, synthetic techniques and those instrumental methods used in modern inorganic and organometallic chemistry. **Professors Arndtsen, Kakkar and Dr. Finkenbine**

▭ **180-377B INSTRUMENTAL ANALYSIS II.** (3) (2 lectures and 4 hours of laboratory) (Prerequisite: 180-257 or 180-277.) Spectroscopic methods of analysis will be studied with respect to fundamentals, operational aspects and instrument design. Topics will range from UV-visible to x-ray spectrometry. Methodologies will be evaluated with respect to their application in spectrometric systems. Laboratory automation will be studied and applied in the laboratory.
NOTE: Each lab section is limited enrolment. **Professor Salin and Dr. Wilczek**

180-381A CHEMISTRY OF TRANSITION ELEMENTS. (3) (3 lectures) (Prerequisite: 180-281. For Honours and Major Chemistry students.) (Not open to students who have taken or plan to take 180-301.) The history of transition chemistry, coordination numbers and geometry, nomenclature and symmetry. Crystal field theory will be described and applied to problems in spectroscopy, magnetochemistry, thermodynamics and kinetics. Several aspects of organometallic and bioinorganic chemistry are also discussed.
Professor Kakkar

180-382B ORGANIC CHEMISTRY OF NATURAL PRODUCTS. (3) (3 lectures) (Prerequisite/corequisite: 180-302.) Structure, synthesis, stereochemistry and biosynthesis. **Professor Just**

180-392A,B OR D INTEGRATED INORGANIC/ORGANIC LAB. (3) (4 hours) (Prerequisite/corequisites: 180-381 and 180-302.

Advanced laboratory for Chemistry Honours and Major students. Students enrolled in 180-392 are strongly advised to choose the D option.) (Not open to students previously enrolled in 180-362.) Modular format of self-paced and self-guided instruction. A program of modules is selected in consultation with the laboratory staff. The experimental modules consist of projects related to the theoretical principles, synthetic techniques and instrumental methods used in modern organic, inorganic and organometallic chemistry. **Professors Arndtsen, Farrell, Kakkar and Dr. Finkenbine**

180-393A,B PHYSICAL CHEMISTRY LAB II. (2) (3 hours) (Prerequisites: 180-273, 180-363.) Selected experiments to illustrate physico-chemical principles more advanced than those of 180-363. *NOTE: Each lab section is limited enrolment.*
Professor Galley and Dr. Wilczek

180-402B ADVANCED BIO-ORGANIC CHEMISTRY. (3) (2 lectures, 1 hour seminar per week) (Prerequisite: 180-302) The application of advanced concepts of organic and physical chemistry to biological systems. The properties of amino acids, peptides, proteins, enzymes, nucleosides, etc., will be discussed and their relationship to biochemical reactions, the origins of life, coenzymes, template syntheses, neurochemistry, etc. **Professor Damha**

★**180-419B ADV. IN CHEM. OF ATMOSPHERE.** (3) (3 lectures) (Prerequisites: 180-213, 180-273, 189-222 and 189-315 (or equivalents), or permission of instructor.) (Not open to students who have taken 195-419, 180-619, or 195-619.) (Offered in even years. Students should register in 195-419 in odd years.) Selected areas of atmospheric chemistry from field and laboratory to theoretical modelling are examined. The principles of atmospheric reactions (gas, liquid and heterogeneous phases in aerosols and clouds) and issues related to chemical global change will be explored.
Professor Ariya

180-455A POLYMER CHEMISTRY. (3) (Prerequisites: 180-213 and 180-273.) A survey course on the structure of polymers, kinetics and mechanisms of polymer and copolymer synthesis; characterization and molecular weight distributions; polymer microstructure, the thermodynamics of polymer solutions; the crystalline and amorphous states, rubber elasticity and structure-property relationships. **Professors Marchessault and Eisenberg**

180-462A GREEN CHEMISTRY. (3) (3 lectures) (Prerequisities: 180-302, 180-381) New reactions and methods which can be used for the production of chemicals from renewable feedstocks; the use of new environmentally benign solvents, catalysts and reagents; organic reactions in aqueous media and in supercritical carbon dioxide; bio-catalysis and bio-processes. **Professor Chan**

180-470C,D RESEARCH PROJECT. (6) (Prerequisite: registration by Departmental permission only.) (Please see regulations concerning Project Courses, section 2.6.2 in the Faculty Degree Requirements section.) A course designed to give students research experience. The student will be assigned a project supervisor and a research project at the beginning of the session. The project will consist of a literature survey, experimental and /or theoretical work, a written research report and an oral examination. (Awaiting University Approval) **Professor Arndtsen (Coordinator) and Staff**

180-480D RESEARCH PROJECT. (3) (Prerequisite or Corequisite: 180-490. Registration by Departmental permission only.) (Please see regulations concerning Project Courses, section 2.6.2 in the Faculty Degree Requirements section.) A course designed to give Honours students research experience. The student will be assigned a project supervisor and a research project at the beginning of the session. The project will consist of a literature survey, experimental or theoretical work, a written research report and an oral examination. **Professor Arndtsen (Coordinator) and Staff**

180-490D RESEARCH PROJECT. (3) (9 hours laboratory) (Prerequisite or Corequisite: 180-480. Registration by Departmental permission only.) (Please see regulations concerning Project Courses, section 2.6.2 in the Faculty Degree Requirements section.) For description, see 180-480. **Professor Arndtsen (Coordinator) and Staff**

180-511A RADIOCHEMISTRY. (3) (3 lectures) (Prerequisites: 180-204 and 214 or equivalents.) The basic concepts of nuclear chemistry described in a qualitative way. Topics include: forces within nuclei, theories of nuclear structure, radioactive decay, nuclear reactions and fission, particle accelerators and reactors, radiocarbon dating, and tracer technique. **Professor Hogan**

180-531B CHEMISTRY OF INORGANIC MATERIALS. (3) (3 lectures) (Prerequisite: 180-381.) Structure, bonding, synthesis, properties and applications of covalent, ionic, metallic crystals, and amorphous solids. Defect structures and their use in synthesis of specialty materials such as electronic conductors, semiconductors, and superconductors, and solid electrolytes. Basic principles of composite materials and applications of chemistry to materials processing. **Professor Andrews**

180-543A CHEMISTRY OF PULP & PAPER. (3) (2 lectures plus a reading/research project.) (Prerequisites: 180-302 or permission of instructor.)The industrial processes for converting wood to paper are described with emphasis on the relevant organic, physical, surface chemistry and colloid chemistry. The structure and organization of the polymeric constituents of wood are related to the mechanical, optical and other requisite properties of paper.
Professor Gray

180-547B LABORATORY AUTOMATION. (5) (Two 1.5 hour lectures, laboratory) (Prerequisite: 180-377, equivalent or permission of instructor.) Automation and data handling with respect to modern chemical laboratory instrumentation. Basic electronics, data acquisition, evaluation of laboratory needs, data processing methodologies. **Professor Salin**

180-552B PHYSICAL ORGANIC CHEMISTRY. (3) (Prerequisite: 180-302) The correlation of theory with physical measurements on organic systems; an introduction to photochemistry; solvent and substituent effects on organic reaction rates, etc.; reaction mechanisms. **Professors Kazlauskas, Lennox and Farrell**

180-555A NMR SPECTROSCOPY. (3) (3 lectures) (Prerequisite: 180-355 or equivalent.) Interpretation of proton and carbon -13 nuclear magnetic resonance spectroscopy in one dimension for structural identification. **Professor Gilson**

180-556B ADVANCED QUANTUM MECHANICS. (3) (3 lectures) (Prerequisites: 180-345, 198-242.) Quantum mechanical treatment of species of chemical interest. Introduction to perturbation theory, both time-dependent and time-independent. Treatment of the variational principle. Introduction to atomic spectra. Chemical bonding in terms of both the valence bond and molecular orbital theory. Elementary collision theory. Interaction of radiation with molecules. **Professor Barrett**

▭ **180-567A CHEMOMETRICS: ANALYSIS OF CHEMICAL DATA.** (3) (2 lectures and 3 hours of laboratory) (Prerequisites: linear algebra and experience in some computer programming language.) The course is designed to provide a background in mathematical methods for chemical experimental design, system optimization, and sensor calibration. Topics covered include: factorial analysis of chemical spectra, pattern recognition from multisensor data, linear and nonlinear optimization for the determination of optimal reaction conditions, molecular modelling, multisensor calibration, etc.
Professor Burns

180-571B POLYMER SYNTHESIS. (3) (3 lectures) (Prerequisites: 180-302 or equivalent, or permission of instructor.) A survey of polymer preparation and characterization; mechanisms of chain growth, including free radical, cationic, anionic, condensation and trans:tion metal-mediated polymerization, and the effects of these mechanisms on polymer architecture; preparation of alternating, block, graft and stereoblock copolymers; novel macromolecular structures including dendrimers and other nanostructures.
Professor Sleiman

● **180-572B SYNTHETIC ORGANIC CHEMISTRY.** (3) (3 lectures) (Prerequisite: 180-382.)

● **180-575B CHEMICAL KINETICS.** (3) (3 lectures) (Prerequisite: 180-273 and -213.)

● **180-576B QUANTUM CHEMISTRY.** (3) (Lecture and/or reading course) (Prerequisite: 180-345)

● **180-577B ELECTROANALYTICAL CHEMISTRY.** (3) (Prerequisite: 180-367 and 180-377.)

180-581B INORGANIC TOPICS I. (3) (Prerequisite: 180-381. Not open to students who have taken 180-481.) An introduction to some areas of current interest in inorganic chemistry. Each year a selection of several particularly active areas will be chosen. **Professors Butler and Shaver**

180-585B COLLOID CHEMISTRY. (3) (Prerequisites: 180-273 and 180-345, 189-223 and 189-315, 198-241 and 198-242 or permission of instructor.) Principles of the Physical Chemistry of phase boundaries. Electrical double layer theory; van der Waals forces; Brownian motion; kinetics of coagulation; electrokinetics; light scattering; solid/liquid interactions; adsorptions; surfactants; hydrodynamic interactions; rheology of dispersions. **Professor van de Ven**

180-587A SELECTED TOPICS IN MODERN ANALYTICAL CHEM. (3) (Prerequisite: 180-367 and 180-377) Current theories of aqueous and nonaqueous solutions, with application to analytical chemistry; recent advances in analytical techniques. Topics may include: chromatography; applications of kinetics, solvent extraction and thermal analysis) with emphasis on their theoretical basis. **Professor Power**

180-591B ADVANCED COORDINATION CHEM. (3) (3 hours) (Prerequisite: 180-381.) (For Honours and Major Chemistry students or with permission.) In-depth treatment of advanced coordination chemistry, including bio-inorganic chemistry and transition metal catalysis and solid state inorganic chemistry. **Professor Kakkar**

180-593A STATISTICAL THERMODYNAMICS. (3) (3 lectures; research project) (Prerequisite: 180-345. Recommended: 180-355.) Basic hypotheses of statistical thermodynamics; ideal monatomic, diatomic and polyatomic gases; Einstein and Debye models of solids; statistical theory of black-body radiation; Debye-Huckel theory of electrolyte solutions; absolute reaction rate theory of rate processes; theories of solutions. **Professor Eu**

180-597A ANALYTICAL SPECTROSCOPY. (3) (2 lectures; 3 hours laboratory) (Prerequisite 180-367 and 180-377) The design and analytical use of spectroscopic instrumentation will be examined with respect to fundamental and practical limitations. Classical emission, fluorescence, absorption and chemical luminescence will be discussed. Contemporary topics may include photo-acoustic spectroscopy, multielement analysis, X-ray fluorescence and modern multiwavelength detector systems. **Professors Power and Salin**

11.7 Cognitive Science

Dr. Jim McGilvray, Department of Philosophy, Program Director
Telephone: (514) 398-6053

Cognitive Science is the multi-disciplinary study of cognition in humans and machines. The goal is to understand the principles of intelligence with the hope that this will lead to better understanding of the mind and of learning, and to the development of intelligent devices that constructively extend human abilities.

The Minor in Cognitive Science is intended to supplement and support Major or Honours programs in Computer Science, Linguistics, Philosophy, or Psychology. Students wishing to enrol in this Minor must register with the Program Director.

MINOR PROGRAM IN COGNITIVE SCIENCE (27 credits)
[MARS Program Code 6-265600]

Required Course (3 credits)
204-532 (3) Cognitive Science

Complementary Courses (24 credits)
from outside of the student's home department, selected from the courses listed below.

Computer Science
308-424 (3) Topics in Artificial Intelligence I
308-426 (3) Automated reasoning

Educational Psychology
416-555 (3) Applied Cognitive Science

Linguistics
104-321 (3) Linguistics Applied to Language Learning
104-351 (3) Phonology I
104-360 (3) Syntax I
104-370 (3) Semantics I
104-440 (3) Morphology
104-491 (3) Linguistic Theory I
104-530 (3) Phonology II
104-555 (3) Linguistic Theory & Language Acquisition
104-571 (3) Syntax II
104-590 (3) Introduction to Neurolinguistics

Mathematics
189-318 (3) Mathematical Logic
189-328 (3) Computability and Mathematical Linguistics

Philosophy
107-210 (3) Introduction to Deductive Logic
107-306 (3) Philosophy of Mind
107-310 (3) Intermediate Logic
107-410 (3) Topics in Advanced Logic I
107-415 (3) Philosophy of Language
107-419 (3) Epistemology
107-506 (3) Seminar: Philosophy of Mind
107-507 (3) Seminar: Cognitive Science

Psychology
204-311 (3) Human Behaviour and the Brain
204-314 (3) Thinking and Concepts
204-334 (3) Computer Simulation - Psych. Process.
204-335 (3) Formal Models of Psych. Processes
204-340 (3) The Psychology of Language
204-343 (3) Language Acquisition in Children
204-352 (3) Laboratory in Cognitive Psychology
204-353 (3) Laboratory in Human Perception
204-401 (3) Theories of Cognition
204-413 (3) Cognitive Development
204-470 (3) Memory and Brain
204-472 (3) Scientific Thinking and Reasoning
204-501 (3) Auditory Perception
204-540 (3) Computational Modelling of Reasoning

11.8 Computer Science (308)

McConnell Engineering Building, Room 318
3480 University Street
Montreal, QC H3A 2A7
Telephone: (514) 398-7071
Fax: (514) 398-3883
Email: ugrad-sec@cs.mcgill.ca
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Director — TBA

Emeritus Professor
Christopher Paige

Professors
David M. Avis; B.Sc.(Wat.), Ph.D.(Stan.)
Luc P. Devroye; M.S.(Louvain), Ph.D.(Texas)
Tim H. Merrett; B.Sc.(Queen's), D.Phil.(Oxon.)
Monroe M. Newborn; B.E.E.(R.P.I.), Ph.D.(Ohio St.), F.A.C.M.
Prakash Panangaden; M.Sc.(I.I.T. Kanpur), Ph.D.(Wis.)
Gerald F.G. Ratzer; B.Sc.(Glas.), M.Sc.(McG.)
Denis Thérien; B.Sc.(Montr.), M.Sc., Ph.D.(Wat.)
(on leave 2000-01)
Godfried T. Toussaint; B.Sc.(Tulsa), Ph.D.(Br.Col.)

Associate Professors
Claude Crepeau; B.Sc., M.Sc.(Montr.) Ph.D.(M.I.T.)
Gregory Dudek; B.Sc.(Queen's), M.Sc., Ph.D.(Tor.)
(on leave 2000-01)

Nathan Friedman; B.A.(W.Ont.), Ph.D.(Tor.)
Laurie Hendren; B.Sc., M.Sc.(Queen's), Ph.D.(C'nell)
Nazim Madhavji; B.Sc.(Essex), Ph.D.(Man.) *(on leave 2000-01)*
Carl Tropper; B.Sc.(McG.), Ph.D.(Brooklyn Poly.)
(on leave 2000-01)
Sue Whitesides; M.S.E.E.(Stan.), Ph.D.(Wis.)

Assistant Professors
Xiao-Wen Chang; B.Sc., M.Sc.(Nanjing), Ph.D.(McG.)
Karel Driesen; Licentiate, Masters (Free Brussels Univ.), Ph.D.(U.C. Santa-Barbara)
Kaleem Siddiqi; B.Sc.(Lafayette), M.Sc., Ph.D.(Brown)

Lecturer
Alan Greenberg; M.Sc.(McG.)

Adjunct Professors
Renato De Mori, Khaled El Emam, Guang R.Gao, Syed Hyder, Vincent Van Dongen

The study of computer science encompasses everything from pure theory to hands-on applications including the analysis of algorithms, the study of computer architectures, compilers, databases, operating systems, networks and the study of software engineering.

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

The teaching facility consists of a network of over 60 Pentium workstations running the Linux operating system, 25 Pentium workstations running Windows NT, 4 SGI graphics workstations and a variety of MacIntosh systems. The facility also includes several compute engines including 3 SUN sparc20 servers, 2 SUN Ultrasparc and 2 SUN Enterprise 250s. Dialup access is provided through the Computing Centre along with PPP network connections. For introductory courses most work is completed using the NT workstations and compute engines. All other courses use UNIX as a development environment.

The School of Computer Science offers a Majors program and an Honours program through the Faculty of Science, and a Minor program through the Faculties of Science and Engineering. The School also offers Major and Minor Concentrations through the Faculty of Arts. In conjunction with the Department of Mathematics and Statistics, the School offers a Joint Honours program, a Joint Majors program and two Faculty programs through the Faculty of Science. Special programs involving Computer Science are also available in the Faculties of Management, Engineering, and Music. For further details on programs outside the Faculty of Science, consult the other faculties' sections of this Calendar. *All students planning to enter Computer Science programs should make an appointment with an academic adviser through the School's Undergraduate secretary.*

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

The School's courses are available as electives to Engineering students. Engineering students interested in a Minor in Computer Science should consult "Computer Science Courses and Minor Program" on page 267 in the Faculty of Engineering section.

An industrial internship year is available to Computer Science students. IYES, the Internship Year Program for Engineering and Science, is a pre-graduate work experience program for Computer Science students normally between their U2 and U3 years. See the Faculty of Engineering section 2.8 for further information on IYES.

MINOR PROGRAM IN COMPUTER SCIENCE (24 credits)
[MARS Program Code 6-265700]

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

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

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

Required Courses (12 credits)

308-202A,B	(3)	Introduction to Computing I
308-203A,B	(3)	Introduction to Computing II
308-273A,B	(3)	Introduction to Computer Systems
308-302A,B	(3)	Programming Languages and Paradigms

Complementary Courses (12 credits)
selected from:

308-305A	(3)	Computer System Architecture
308-310B	(3)	Computer Systems and Organization
308-335B	(3)	Software Engineering Methods
308-350A	(3)	Numerical Computing
or 189-317A	(3)	Numerical Analysis
308-360A	(3)	Algorithm Design Techniques
308-420A	(3)	Files and Databases
308-421B	(3)	Database Systems
308-424A	(3)	Topics in Artificial Intelligence I
308-426B	(3)	Automated Reasoning
308-433A	(3)	Personal Software Engineering
308-505A	(3)	High-Performance Computer Architecture
308-506B	(3)	Advanced Analysis of Algorithms
308-507A	(3)	Computational Geometry
308-520B	(4)	Compiler Design
308-524B	(3)	Programming Language Theory
308-530A	(3)	Formal Languages
308-534B	(3)	Team Software Engineering
308-535A	(3)	Computer Networks
308-537B	(3)	Internet Programming
308-538B	(3)	Person-Machine Communication
308-540B	(3)	Matrix Computations
308-557B	(3)	Fundamentals of Computer Graphics
308-560A	(3)	Graph Algorithms and Applications
308-566A	(3)	Computer Methods in Operations Research
308-573A,B	(3)	Microcomputers
308-575A	(3)	Fundamentals of Distributed Algorithms

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

FACULTY PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE See page 390 in the Mathematics and Statistics section for complete program information.

FACULTY PROGRAM IN MATHEMATICS, STATISTICS AND COMPUTER SCIENCE See page 390 in the Mathematics and Statistics section for complete program information.

MAJOR PROGRAM IN COMPUTER SCIENCE (60 credits)
[MARS Program Code 1-265700]

To enter the program, students must have completed 189-140 and 189-141, or their equivalents. 189-133, or its equivalent, may be taken prior to entry or concurrently with 308-250 during the first semester in the program. Freshman Program students interested in Computer Science should take 308-102. A student entering with

insufficient programming background may take 308-202 but it will not count for program credit.

Required Courses (42 credits)

308-250A,B	(3)	Introduction to Computer Science
308-251A,B	(3)	Data Structures and Algorithms
308-273A,B	(3)	Introduction to Computer Systems
308-302A,B	(3)	Programming Languages and Paradigms
308-305A	(3)	Computer System Architecture
308-310B	(3)	Computer Systems and Organization
308-330A	(3)	Theoretical Aspects of Computer Science
308-350A	(3)	Numerical Computing
308-360A	(3)	Algorithm Design Techniques
189-222A,B	(3)	Calculus III
189-223A,B	(3)	Linear Algebra
189-240A	(3)	Discrete Structures and Computing
189-323A,B	(3)	Probability Theory
189-340B	(3)	Abstract Algebra and Computing

Complementary Courses (18 credits)
15 credits from:

308-335B	(3)	Software Engineering Methods
308-420A	(3)	Files and Databases
308-421B	(3)	Database Systems
308-424A	(3)	Topics in Artificial Intelligence I
308-426B	(3)	Automated Reasoning
308-433A	(3)	Personal Software Engineering
308-435B	(3)	Basics of Computer Networks
308-505A	(3)	High-Performance Computer Architecture
308-506B	(3)	Advanced Analysis of Algorithms
308-507A	(3)	Computational Geometry
308-520B	(4)	Compiler Design
308-524B	(3)	Programming Language Theory
308-531B	(3)	Theory of Computation
308-534B	(3)	Team Software Engineering
308-535A	(3)	Computer Networks
308-537B	(3)	Internet Programming
308-538B	(3)	Person-Machine Communication
308-540B	(3)	Matrix Computations
308-547A	(3)	Cryptography and Data Security
308-557B	(3)	Fundamentals of Computer Graphics
308-560A	(3)	Graph Algorithms and Applications
308-566A	(3)	Computer Methods in Operations Research
308-573A,B	(3)	Microcomputers
308-575A	(3)	Fundamentals of Distributed Algorithms
304-323A,B	(3)	Digital System Design
304-426A,B	(3)	Microprocessor Systems
304-531B	(3)	Real Time Systems
304-548A	(3)	Introduction to VLSI Systems

3 credits from Mathematics selected from:

189-314A,B	(3)	Advanced Calculus
189-315A,B	(3)	Ordinary Differential Equations
189-322B	(3)	Dynamical Systems, Fractals and Chaos
189-324A,B	(3)	Statistics
189-348A	(3)	Topics in Geometry
189-407B	(3)	Dynamic Programming
189-417A	(3)	Mathematical Programming
189-591B	(3)	Mathematical Logic I

JOINT MAJOR PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE See page 391 in the Mathematics and Statistics section for complete program information.

JOINT MAJOR PROGRAM IN PHYSICS AND COMPUTER SCIENCE See page 407 in the Physics section for complete program information. (Awaiting Final Approval)

HONOURS PROGRAM IN COMPUTER SCIENCE (72 credits)
[MARS Program Code 2-265700]

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

Required Courses (45 credits)
all Major Program required courses, plus

308-400A,B	(3)	Technical Project and Report

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

JOINT HONOURS PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE See page 392 in the Mathematics and Statistics section for complete program information. Students must consult an Honours adviser in both Departments.

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

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

The following programs are also available with an Internship component. For more information, please see section 2.8 in the Faculty of Engineering section.

Major in Computer Science
Honours in Computer Science

COURSE DESCRIPTIONS

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

▭ Denotes courses with limited enrolment

Students are strongly recommended to consult infoMcGill for the latest course offerings.

Notes:

A. A student cannot receive credit for both 308-202 and 308-208. 308-202 is intended as a general introductory course, while 308-208 is intended for students interested in scientific computations. The credits for either of these courses will not count towards the 60-credit Major in Computer Science.

B. 308-203 and 308-250 are considered to be equivalent from a prerequisite point of view, and may not both be taken for credit. Computer Science Major and Honours students are strongly advised to take 308-250 insead of 308-203. They are also advised to take 189-240 with 308-250 (or with 308-202 or 308-203) but before 308-251.

C. A student cannot receive credit for both 308-330 and 308-530.

D. A student cannot receive credit for 308-102 if it is taken concurrently with, or after any of the following: 308-202, -203, -208, or -250.

E. 308-431 is restricted to students in Electrical Engineering. A student cannot receive credit for both 308-431 and 308-251, or for both 308-431 and 308-360 or 308-405.

F. Management students may not receive credit for both 308-202 and 635-300. Likewise, they may not receive credit for both 308-203 and 635-301.

308-102A COMPUTERS AND COMPUTING. (3) (2 hours lectures; 2 hours laboratory) (Prerequisite: high school level mathematics course on functions.) (For restrictions, see Note D.) A course for students with no previous knowledge of computer science who may be interested in further study. The structure of a computer; methodologies for problem solving – algorithm design and data structures, the limitations of computers. An introduction to programming in a high level language. **Professor Friedman**

▭ **308-199A EXCURSIONS IN COMPUTER SCIENCE.** (3) (3 hours) (Prerequisite: high school mathematics) (FYS - for first year students only, maximum 25.) This is a seminar format course intended for freshman and other beginning students. The topics are chosen to encourage critical discussion of fundamental ideas. Possible topics are computability, complexity, geometry, vision, AI, pattern recognition, machine models, cryptography and security and social implications of computing. **Professor Toussaint**

▭ **308-202A,B INTRODUCTION TO COMPUTING I.** (3) (3 hours) (Prerequisite: a CEGEP level mathematics course.) (For restrictions, see Notes A and F.) Overview of components of micro-

computers, the internet, design and implementation of programs using a modern high-level language, and introduction to modular software design and debugging. Programming concepts are illustrated using a variety of application areas. **Professor Hendren**

308-203A,B INTRODUCTION TO COMPUTING II. (3) (3 hours) (Prerequisite: 189-133 and 308-202.) (For restrictions, see Notes B and F.) Basic data structures. Representation of arrays, stacks, and queues. Linked lists and their applications to binary trees. Internal sorting. Graph representation. Elementary graph algorithms. **Professors Avis and Friedman**

308-206A INTRO TO SOFTWARE SYSTEMS. (3) (3 hours) (Prerequiste: 308-203 or 308-250) Comprehensive overview of programming in C, use of system calls and libraries, debugging and testing of code; use of developmental tools like make, version control systems. (Revisions Awaiting University Approval) **Staff**

308-208A,B COMPUTERS IN ENGINEERING. (3) (3 hours) (Prerequisite: differential and integral calculus. Co-requisite: linear algebra: determinants, vectors, matrix operations.) (For restrictions, see Note A.) Introduction to computer systems. Concepts and structures for high level programming. Elements of structured programming using FORTRAN 90 and "C". Assignments in both mainframe and microcomputer environment. Numerical algorithms such as root finding, numerical integration and differential equations. Non-numerical algorithms for sorting and searching.
Professor Ratzer

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

308-251A,B DATA STRUCTURES AND ALGORITHMS. (3) (3 hours) (Prerequisite: 308-250 or 308-203.) (For restrictions, see Notes B and E.) Design and analysis of algorithms. Complexity of algorithms. Data structures. Introduction to graph algorithms and their analysis. **Professor Devroye**

308-273A,B INTRODUCTION TO COMPUTER SYSTEMS. (3) (3 hours) (Prerequisite: 308-202. Corequisite: 308-250 or 308-203.) Computer structure, machine instruction execution, addressing techniques, digital representation of data. Assemblers, cross-assemblers and simulators. Interrupts. Input and output programming and devices. System support macros and software. Program segmentation and linkage. **Professor Dudek**

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

308-305A COMPUTER SYSTEM ARCHITECTURE. (3) (3 hours) (Prerequisite: 308-273) A functional description of computer hardware. Hardware concepts and current technology. Memories, memory hierarchies and dynamic address translation. CPU characteristics, performance factors, overlap, parallel and pipeline systems. Microprogramming. Interrupt mechanism and clocks. Input/Output devices including telecommunications.
Mr. Greenberg

308-310B COMPUTER SYSTEMS AND ORGANIZATION. (3) (3 hours) (Prerequisite: 308-305) Control and scheduling of large information processing systems. Operating system software – resource allocation, dispatching, processors, access methods, job control languages, main storage management. Batch processing, multiprogramming, multiprocessing, time sharing. **Professor Tropper**

308-330A THEORETICAL ASPECTS OF COMPUTER SCIENCE. (3) (3 hours) (Prerequisite: 308-251. For Major and Honours students.) (For restrictions, see Note C.) Mathematical models of computers, finite automata, Turing machines, counter machines, push-down machines, computational complexity.
Professor Thérien

308-335B SOFTWARE ENGINEERING METHODS. (3) (3 hours) (Pre/co-requisite: 308-302A.) This course in software engineering teaches basic concepts and methods for software development. The focus is on engineering and analysing requirements, design and code. Small software development exercises will be given where students would learn how to apply different methods. **Staff**

▭ **308-350A NUMERICAL COMPUTING.** (3) (3 hours) (Prerequisites: 308-202 OR -208 OR -250, and 189-222 and -223, or equivalents.) Computer representation of numbers, IEEE Standard for Floating Point Representation, computer arithmetic and rounding errors. Numerical stability. Matrix computations and software systems. Polynomial interpolation. Least-squares approximation. Iterative methods for solving a nonlinear equation. Discretization methods for integration and differential equations.
Professor Chang

308-360A ALGORITHM DESIGN TECHNIQUES. (3) (3 hours) (Prerequisite: 308-251.) (For restrictions, see Note E.) A study of techniques for the design and analysis of algorithms.
Professor Whitesides

308-400A,B TECHNICAL PROJECT AND REPORT. (3) (Prerequisites: 15 Computer Science credits. For Honours students.) A computer related project, typically a programming effort, along with a report will be carried out in cooperation with a staff member in the School of Computer Science. **Staff**

308-420A FILES AND DATABASES. (3) (3 hours) (Prerequisite: 308-302) Language essentials for file processing; sequential files; sorting, updating, tree files; direct files; files of structured data; basics of relational databases. **Professor Merrett**

308-421B DATABASE SYSTEMS. (3) (3 hours) (Prerequisite: 308-251, -302)The relational model of databases, an introduction to object-oriented concepts. Relational algebra, conceptual design of databases, concurrency control issues and databases. **Staff**

308-424A TOPICS IN ARTIFICIAL INTELLIGENCE I. (3) (3 hours) (Prerequisite: 308-203 or -250 or equivalent.) Introduction to search methods in AI problems. Mechanical theorem-proving techniques, game playing by computers, the minimax and alpha-beta algorithms, and heuristic approaches to state space search problems.
Professor Newborn

308-426B AUTOMATED REASONING. (3) (3 hours) (Prerequisites: 308-424; or 308-302 with 189-340.) Representing and reasoning with knowledge. The case for logics. Introduction to Logic Programming and, for example, PROLOG. Introduction to some Artificial Intelligence applications of Logic Programming: Meta-interpreters, Expert Systems and their implementation, Planning, Natural Language Processing, Machine Learning. **Staff**

308-431A ALGORITHMS AND DATA STRUCTURES. (3) (3 hours) (Prerequisites: 304-222 and 189-363.) (For restrictions, see Note E.) Advanced data structures: heaps, binary search trees, graphs, algorithmic analysis: space-time analysis, worst-case and expected complexity. Examples of searching sorting and merging. Algorithm design: divide-and-conquer, dynamic programming, greedy methods, backtracking. Algorithms: set manipulation, tree traversals. Memory management: hashing, dynamic storage allocation and garbage collection. **Staff**

308-433A PERSONAL SOFTWARE ENGINEERING. (3) (3 hours) (Prerequisite: 308-335B.) This software engineering course teaches students how to develop, manage and improve their personal processes for developing software. Selected software development practices are introduced through 10 small programming exercises. The students then use these programs to analyse data on their personal performance, plan homework projects, and guide their process improvement. **Professor Madhavji**

308-435B BASICS OF COMPUTER NETWORKS. (3) (3 hours) (Prerequisite: 308-310) Exposition of the first four layers of the ISO

model for computer network protocols. Socket programming. Network administration and configuration and Security issues. **Staff**

308-505A HIGH-PERFORMANCE COMPUTER ARCHITECTURE. (3) (3 hours) (Prerequisites: 308-302 and 308-305 or equivalent.) Basic principles and techniques in the design of high-performance computer architecture. Topics include memory architecture: cache structure and design, virtual memory structures; pipelined processor architecture: pipeline control and hazard resolution, pipelined memory structures, interrupt, evaluation techniques; vector processing; RISC vs. CISC architectures; general vs. special purpose architectures; VLSI architecture issues. **Professor Driesen**

308-506B ADVANCED ANALYSIS OF ALGORITHMS. (3) (3 hours) (Prerequisite: 308-330 or 308-360 or 308-405 or 308-431.) The study of computational complexity and intractability: Cook's Theorem, NP-completeness, oracles, the polynomial hierarchy, lower bounds, heuristics, approximation problems. **Professor Whitesides**

308-507A COMPUTATIONAL GEOMETRY. (3) (3 hours) (Prerequisite: 308-360 or 308-405 or equivalent or co-requisite 506.) Problems in computational geometry; worst-case complexity of geometric algorithms; expected complexity of geometric algorithms and geometric probability; geometric intersection problems; nearest neighbor searching; point inclusion problems; distance between sets; diameter and convex hull of a set; polygon decomposition; the Voronoi diagram and other planar graphs; updating and deleting from geometric structures. **Professor Toussaint**

308-520A COMPILER DESIGN. (4) (3 hours, 1 hour consultation) (Prerequisites: 308-273 and 308-302.) The structure of a compiler. Lexical analysis. Parsing techniques. Syntax directed translation. Run-time implementation of various programming language constructs.Introduction to code generation for an idealized machine. Students will implement parts of a compiler. **Professors Friedman and Hendren**

308-524B PROGRAMMING LANGUAGE THEORY. (3) (3 hours) (Prerequisite: 308-302, and 189-340 or 189-235) Operational and denotational semantics of programming languages. Equivalence theorems for first-order languages. Lambda calculus. Type-inference, typed lambda calculus. Polymorphism. Elements of domain theory and fixed-point induction. **Professors Friedman and Panangaden**

308-530A FORMAL LANGUAGES. (3) (3 hours) (Prerequisite: 308-203.) (For restrictions, See Note C.) The definition of a language. Grammars. Finite automata and regular languages. Context free languages. Pushdown automata. Turing machines and undecidable problems. Context sensitive and phrase-structure languages. **Professor Thérien**

308-531B THEORY OF COMPUTATION. (3) (3 hours) (Prerequisite: 308-330.) Models for sequential and parallel computations: Turing machines, boolean circuits. The equivalence of various models and the Church-Turing thesis. Unsolvable problems. Model dependent measures of computational complexity. Abstract complexity theory. Exponentially and super-exponentially difficult problems. Complete problems. **Professor Thérien**

308-534B TEAM SOFTWARE ENGINEERING. (3) (3 hours) (Prerequisite: 308-433A or equivalent.) Team-work and team-processes for evolving software systems. Guided by defined processes, project teams will elicit new requirements, design code and test an enhanced software system. Team members will play various technical and managerial roles in carrying out their software project. **Professor Madhavji**

308-535A COMPUTER NETWORKS. (3) (3 hours) (Prerequisite: 308-310.) Exposition of the first four layers of the ISO model for computer network protocols, i.e., the physical, data, network, and transport layers. Basic hardware and software issues with examples drawn from existing networks, notably SNA, DECnet, and ARPAnet. **Professor Tropper**

308-537B INTERNET PROGRAMMING. (3) (3 hours) (Prerequisite: 308-302 and 308-251) Sockets, User Datagram Protocol (UDP), Transmission utility protocals; Remote Terminal Protocol (Telnet), Simple Mail Transfer Protocol (SMTP), File Transfer Protocol (FTP) Hypertext Transfer Protrocol (HTTP), Internet resource database and search engines. Transactions and transaction processing systems and monitors. Distributed objects, Common Object Request Broker Architecture (CORBA) and OpenDoc. **Professor Merrett**

▭ **308-538B PERSON-MACHINE COMMUNICATION.** (3) (3 hours) (Prerequisites: 308-251, -302) Introduction to programming techniques and hardware design concepts that facilitate interaction between humans and computers. Theories and models for person-machine communication, object oriented Design and Software Engineering of interfaces. Natural language facilities. **Staff**

308-540B MATRIX COMPUTATIONS. (3) (3 hours) (Prerequisite: 189-327 or 308-350) Designing and programming reliable numerical algorithms. Stability of algorithms and condition of problems. Reliable and efficient algorithms for solution of equations, linear least squares problems, the singular value decomposition, the eigenproblem and related problems. Perturbation analysis of problems. Algorithms for structured matrices. **Professor Chang**

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

308-557B FUNDAMENTALS OF COMPUTER GRAPHICS. (3) (3 hours) (Prerequisite: 189-223, and 308-251 or -302.) The study of fundamental mathematical, algorithmic and representational issues in computer graphics. The topics to be covered are: overview of graphics process, projective geometry, homogeneous coordinates, projective transformations, quadrics and tensors, line-drawing, surface modelling and object modelling reflectance models and rendering, texture mapping, polyhedral representations, procedural modeling, and animation. **Professor Dudek**

308-560A GRAPH ALGORITHMS AND APPLICATIONS. (3) (3 hours) (Prerequisite: 308-360 or 308-405 or 308-431 or 189-343) Algorithms for connectivity, partitioning, clustering, colouring and matching. Isomorphism testing. Algorithms for special classes of graphs. Layout and embeddings algorithms for graphs and networks. **Professor Whitesides**

308-566A COMPUTER METHODS IN OPERATIONS RESEARCH. (3) (3 hours) (Prerequisites: 308-360 or 308-405 and 189-223) Use of the computer in solving deterministic problems in operations research. Linear programming and extensions. Efficient methods for large problems. Transportation problems. Network models. Integer programming. **Professor Avis**

▭ **308-573A,B MICROCOMPUTERS.** (3) (3 hours) (Prerequisite: 308-305.) Characteristics and internal structure of microcomputers and workstations. Architectures of current CISC and RISC micro processors. Assembler and machine languages for microcomputers. System software. Applications for single and networked microcomputers. Students will be assigned "hands-on" projects. **Professor Ratzer**

308-575A FUNDAMENTALS OF DISTRIBUTED ALGORITHMS. (3) (3 hours) (Prerequisite: 308-310.) Study of a collection of algorithms which are basic to the world of concurrent programming. Discussion of algorithms from the following areas: termination detection, deadlock detection, global snapshots, clock synchronization, fault tolerance (byzantine and self-stabilizing systems). Students will implement algorithms on the BBN butterfly and will present papers on topics in these areas. **Professor Tropper**

11.9 Earth and Planetary Sciences (186)

Frank Dawson Adams Building, Room 238
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Chair — Alfonso Mucci

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

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

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

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

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

Career opportunities are many and varied for graduates in the Earth and Planetary Sciences. There is presently a very strong demand for graduates with expertise in geology. Students graduating in this field are recruited for employment in the mining and petroleum industries, and in the environmental sector. In addition, government geological surveys employ goescientists. During the summer months undergraduate students are generally able to obtain employment from industry and government agencies, providing them with both financial benefits and first-hand geoscientific experience. Career opportunities in planetary science are presently limited to universities and research organizations.

The Department has a full-time staff of 11 professors and one faculty lecturer. There are approximately 50 graduate and 60 undergraduate students. Classes are therefore small at all levels, resulting in an informal and friendly atmosphere throughout the Department in which most of the faculty and students interact on a first name basis. Emphasis is placed equally on quality teaching and research providing undergraduate students with a rich and exciting environment in which to learn and explore. The Department offers two entrance scholarships of $1,000 each to new undergraduate students. To be considered for one of these scholarships, new applicants should forward a copy of their transcript directly to the Department Chair.

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

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

Students interested in any of the programs should inquire at Room 238, Frank Dawson Adams Building, (514) 398-6767, or should consult the Undergraduate Director, Don Francis, Room 311, Frank Dawson Adams Building, (514) 398-4885, if they do not have an advisor.

MINOR PROGRAM IN EARTH AND PLANETARY SCIENCES
(18 credits) [MARS Program Code 6-480100]

Required Courses (7 credits)
186-210A (3) Mineralogy
186-212B (4) Petrology

Complementary Courses (11 credits)
186-201A (3) Understanding Planet Earth
or 186-233A (3) Earth & Life History

8 credits selected from:
186-203B (3) Structural Geology I
186-231E (2) Field School I
186-243A,B (3) Environmental Geology
186-334B (3) Invertebrate Palentology & Evolution
186-350B (3) Tectonics
186-430B (3) Geology of Energy Sources
186-451B (3) Hydrothermal Mineral Deposits
186-452A (3) Mineral Deposits
186-542A (3) Chemical Oceanography
177-352B (3) Vertebrate Evolution
Other Earth and Planetary Sciences courses may be substituted with permission.

MINOR PROGRAM IN GEOCHEMISTRY (25 credits)
[MARS Program Code 6-460000]

Required Courses (10 credits)
186-201A (3) Understanding Planet Earth
186-210A (3) Mineralogy
186-212B (4) Petrology

Complementary Courses (15 credits)
15 credits selected from:
186-220B (3) Principles of Geochemistry
186-243A,B (3) Environmental Geology
186-501A (3) Crystal Chemistry
186-519A (3) Isotope Geology
186-542A (3) Chemical Oceanography
186-545B (3) Low-Temperature Geochemistry & Diagenesis

MAJOR AND HONOURS PROGRAMS IN EARTH AND PLANETARY SCIENCES
[MARS Program Codes: Major 1-480100; Honours 2-480100]
Undergraduate Director: Don Francis, FDA 311, (514) 398-4885

Common U1 Year:

Required Courses (27 credits)
186-210A (3) Mineralogy
186-220A (3) Principles of Geochemistry
186-233A (3) Earth and Life History
189-222A (3) Calculus III
186-203B (3) Structural Geology
186-212B (4) Petrology
186-312B (3) Spectroscopy of Minerals
186-320B (3) Elementary Earth Physics
186-231C (2) Field School I
Note: Students intending to take the Honours Planetary Sciences Program in U2 must also take 189-223B Linear Algebra.

Note: Students who have not had the equivalent in CEGEP or the Freshman Program may be required to take 189-133A,B Vectors, Matrices and Geometry.

U2 and U3: MAJOR PROGRAM IN EARTH AND PLANETARY SCIENCES (66 credits in total)

Required Courses (21 credits)

186-350B	(3)	Tectonics
186-423B	(3)	Igneous Petrology
186-425A	(3)	Depositional Environments & Sequence Stratigraphy
186-445B	(3)	Metamorphic Petrology
186-452A	(3)	Mineral Deposits
186-519A	(3)	Isotope Geology
186-331C	(3)	Field School II
or 186-341C	(3)	Field School III

Complementary Courses (18 credits)
3 credits of statistics, course to be approved by EPS Academic Advisor
plus15 additional credits approved by EPS Academic Advisor

U2 and U3: HONOURS IN EARTH SCIENCES PROGRAM
(CGPA ≥3.20) (75 credits in total)
[MARS Program Code 2-480200]

Required Courses (33 credits)

186-350B	(3)	Tectonics
186-423B	(3)	Igneous Petrology
186-425A	(3)	Depositional Environments & Sequence Stratigraphy
186-445B	(3)	Metamorphic Petrology
186-452A	(3)	Mineral Deposits
186-480D	(6)	Honours Research Project
186-519A	(3)	Isotope Geology
186-331C	(3)	Field School II
or 186-341C	(3)	Field School III
189-314A	(3)	Advanced Calculus
189-315A	(3)	Ordinary Differential Equations

Complementary Courses (15 credits)
3 credits of statistics, course to be approved by EPS Academic Advisor
plus12 additional credits approved by EPS Academic Advisor

U2 and U3: HONOURS IN PLANETARY SCIENCES PROGRAM
(CGPA ≥3.20) (77 credits in total)
[MARS Program Code 2-480300]

Required Courses (42 credits)

186-330B	(3)	Earthquakes & Earth Structure
186-350B	(3)	Tectonics
186-423B	(3)	Igneous Petrology
186-480D	(6)	Honours Research Project
186-510A	(3)	Global Geodynamics & Geomagnetism
186-519A	(3)	Isotope Geology
186-570B	(3)	Cosmochemistry
189-314A	(3)	Advanced Calculus
189-315A	(3)	Ordinary Differential Equations
189-317A	(3)	Numerical Analysis
189-319B	(3)	Partial Differential Equations
198-251A	(3)	Classical Mechanics
or 198-230A	(3)	Dynamics of Simple Systems
198-340B	(3)	Electricity & Magnetism

Complementary Courses (9 credits)
To be approved by EPS Academic Advisor

JOINT MAJOR PROGRAM IN PHYSICS AND GEOPHYSICS
See page 407 in the Physics section for complete program information.

COURSE DESCRIPTIONS

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

● Denotes courses not offered in 2000-01.

The following courses are without prerequisite and could be taken by students in the Faculty of Arts: 186-200A,B; 186-201A,B; 186-202A; 186-233A; and 186-243A,B. Other courses assume as a prerequisite completion of the courses required in the Sciences option of the CEGEP curriculum.

186-200A,B THE TERRESTRIAL PLANETS. (3) (3 hours lectures) A comparative survey of the planets of our solar system with an emphasis on the terrestrial planets and their implications for the Earth as a planet. Topics include: structure and origin of the solar system, meteorites, and comparisons of the terrestrial planets in terms of their rotational properties, magnetic fields, atmospheres, surface histories, internal structure, chemical composition, volcanism, and tectonics. **Staff**

186-201A,B UNDERSTANDING PLANET EARTH. (3) (3 lectures; afternoon field trips) Learn about Earth's origin, its place in the solar system, its internal structure, rocks and minerals, the formation of metal and fossil fuel deposits, and the extinction of dinosaurs. Discover the impact of the volcanic eruptions, earthquakes and mountain chains on Earth's past, present and future. Explore 125 million-year-old Mount Royal. **Staff**

186-203B STRUCTURAL GEOLOGY I. (3) (2 hours lectures, 3 hours laboratory) Primary igneous and sedimentary structures, attitudes of planes and lines, stress and strain, fracturing of rocks, faulting, homogeneous strain, description and classification of folds, foliation and lineation, orthographic and stereographic projections. **Professor Hynes**

186-205B ASTROBIOLOGY. (3) (3 hours lectures) (Not open to students who have taken or are taking 504-205.) Astrobiology is the search for the origin, evolution and destiny of life in the universe. The course will provide insight into the formation and evolution of habitable worlds, the evolution of life and the biogeochemical cycles in the Earth's oceans and atmosphere, and the potential for biological evolution beyond an organism's planet of origin. **Professor Vali**

186-210A INTRODUCTION TO MINERALOGY. (3) (2 hours lecture, 3 hours laboratory) Crystal chemistry and identification of the principal rock-forming and ore minerals. Elementary crystallography. Optional 2-day field trip. **Professor Paquette**

186-212B INTRODUCTORY PETROLOGY. (4) (3 hours lecture, 3 hours laboratory) (Prerequisite: 186-210A) Survey course of igneous, sedimentary and metamorphic rocks and the processes leading to their formation. Emphasis in the laboratory on hand-specimen description and classification, supplemented by thin sections. **Professor Francis**

● **186-215B ANALYSIS OF GEOLOGICAL DATA.** (3) (3 lectures, and problems) (Note: Credit for other statistics courses may preclude credit for this course and conversely. See "Course Overlap" on page 345.)

186-220A PRINCIPLES OF GEOCHEMISTRY. (3) (2 lectures, 3 hours laboratory) (Prerequisites: 186-201A, -210A) Basic concepts in geochemistry and the application of geochemical principles of chemistry to geological subdisciplines. Particular emphasis on origin of elements, controls on their distribution in Earth and cosmos, isotopes, organic geochemistry and water chemistry. Application of phase diagrams to geology. **Professor Baker**

186-231C FIELD SCHOOL I. (2) (Two-week field school in May) (Prerequisite: 186-203B, 186-212B, or equivalent.) Geological mapping of selected areas, preparation of maps, reports from field notes, aerial photographs, etc. **Professor Hynes**

186-233A EARTH AND LIFE HISTORY. (3) (3 lectures) Interpretation of stratified rocks; history of Earth with special emphasis on the regions of North America; outline of the history of life recorded in fossils. **Staff**

186-243A,B ENVIRONMENTAL GEOLOGY. (3) (3 hours lectures) Introduction to the relationship of geological processes and materials to the human environment; geologic hazards; hydrogeology; impacts of waste disposal, energy use, land resource development. **Staff**

186-250A NATURAL DISASTERS. (3) (3 lectures) (Restriction: Not open to students who have taken or are taking 195-250A.) This

course examines the science behind different types of disasters and our ability or inability to control and predict such events. From this course the student will gain an appreciation of natural disasters beyond the newspaper headlines, and will better understand how the effects of disasters can be reduced.
Professors Gyakum and Stix

186-312B SPECTROSCOPY OF MINERALS. (3) (6 hours laboratory and relevant in-lab lectures) (Prerequisite: 186-210A) Interaction of minerals with electromagnetic radiation. Optical mineralogy on thin and polished sections. Demonstrations of other spectroscopic techniques applied to the identification of minerals and to the analysis of their composition and structure. **Professor Francis**

186-320B ELEMENTARY EARTH PHYSICS. (3) (3 hours lectures) (Prerequisite: 189-222A,B) Physical properties of Earth and the processes associated with its existence as inferred from astronomy, geodesy, seismology, geology, terrestrial magnetism and thermal evolution. **Professor Jensen**

186-330B EARTHQUAKES & EARTH STRUCTURE. (3) (3 hours lectures, tutorial as required) (Prerequisites: 189-314B, 186-320A. Corequisites: 189-319) Seismic wave theory; body waves, surface waves and free oscillations; seismicity and earthquakes; seismology and Earth's internal structure. **Professor Jensen**

186-331C FIELD SCHOOL II. (3) (Two-week field school in May.) Geological field study of igneous, sedimentary and metamorphic terranes of the Applachian origin, including preparation of stratigraphic sections, and edited field notes. **Staff**

186-334B INVERTEBRATE PALEONTOLOGY AND EVOLUTION. (3) (2 lectures and one laboratory period) Preservation of fossils; the fossil record of invertebrates; use of fossils in stratigraphy and paleoecology; fossils in evolutionary studies. Fossils of invertebrates are studied in the laboratory. **Professor Paquette**

● **186-341C FIELD SCHOOL III.** (3) (Prerequisites: 186-210A, -203B, -212B and -231E or permission of the instructor.)

186-350B TECTONICS. (3) (Prerequisites: 186-320A, Calculus III or equivalent.) Rheology of the Earth, mechanics of the crust and mantle and core, convection in the mantle, evolution and kinematics and deformations of the oceanic and continental plates, thermal evolution of the Earth, the unifying theory of plate tectonics.
Professor Hynes

● **186-401B ADVANCED ENVIRONMENTAL GEOLOGY.** (3) (1 lecture, 2 seminar) (Prerequisite: 186-220B or 180-204A or equivalent. Corequisite: 186-580A)

● **186-402C ENVIRONMENTAL FIELD SCHOOL.** (2) (1 laboratory, 2 other) (Prerequisites: 186-220B or 180-204A or equivalent.)

● **186-405A PLANETARY GEOLOGY.** (3) (3 lecture) (Prerequisites: 186-210A, -203B, -212B or permission of the instructor.)

● **186-423B IGNEOUS PETROLOGY.** (3) (2 hours lectures, 3 hours laboratory) (Prerequisites: 186-212B, 312B)

186-425A DEPOSITIONAL ENVIRONMENTS & SEQUENCE STRATIGRAPHY. (3) (2 lecture, 3 laboratory) (Prerequisites: 186-210A, -212B) Carbonate and clastic sedimentation: Physical processes of transport and deposition, facies associations and sequences, depositional environments of modern and ancient settings. Stratigraphic correlations, seismic and sequence stratigraphy. Basin analysis. Tectonics and sedimentation. **Staff**

● **186-430A GEOLOGY OF ENERGY SOURCES.** (3) (2 lecture and 2 hours laboratory or seminar) (Corequisite: 186-425A or permission of the instructor.)

● **186-435A EXPLORATION & ENVIRONMENTAL GEOPHYSICS.** (3) (3 hours lecture) (Prerequisites: Calculus III, Linear Algebra and 186-320A or equivalents.)

186-445B METAMORPHIC PETROLOGY. (3) (Prerequisites: 186-212B, 303A, 312B) The origin, classification and petrological significance of metamorphic rocks, from the point of view of theory, experiment and field observations. **Staff**

● **186-451B HYDROTHERMAL MINERAL DEPOSITS.** (3) (Prerequisite: 186-220B)

● **186-452A MINERAL DEPOSITS.** (3) (Prerequisite: 186-312B, 220B)

186-480D HONOURS RESEARCH PROJECT. (9) (For Honours students in 3rd year.) A written proposal outlining the studies to be undertaken must be submitted to the undergraduate Student Adviser by May 1st of the U-2 year. The proposal will be reviewed by a committee and a decision forwarded by mail. If approved the investigation will be supervised by a staff member, and the results must be presented in the form of an undergraduate thesis. **Staff**

186-482A,B,D INDEP. STUDIES IN EARTH & PLANETARY SCIENCES. (3) (May not be taken concurrently with 186-480D.) Research and/or reading project enabling independent study under the guidance of qualified staff in areas of special interest to the student. A statement of the proposed project and the method of evaluation must be approved by the Department curriculum committee before commencement of the course. This statement will be included in the student's file. **Staff**

186-483D INDEP. STUDY IN ENVIRONMENTAL GEOLOGY. (3) (To be taken concurrently with 182-500D.) Research and/or reading project on environmental topic, designed by student in consultation with a faculty supervisor. Project must be approved by Department before commencement of course. **Staff**

● **186-501B CRYSTAL CHEMISTRY.** (3) (2 hours lectures, 1 hour seminar) (Prerequisite: 180-203A or 180-213A,B)

● **186-510B GLOBAL GEODYNAMICS AND GEOMAGNETISM.** (3) (3 lecture) (Prerequisites: 186-320A, 189-319B or permission of the instructor. Corequisite: 186-350B.)

● **186-519A ISOTOPE GEOLOGY.** (3) (3 lectures) (Prerequisites: U2 core program.)

● **186-530A VOLCANOLOGY.** (3) (3 lecture) (Prerequisites: 186-212B and –312B, or permission of instructor)

● **186-540B PHANEROZOIC GEOLOGY OF NORTH AMERICA.** (3) (2 hours lectures, 3 hours laboratory) (Prerequisite: U2 Major sequence. Corequisite: U3 Major sequence.)

186-542A CHEMICAL OCEANOGRAPHY. (3) (Prerequisites: 180-213A,B, 180-257D or equivalents, or registration in Graduate Program in Oceanography.) History of chemical oceanography. Seawater composition and definition of salinity/chlorinity. Minor and trace-element distribution in the ocean. Geochemical mass balance. Dissolved gases in sea water. CO_2 and the carbonate system. Chemical speciation. Physical chemistry of seawater. Organic matter and the carbon cycle in the marine environment. Sediment geochemistry. **Professor Mucci**

● **186-545B LOW-TEMPERATURE GEOCHEMISTRY & DIAGENESIS.** (3) (Prerequisites 180-203A/213B, 186-212B, -312B)

● **186-546A DIAGENESIS OF SEDIMENTARY ROCKS.** (3) (2 lecture, 3 laboratory/seminars) (Prerequisites: 186-212B, -220B, -312A)

186-547A THERMOCHEMISTRY OF HIGH-TEMPERATURE GEOLOGICAL SYSTEMS. (3) (2 hours lectures, 3 hours laboratory) (Prerequisites 180-203/4 or 180-213, or permission of instructor.) The application of thermodynamic principles to igneous and metamorphic petrology and economic geology. Topics include but are not restricted to: solid solutions in minerals, behaviour of geological fluids, phase equilibria, flow processes, estimation of thermodynamic data.
Professor Baker

● **186-548A MECHANISMS OF IGNEOUS PETROGENESIS.** (3) (2 hours lecture, 1 hour seminar) (Prerequisite: 186-423B)

186-549B HYDROGEOLOGY. (3) (3 hours lecture, 1-2 hours laboratory) (Prerequisite: permission of the instructor.) Introduction to groundwater flow through porous media. Notions of fluid potential and hydraulic head. Darcy flux and Darcy's Law. Physical properties of porous media and their measurement. Equation of groundwater flow. Flow systems. Hydraulics of pumping and recharging

wells. Notions of hydrology. Groundwater quality and contamination. Physical processes of contaminant transport. **Staff**

186-550A SELECTED TOPICS IN EARTH AND PLANETARY SCIENCES I. (3) (2 hours seminar, permission of department undergraduate adviser.) Research seminar and readings in topics concerning some aspects of current development in geological sciences. **Staff**

186-551B SELECTED TOPICS IN EARTH AND PLANETARY SCIENCES II. (3) (2 hours seminar, permission of department undergraduate adviser.) Research seminar and readings in topics concerning some aspects of current development in geological sciences. **Staff**

● **186-570B COSMOCHEMISTRY.** (3) (3 hours lecture) (Prerequisites: 186-220B, -210A or permission of instructor.)

● **186-580A AQUEOUS GEOCHEMISTRY.** (3) (3 hours lecture) (Prerequisites: 186-210A, 186-212B or permission of instructor.)

● **186-590B APPLIED GEOCHEMISTRY SEMINAR.** (3) (3 hours seminar) (Prerequisite: permission of instructor.)

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

186-221A GENERAL GEOLOGY. (3) (3 hours lecture, 3 hours laboratory) A survey course in physical geology with emphasis on engineering and economic aspects. **Staff**

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

11.10 Environmental Studies

Science students who are interested in studying the environment should refer to the McGill School of Environment section, page 465, where they will find information concerning the Minor, the Major, and the Diploma in Environment.

11.11 Experimental Medicine (516)

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

516-401 – (514) 842-1231, ext. 5738
516-502 and 516-503 – (514) 842-1231, ext. 5243 or 5833
516-504 – (514) 934-8038
516-506 – (514) 937-6011, ext. 2908
516-507 and 516-508 – (514) 398-3864, ext. 3249
516-509 – (514) 934-8308
516-510 – (514) 937-6011, ext. 3022
516-511 – (514) 398-3466
516-512 – (514) 987-5550

COURSES

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

516-401B PHYSIOLOGY AND BIOCHEMISTRY OF ENDOCRINE SYSTEMS. (3) (Prerequisite: 177-200A and 177-201B) Offered in conjunction with the Department of Physiology. The course provides a basic knowledge of endocrine systems encompassing biosynthesis, metabolism and physiological actions of hormones. Specific topics covered are hormones of the hypothalamus, pituitary, adrenals, thyroids, parathyroids, pancreas, gut and the gonads. The role of hormones and growth factors in pregnancy and fetal development are also discussed. **Professors Mulay, Cianflone and Staff**

516-502A ADVANCED ENDOCRINOLOGY – PART I. (3) (Prerequisite: 516-301A or an equivalent course.) This course is designed for U3 students who are in a major or honours program in anatomy, biology, biochemistry or physiology and for graduate students. A multidisciplinary approach will be used to teach biosynthesis and processing of hormones, their regulation, function and mechanism of action. The material will cover hypothalamic, pituitary, thyroid, atrial and adrenal hormones as well as prostaglandins and related substances. **Professors Bennett, Bateman and Staff**

516-503B ADVANCED ENDOCRINOLOGY – PART II. (3) (Prerequisite: 516-502A) Study of the parathyroids, gut and pancreatic hormones and growth factors. In addition, the role of hormones and growth factors in reproduction and fetal maturation will be discussed. **Professors Bennett, Bateman and Staff**

▭ **516-504A BIOLOGY OF CANCER.** (3) (Prerequisite: A good knowledge of biology at the cellular and molecular level. Open to U3 and graduate students only.) An introduction to the biology of malignancy. A multidisciplinary approach dealing with the etiology of cancer, the biological properties of malignant cells, the host response to tumour cell growth and the principles of cancer therapy. **Professor Thomson and Staff**

516-506B ADVANCED CARDIOVASCULAR PHYSIOLOGY. (3) (Prerequisite: 552-313B or by permission of Instructors.) Offered in conjunction with the Department of Physiology. Current topics, methods and techniques for studying the cardiovascular system. Basic and applied cardiac electrophysiology, mechanisms of pacemaker activity, arrhythmias, the effects of drugs on cardiac functions, fetal circulation, coronary circulation, mechanics of blood flow, cardiovascular diseases, renal and neural control of the circulation, and cardiac assist devices.
Professors Goldsmith and Shrier

516-507A ADVANCED APPLIED RESPIRATORY PHYSIOLOGY. (3) (Prerequisite: 552-313B) Offered in conjunction with the Department of Physiology. In depth coverage of respiratory biology including: functional anatomy of the respiratory system, pulmonary statics and dynamics, chest wall and respiratory muscles, ventilation and perfusion, control of breathing, and defense mechanisms. This course is aimed at providing a solid grounding in pulmonary biology and its research applications. **Professor Petrof and Staff**

516-508B ADVANCED TOPICS IN RESPIRATION. (3) (Prerequisite: 516-507A) Offered in conjunction with the Department of Physiology. In depth coverage of developmental physiology, pulmonary vascular physiology, biology of airway smooth muscle, respiratory epithelium and molecular biology of respiratory muscles. Dyspnea, mechanical ventilation and respiratory failure will also be covered. This course emphasizes application of respiratory biology to basic and applied research and touches on pulmonary pathophysiology. **Professor Fixman and Staff**

● **516-509B GASTROINTESTINAL PHYSIOLOGY AND PATHOPHYSIOLOGY.** (3) (Prerequisite: Graduate students, U3 undergraduates.)

516-510A BIOANALYTICAL SEPARATION METHODS. (3) The student will be taught the capabilities and limitations of modern separation methods (gas and high-performance liquid chromatography, capillary electrophoresis, hyphenated techniques). Application of these techniques to solve analytical problems relevant to biomedical research will be emphasized, with special attention being paid to the processing of biological samples. **Professor Wainer and Staff**

516-511B JOINT VENTURING WITH INDUSTRY. (3) (Offered in conjunction with the Centre for Continuing Education.) Using problem-based learning, the course examines the various business interactions between researchers and their business partners in support and development of research into commercial endeavours using models such as venture capital, business partnerships, or grants-in-aid. **Professors Price and Yalovsky**

● **516-512C RECENT PROGRESS IN AIDS RESEARCH.** (6)