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**Course Description**

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

**202-505A SELECTED TOPICS IN BIOTECHNOLOGY**

- **Prerequisite:**
- **Course Content:** 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**

**Chair — David N. Harpp**

**Emeritus Professors**

- John F. Harrod; B.Sc., Ph.D. (Birm.)
- Leon E. St-Pierre; B.Sc.(Alta.), Ph.D.(Notre Dame, Ind.), F.C.I.C.
- Byung Chan Eu; B.Sc.(Seoul), Ph.D.(Brown)
- William F. Gilson; B.Sc.(Car.), Ph.D.(Birm.)
- Addison J. Eisenberg; B.Sc.(Worcester Polytech.), M.A., Ph.D.(Prin.), F.C.I.C.
- Alain G. Shaver; B.Sc.(Car.), Ph.D.(M.I.T.)
- Arthur S. Perlin; M.Sc., Ph.D.(McG.), F.R.S.C.
- Donald Patterson; M.Sc.(McG.), Doc. Hon. causa(Etienne)
- Byung Chan Eu; B.Sc.(Seoul), Ph.D.(Brown)
- William F. Gilson; B.Sc.(Car.), Ph.D.(Birm.)
- Addison J. Eisenberg; B.Sc.(Worcester Polytech.), M.A., Ph.D.(Prin.), F.C.I.C.

**Associate Professors**

- 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.(D.Cantub.)
- Mario Onyszchuk; B.Sc.(McG.), M.Sc.(W.Ont.), Ph.D.(McG.), Ph.D.(D.Cantub.)
- Mario Onyszchuk; B.Sc.(McG.), M.Sc.(W.Ont.), Ph.D.(McG.), Ph.D.(D.Cantub.)
- Mario Onyszchuk; B.Sc.(McG.), M.Sc.(W.Ont.), Ph.D.(McG.), Ph.D.(D.Cantub.)
- Mario Onyszchuk; B.Sc.(McG.), M.Sc.(W.Ont.), Ph.D.(McG.), Ph.D.(D.Cantub.)
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. (Beif.), 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 collegiate 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

CHEMISTRY MAJORS

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

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 fulfill 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 2-172206]

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,
MAJOR PROGRAM IN CHEMISTRY (66 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.

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.

**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 Schwarz

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 Schwarz

180-199A WHY CHEMISTRY? (3) (2 lectures and 1 seminar) (FY/ – 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.

  Professors Ronis

180-214B PHYSICAL CHEM./BIOL. SCI. II. (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 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 Arya

180-222A,B,T ORGANIC CHEMISTRY II. (4) (3 lectures and laboratory) (Prerequisite: 180-216. 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. Daupt

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. Daupt
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 Chemistry Honours and Majors students only.) (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 chemical bonds. 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 180-301.)

180-302A,B ORGANIC CHEMISTRY III. (3) (3 lectures) (Prerequisites: 180-212 and 222.) Topics covered may include the following: aromatics and heterocyclics, carboxylics, 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,P PHYSICAL CHEMISTRY LAB. (3) (3 hours) (Prerequisites: 180-213 and 180-273.) Selected experiments to illustrate physical-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 self-guided 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 Arndtensen, 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, magnetoochemistry, 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/corequisite: 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. 

Professor Arndtse, Farelli, Kakkar and Dr. Finkbine

180-393A/B PHYSICAL CHEMISTRY LAB II. (2) (3 hours) (Prerequisites: 180-273, 180-363.) Selected experiments to illustrate physical-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) (Prerequisites: 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 Arndtse (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 Arndtse (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 Arndtse (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 modeling, 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 transition metal-mediated polymerization, and the effects of these mechanisms on polymer architecture; preparation of alternating, block, graft and stereo block copolymers; novel macromolecular structures including dendrimers and other nanostructures.

Professor Reiman

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, multi-element analysis, X-ray fluorescence and modern multi-wavelength 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 Minors 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)
[MAORS 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
204-335 (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
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 computer 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 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 secretariat.

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
- 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
- 308-520A (3) Compiler Design
- 308-524A (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...
### Required Courses (42 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>308-250A,B</td>
<td>Introduction to Computer Science</td>
</tr>
<tr>
<td>308-251A,B</td>
<td>Data Structures and Algorithms</td>
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<tr>
<td>308-273A</td>
<td>Introduction to Computer Systems</td>
</tr>
<tr>
<td>308-302A,B</td>
<td>Programming Languages and Paradigms</td>
</tr>
<tr>
<td>308-305A</td>
<td>Computer System Architecture</td>
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<td>308-310B</td>
<td>Computer Systems and Organization</td>
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<td>308-330A</td>
<td>Theoretical Aspects of Computer Science</td>
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<tr>
<td>308-350A</td>
<td>Numerical Computing</td>
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<td>308-360A</td>
<td>Algorithm Design Techniques</td>
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<td>189-222A,B</td>
<td>Calculus III</td>
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<td>189-223A,B</td>
<td>Linear Algebra</td>
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<td>189-240A</td>
<td>Discrete Structures and Computing</td>
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<tr>
<td>189-323A,B</td>
<td>Probability Theory</td>
</tr>
<tr>
<td>189-340B</td>
<td>Abstract Algebra and Computing</td>
</tr>
</tbody>
</table>

### 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 (3) 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 (3) Digital System Design
  - 304-426A (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

[308 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 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 instead 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 308-350.
- D. A student cannot receive credit for 308-102 if it is taken concurrently, 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.


(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) (FY S - 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.) An introduction to computing concepts, the limitations of computers. An introduction to problem solving – algorithm design and data structures. An introduction to programming in a high level language. Professor Friedman

### 308-205A,B Introduction to Computing II.

(3) (3 hours) (Prerequisite: 308-202B) A continuation of 308-202. An introduction to intermediate programming languages: FORTRAN, C. Concepts of data structures, files, file systems, and programs for managing large data sets. A course on functions.) (For restrictions, see Note D.) A course for students interested in scientific computations. The credits for either of these courses will not count towards the 60-credit Major in Computer Science. Students are strongly advised to take 308-250 instead 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. A student cannot receive credit for both 308-330 and 308-350.

- Students must maintain a CGPA of 3.00 and must have at least this average upon graduation as well.
308-202A, B INTRODUCTION TO COMPUTER 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) (Prerequisite: 308-203 or 308-205) 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: Computer science students. This course 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


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 conceptually related project, typically a programming effort, and 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) (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 a report will be carried out in cooperation with a staff member in the School of Computer Science.

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.


Staff

308-433A PERSONAL SOFTWARE ENGINEERING. (3) (Prerequisite: 308-335B.) This software engineering course teaches students how to develop, manage and improve their personal processes for developing software. Selected software development techniques 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) (Prequisites: 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 Driessen**

**308-506B ADVANCED ANALYSIS OF ALGORITHMS.** (3) (3 hours) (Prequisite: 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) (Prequisite: 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 probabilities; geometric intervisibility 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) (2 hours) (Prequisite: 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) (Prequisite: 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**


**308-534B TEAM SOFTWARE ENGINEERING.** (3) (3 hours) (Prequisite: 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) (Prequisite: 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, DEQnet, and ARPAnet. **Professor Tropper**

**308-537B INTERNET PROGRAMMING.** (3) (3 hours) (Prequisite: 308-302 and 308-251) Sockets, User Datagram Protocol (UDP), Transmission utility protocols; Remote Terminal Protocol (Telnet), Simple Mail Transfer Protocol (SMTP), File Transfer Protocol (FTP) Hypertext Transfer Protocol (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) (Prequisites: 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 Designers Software Engineering of interfaces. Natural language facilities. **Staff**

**308-540B MATRIX COMPUTATIONS.** (3) (3 hours) (Prequisite: 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) (Prequisite: 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, quads 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) (Prequisite: 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) (Prequisites: 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) (Prequisite: 308-305.) Characteristics and internal structure of microcomputers and workstations. Architectures of current CISC and RISC microprocessors. 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) (Prequisite: 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
3450 University Street
Montreal, QC H3A 2A7
Telephone: (514) 398-6767
Fax: (514) 398-4699
Email: carol@eps.mcgill.ca
Website: http://www.eps.mcgill.ca

Chair — Alfonso Mucci

Emeritus Professors
Wallace H. MacLean; B.Geol.Eng.(Colorado Sch. of Mines), M.Sc., 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.(Ont.), 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 (Art.), M.Sc., Ph.D.(Tor.)
Hojatollah Vaf; 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 geoscientists. 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 Honour’s 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)
186-210A (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 Paleontology & 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, FFA 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
186-222A (3) Calculus III
186-203B (3) Structural Geology
186-212B (4) Petrology
186-312B (3) Spectroscopy of Minerals
186-320B (3) Elementry 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.
U 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
plus 15 additional credits approved by EPS Academic Advisor

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**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
plus 12 additional credits approved by EPS Academic Advisor

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**Required Courses (42 credits)**
- 186-350B (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 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: 186-210A, -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 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 section, 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 Appalachian 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 lecture, 3 laboratory) (Prerequisites: 186-212B, 321B)

186-425A DEPOSITIONAL ENVIRONMENTS & SEQUENCE STRATIGRAPHY. (3) (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)

196-492A 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 INDEPENDENT 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 INDEPENDENT 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 ISOPTOE 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 lecture, 3 hours laboratory) (Prerequisite: U2 Major sequence. Corequisite: U3 Major sequence.)


186-545B LOW-TEMPERATURE GEOCHEMISTRY & DIAGENESIS. (3) (Prerequisites: 180-203A/231B, 186-212B, -312B)

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

186-547A THERMOCHRONOLOGY 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
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 Instructor.) 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 focuses 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)