YORK UNIVERSITY
FACULTY OF SCIENCE AND ENGINEERING

ENVIRONMENTAL SCIENCE

2011-2012
SUPPLEMENTARY CALENDAR

ENVIRONMENTAL SCIENCE PROGRAM

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INTRODUCTION

Environmental issues are of increasing concern not only in Canada but throughout the world. Broadly educated *environmental scientists* are needed to analyse and solve these problems. Specialists, in a variety of scientific disciplines, contribute to the solution of environmental problems. However, there is growing recognition that an understanding of complex natural systems and specific problems caused by humans requires people with a holistic perspective who can integrate knowledge from several disciplines.

The Faculty of Science and Engineering offers a multidisciplinary Specialized Honours degree in Environmental Science which involves the study of the major interacting systems of the atmosphere, biosphere, hydrosphere and the Earth's surface and the effect of human activities on these systems. The program admits approximately 20 students each year who receive an education organized around the field of environmental science rather than being focused on a single academic discipline. The program is designed to equip students with the scientific knowledge and understanding of how environmental systems are interconnected, that can lead into careers in the scientific investigation of environmental problems.

PROGRAM GOALS AND OBJECTIVES

The goal of the program is to combine the breadth required to understand complex environmental problems with the development of in-depth skills in particular scientific disciplines in order to produce the level of expertise required by an environmental scientist. The program is tightly structured and is offered only as a four-year Honours program. The first two years of the program specify a large number of courses and are organized to ensure that students receive a foundation in the areas of science that are relevant to environmental issues.

The final two years of study provide a greater range of choice, although all students must focus their studies on one of two streams, identified as Physical Sciences and Life Sciences. These two streams are related to existing BSc disciplinary concentrations and therefore, Environmental Science students will be able to enter graduate programs in traditional disciplines as well as pursuing careers or graduate studies in environmental science.

The **Life Sciences stream** involves an integration of physical geography with ecology and population biology. Many environmental problems affect water, air, aquatic sediments and soils as well as plants and animals. An ability to work in the field to identify the significance and sensitivity of both physical and biological features is critical in environmental assessment projects. It is therefore important to have a training that extends beyond an expertise in the biological dynamics of plant and animal communities to include relationships with landforms, soils and water movement in the landscape.

The **Physical Sciences stream** involves an integration of atmospheric science with surface water hydrology, hydro-climatology and landforms. Many environmental problems such as ozone depletion, climate change, acid rain and the pollution of rivers and lakes involve interactions between the atmosphere and the land surface. Environmental scientists with a focus on the linkages between atmospheric processes and surface physical geography can contribute to the solutions of these problems.

In addition to acquiring a solid background in natural environmental systems the program is designed to fulfill several functional goals. These include:

1. A solid basic scientific training. Comments from people in the environment industry emphasize the importance of providing students with a good balance of maths, chemistry, physics, biology and computer science rather than focusing only on environmental issues. It is essential to have an in-depth knowledge of "hard" science in order to make a useful contribution to scientific work on environmental problems.

2. Communication skills. The ability to communicate effectively both orally and in writing is an essential skill in dealing with complex environmental issues. The development of good writing ability and oral communication is emphasized particularly in the required first year general education courses, but is also stressed in upper level science courses.

3. Hands-on experience in environmental research. Many aspects of environmental science require the collection and analysis of field and laboratory data. For this reason an ecology field course is required for students in the Life Sciences stream and a statistics course must be taken by all students. Substantial field and laboratory experience is also an important component of other courses in the program. Summer employment opportunities will be sought in university research activities thus providing an informal internship program for outstanding students.

4. Technical skills. In addition to acquiring a strong background in natural environmental systems, students can also take technical courses in remote sensing and GIS which provide powerful tools for environmental analysis and management. Remote sensing uses data gathered by instruments mounted on orbiting satellites or aircraft to measure and monitor environmental change. Geographic Information Systems (GIS) are designed to store, analyze, overlay and display in map form diverse types of environmental data. York offers a certificate in GIS and Remote Sensing that can be completed as part of the Environmental Science degree. (Details of the certificate are provided on page 27)

CAREER OPPORTUNITIES

The Canadian Council for Human Resources in the Environment Industry (CCHREI) www.cchrei.ca identifies various fields in which environmental practitioners work. Careers for environmental science graduates include span all levels of government, industry, non-governmental organizations, research and education :

Section A Environmental Protection

1. Air Quality Protection
2. Water Quality Protection
3. Environmental lawyer

Section B Conservation and Preservation of Natural Resources

1. Wildlife Biologist
2. Restoration Biologist
3. GIS/RS Analyst
4. Ecologist
5. Geographer

Section C Environmental Education

1. Science Teacher
2. University Professor

Career information for environmental practitioners is provided in an Enviro Employment Guidebook www.cchrei.ca/ee

The 2010 Environmental labour market (ELM) Study* developed by ECO Canada indicates that employment in the environmental workforce continues to increase faster than the economy in general.
Several rapidly emerging fields associated with carbon capture and climate change and green technologies will accelerate this trend.

In the past decade, approximately 40% of environmental science graduates at York University have found employment in environmental-related jobs in the private and public sector. Another 35-40% have enrolled in graduate programmes at major universities across Canada in fields such as , environmental science, biology, earth science, physical geography, atmospheric science and forestry. Other environmental science graduates have enrolled in professional schools (Law, Business) or have found employment in non-environmental fields.

*www.eco.ca/pdf/Profile-Of-Canadian-Environmental-Employment-ECO-Canada-2010.pdf

ADVISING AND ENROLMENT IN THE ENVIRONMENTAL SCIENCE PROGRAM

This Supplementary calendar in addition to the Undergraduate Calendar and Lecture Schedule will enable most students to make their course selections on their own. The most up-to-date information is found in the Faculty of Science & Engineering Undergraduate Calendar on the Internet (http://www.yorku.ca/laps/geog/program.html). However, for students who require advice on specific questions, advising is available from the Coordinator of the Environmental Science program. Appointments are made at the Geography Office (N430 Ross Building).

When you enrol in a course by the Registration and Enrolment Module (R.E.M.), make absolutely sure that you have the proper prerequisites for the course. Failure to do so will cause de-enrolment in the course at a later date even though the R.E.M. may have initially accepted your course request. The R.E.M. does not automatically check prerequisites upon enrolment, this is done later. De-enrolment will cause endless problems for you, the worst of which is trying to get into courses at a late date when most are full. If you wish to get into a course for which you do not have the prerequisites, you must get prior written permission of the course director. To do this you must pick up the form "Authorization to Enrol in a Course" from the office of the department in which the course is offered, have it signed by the course director and return it to the department office for manual enrolment.

ENVIRONMENTAL SCIENCE DEGREE REGULATIONS

i) All degree candidates must complete the **program core**: SC/GEOG1400 6.0; SC/GEOG2400 6.0; SC/GEOG2500 3.0 or SC/GEOG2600 3.0; 6 credits from AS/SC/ GEOG 2610 3.0, SC/GEOG3200 3.0, SC/GEOG3500 3.0, SC/GEOG4180 4.0, SC/GEOG4200 3.0, SC/GEOG4500 3.0; 6 credits from SC/GEOG4205 3.0, SC/GEOG4210 3.0, SC/GEOG4215 3.0, SC/GEOG4310 3.0, SC/GEOG4400 3.0, SC/GEOG4600 3.0; 12 additional credits from Science Geography courses (including 3 credits in statistics for students in the Physical Sciences Stream).

ii) All degree candidates must comply with general regulation 4 (see Faculty of Science and Engineering Undergraduate Calendar) by completing the following (in addition to SC/GEOG1400 6.0 from the program core):

- SC/CSE1540 3.0 (Physical Sciences Stream), or either SC/CSE1520 3.0 or SC/CSE 1540 3.0 (Life Sciences Stream);

- SC/MATH1505 6.0, or both SC/MATH1013 3.0 and SC/MATH1014 3.0 (for the Life Sciences Stream); or SC/MATH1013 3.0, SC/MATH1014 3.0 and SC/MATH1025 3.0 (for the Physical Sciences Stream);

- SC/BIOL1010 6.0, and either SC/EATS1010 3.0 and SC/EATS1011 3.0 or both SC/CHEM 1000 3.0 and SC/CHEM 1001 3.0 (for the Life Sciences Stream);

  or SC/CHEM1000 3.0 plus SC/CHEM 1001 3.0, and one of SC/PHYS1010 6.0 or SC/PHYS1410 6.0 (for the Physical Sciences Stream);

- 12 general education credits (see "General Education Requirements" in the Faculty of Science & Engineering Undergraduate Calendar.

iii) All degree candidates, in accordance with their declared program, must comply with general regulation 6 (see Faculty of Science and Engineering Undergraduate Calendar) and, in so doing, must satisfy the course, credit and standing requirements specified below.

To declare Honours requires successful completion of at least 24 credits and a minimum cumulative credit-weighted grade-point average of 5.0 over all courses completed.

To proceed in each year of a BSc (Hons.) program requires a minimum cumulative credit-weighted grade-point average of 5.0 over all courses completed.

To graduate in a BSc (Hons.) program requires successful completion of all Faculty requirements and program required courses and a minimum cumulative credit-weighted grade-point average of 5.0 over all courses completed.

ADDITIONAL COURSE REQUIREMENTS

- All obligatory courses in one of the following streams:

LIFE SCIENCES STREAM

- SC/BIOL2010 4.0; SC/BIOL2030 4.0; SC/BIOL2050 4.0; SC/BIOL2060 3.0

- one ecology field course (SC/BIOL3001 3.0 or SC/BIOL3001 2.0);

  15 additional credits chosen from the following:
  (SC/BIOL3002 3.0 or SC/BIOL3002 2.0); SC/BIOL3170 3.0, SC/BIOL4000 8.0, BIOL 4020 3.0, SC/BIOL4070 3.0, SC/BIOL4080 3.0, SC/BIOL4090 4.0, SC/BIOL4095 3.0, SC/BIOL4100 3.0, SC/BIOL4120 3.0, SC/BIOL4130 3.0, SC/BIOL4230 4.0. SC/BIOL4240 3.0, SC/BIOL4245 3.0, SC/BIOL4250 3.0, SC/BIOL4255 3.0, SC/BIOL4260 3.0, SC/BIOL4265 3.0, SC/BIOL4340 3.0, SC/BIOL4400 3.0, SC/BIOL4420 3.0;

- additional elective credits as required for an overall total of at least 120 credits, including at least 42 credits at the 3000 or higher level.

PHYSICAL SCIENCES STREAM

- SC/EATS2010 3.0; SC/EATS2470 3.0 (formerly 2470 4.0);

- SC/CHEM2030 3.0; SC/PHYS2020 3.0;
- SC/MATH2015 3.0; SC/MATH2271 3.0;
- SC/EATS3030 3.0; SC/EATS3130 3.0; SC/EATS4220 3.0;

- 6 additional credits chosen from SC/EATS3040 3.0, SC/EATS4050 3.0,SC/EATS4051 3.0, SC/EATS4120 3.0, SC/EATS4130 3.0, SC/EATS4140 3.0, SC/EATS4160 3.0, SC/EATS4230 3.0, SC/EATS4240 3.0, SC/EATS 4300 3.0, SC/MATH3241 3.0.

- additional elective credits as required for an overall total of at least 120 credits, including at least 42 credits at the 3000 or higher level.

A typical student who is pursuing the BSc program in Environmental Science on a full-time basis could arrange their program as follows:

LIFE SCIENCES STREAM

YEAR ONE

General education requirements (12 credits)
Science requirements (27 credits)

SC/CSE 1520 3.0 Computer Use: Fundamentals
or
SC/CSE 1540 3.0 Computer Use for the Natural Sciences

SC/MATH1505 6.0	Mathematics for the Life and Social Sciences	
or both		
SC/MATH1013 3.0	Applied Calculus I	*and*
SC/MATH1014 3.0	Applied Calculus II	
SC/GEOG1400 6.0	Physical Geography	
SC/BIOL1010 6.0	Biological Science	
SC/EATS1010 3.0	Dynamic Earth and Space Geodesy	*and*
SC/EATS 1011 3.0	Introduction to Atmospheric Science	
or		
SC/CHEM1000 3.0	Chemical Structure	*and*
SC/CHEM 1001 3.0	Chemical Dynamics	

Note: N*ot all of these courses can be taken in your first year (approximately 30 credits is a normal full-time course load)*

YEAR TWO

2000 level requirements (27 credits)

SC/GEOG2400 6.0	The Hydrosphere
SC/GEOG2500 3.0	Introduction to Vegetation and Soils
or	
SC/GEOG2600 3.0	Geomorphology I
SC/BIOL2010 4.0	Plant Biology
SC/BIOL2030 4.0	Animals
SC/BIOL2050 4.0	Ecology
SC/BIOL2060 3.0	Statistics for Biologists

Completion of Year one requirements

YEARS THREE AND FOUR

3000 and 4000 level requirements (14 or 15 credits)

One ecology field course (SC/BIOL3001 3.0 or SC/BIOL3001 2.0)

6 credits from the following Geography courses which have a life science emphasis:

SC/GEOG3200 3.0	Terrestrial Ecosystems
SC/GEOG3500 3.0	Biogeography (same as SC/BIOL3500 3.0)
SC/GEOG4180 4.0	Laboratory Analysis of Ecological Materials
SC/GEOG4200 3.0	Water Quality and Stream Ecosystems
SC/GEOG4215 3.0	Ecological Climatology
SC/GEOG4410 3.0	Desert Ecosystems

6 credits from the following Geography courses which have a physical science emphasis:

SC/GEOG4205 3.0	Climatology of High Latitudes
SC/GEOG4210 3.0	Hydrometeorology
SC/GEOG4310 3.0	Dynamics of Snow and Ice
SC/GEOG4400 3.0	Physical Hydrology and Water Resources
SC/GEOG4600 3.0	Rivers: Environment and Process

Additional requirements:

12 additional SC/GEOG credits at the 2000 level or higher

These credits can be taken from the SC/GEOG courses listed above as well as from the following SC/GEOG courses:

SC/GEOG2130 3.0	Fundamentals of Map Design and Interpretation
SC/GEOG2350 3.0	Introduction to Geoinformatics
SC/GEOG2610 3.0	Geomorphology II
SC/GEOG3180 3.0	Introduction to Geographic Information Systems (GIS)
SC/GEOG3440 3.0	Environmental Remote Sensing
SC/GEOG3900 3.0	Physical Geography of the City
SC/GEOG4000 6.0	Honours Thesis (*only thesis topics in **physical** geography are eligible for science credit*).
SC/GEOG4340 3.0	Geographic Information Systems
SC/GEOG4440 3.0	Remote Sensing and Image Processing for Geographical Analysis and Environmental Monitoring
SC/GEOG 4540 3.0	Research Design and Field Studies in Physical Geography
SC/GEOG 4541 3.0	Advanced Field Studies in Physical Geography

15 additional BIOL credits from the following courses:

A second ecology field course (SC/BIOL3002 3.0 or SC/BIOL3002 2.0)

SC/BIOL3170 3.0	Population Ecology
SC/BIOL3500 3.0	Biogeography*
SC/BIOL4000 3.0	Honours Thesis
SC/BIOL4000 8.0	Honours Thesis
SC/BIOL4070 3.0	Behavioural Ecology
SC/BIOL4080 3.0	Limnology and Aquatic Ecology
SC/BIOL4090 4.0	Plant Ecology
SC/BIOL4095 3.0	Applied Plant Ecology
SC/BIOL4100 3.0	Natural History
SC/BIOL4130 3.0	Plant Evolution
SC/BIOL4230 4.0	General Entomology
SC/BIOL4240 3.0	Mammalian Systematics and Ecology (Mammalogy)
SC/BIOL4245 3.0	Conservation Biology
SC/BIOL4250 3.0	Birds and the Environment
SC/BIOL4255 3.0	Biodiversity
SC/BIOL4260 3.0	Systematic Biology in Theory and Practice
SC/BIOL4265 3.0	Biology in Environmental Management
SC/BIOL4340 3.0	Fish Biology
SC/BIOL4400 3.0	Behavioural Genetics
SC/BIOL4420 3.0	Herpetology

Plus unspecified elective credits as required for an overall total of at least 120 credits, including at least 42 credits at the 3000 or higher level.

* *Note Biography 3500 3.0 can be used as a credit in this group only if it is not used as a Geography credit.*

PHYSICAL SCIENCES STREAM

YEAR ONE

General education requirements (12 credits)

Science requirements (30 credits)

SC/CSE 1540 3.0	Computer Use for the Natural Sciences
SC/MATH1013 3.0	Applied Calculus I
SC/MATH1014 3.0	Applied Calculus II
SC/MATH1025 3.0	Applied Linear Algebra
SC/GEOG1400 6.0	Physical Geography
SC/CHEM1000 3.0	Chemical Structure
SC/CHEM 1001 3.0	Chemical Dynamics
SC/PHYS1010 6.0	Physics
or	
SC/PHYS1410 6.0	Physical Science

Note: Not all of these courses can be taken in your first year (approximately 30 credits is a normal full-time course load)

YEAR TWO

2000 level requirements (29 credits)

SC/GEOG2400 6.0	The Hydrosphere
SC/GEOG2500 3.0	Introduction to Vegetation and Soils
or	
SC/GEOG2600 3.0	Geomorphology I
SC/EATS2010 3.0	Introductory Meteorology
SC/EATS2470 3.0	Introduction to Continuum Mechanics
SC/PHYS2020 3.0	Electricity and Magnetism
SC/MATH2015 3.0	Applied Multivariate and Vector Calculus
SC/MATH2270 3.0	Differential Equations
SC/CHEM2030 4.0	Basic Inorganic Chemistry (*note, this course will not exist after 2010*)

YEARS THREE AND FOUR

3000 and 4000 level requirements (21 credits)

SC/EATS3030 3.0 Atmospheric Radiation and Thermodynamics (same as SC/PHYS3080 3.0)
SC/EATS3130 3.0 Introductory Atmospheric Chemistry (same as SC/CHEM3060 3.0)
SC/EATS4220 3.0 Remote Sensing of the Earth's Surface6 credits from the following

Geography courses which have a life science emphasis:

SC/GEOG3200 3.0 Terrestrial Ecosystems
SC/GEOG3500 3.0 Biogeography (same as SC/BIOL3500 3.0)
SC/GEOG4180 4.0 Laboratory Analysis of Ecological Materials
SC/GEOG4200 3.0 Water Quality and Stream Ecosystems
SC/GEOG4215 3.0 Ecological Climatology
SC/GEOG4410 3.0 Desert Ecosystems

6 credits from the following Geography courses which have a physical science emphasis:

SC/GEOG4205 3.0 Climatology of High Latitudes
SC/GEOG4210 3.0 Hydrometeorology
SC/GEOG4310 3.0 Dynamics of Snow and Ice
SC/GEOG4400 3.0 Physical Hydrology and Water Resources
SC/GEOG4600 3.0 Rivers: Environment and Process

Additional requirements

12 additional SC/GEOG credits at the 2000 level or higher (including SC/GEOG 2420 3.0 Introductory Statistical Analysis in Geography)

These credits can be taken from the SC/GEOG courses listed above as well as from the following SC/GEOG courses:

SC/GEOG2130 3.0 Fundamentals of Map Design and Interpretation
SC/GEOG2610 3.0 Geomorphology II
SC/GEOG2350 3.0 Introduction to Geoinformatics
SC/GEOG3180 3.0 Introduction to Geographic Information Systems
SC/GEOG3440 3.0 Environmental Remote Sensing
SC/GEOG3900 3.0 Physical Geography of the City
SC/GEOG4000 6.0 Honour Thesis (*only thesis topics in **physical** geography are eligible for science credit*).
SC/GEOG4340 3.0 Geographic Information Systems
SC/GEOG4440 3.0 Remote Sensing and Image Processing and Environmental Monitoring
SC/GEOG 4540 3.0 Research Design and Field Studies in Physical Geography
SC/GEOG 4541 3.0 Advanced Field Studies in Physical Geography

6 additional credits from the following courses in Earth and Atmospheric Science

SC/EATS3040 3.0	Atmospheric Dynamics I
SC/EATS4050 3.0	Synoptic Meteorology I (or 4050 6.0)
SC/EATS4051 3.0	Synoptic Meteorology II (formerly second half of 4050 6.0)
SC/EATS4120 3.0	Cloud Physics and Radar Meteorology
SC/EATS4130 3.0	Atmospheric Dynamics II
SC/EATS4140 3.0	Numerical Weather Prediction
SC/EATS4160 3.0	Climate and Climate Change
SC/EATS4230 3.0	Remote Sensing of the Atmosphere
SC/EATS4240 3.0	Storms and Weather Systems
SC/MATH3241 3.0	Numerical Methods I

Plus unspecified elective credits as required for an overall total of at least 120 credits, including at least 42 credits at the 3000 or higher level.

COURSE DESCRIPTIONS

1000 LEVEL COURSES

SC/BIOL 1010 6.0 Biological Science. A course for Biology students examining unifying concepts and fundamental principles of biology. The course offers an introduction to cell and molecular biology, genetics, ecology and evolution. **The laboratory exercises are an integral component; therefore, students must pass the laboratory section in order to pass the course.** Three lecture hours, two lecture hours per week in alternate weeks; one tutorial hour per week; twelve three-hour laboratories. Two terms. Six credits.
Prerequisite: OAC Chemistry or 12u Chemistry or SC/CHEM 1500 4.0.
Course Credit Exclusions: SC/BIOL 1410 6.0.

SC/CHEM 1000 3.0 Chemical Structure . Introduction to chemistry with emphasis on physical and electronic structure of matter, including gases, liquids and solids. Topics include behaviour of gases; thermochemistry; atomic structure and periodic table; chemical bonding and architecture; structure of liquids and solids; frontiers of chemistry. Two and one-half lecture hours per week, one tutorial hour per week, six three-hour laboratory sessions. One term. Three credits.
Prerequisites: OAC CHEM, 12U CHEM OR SC/CHEM 1500 4.00 OR EQUIVALENT
Course Credit Exclusions: SC/CHEM 1000 6.0, SC/CHEM 1010 6.0, CHEM 2000 6.0.

SC/CHEM 1001 3.0 Chemical Dynamics (formerly half of SC/CHEM 1000 6.0 - before 2001-2002). This course complements SC/CHEM 1000 3.0 - with emphasis on chemical change and equilibrium. Topics include chemical kinetics; chemical equilibrium; entropy and free energy as driving forces for chemical change; electrochemistry; frontiers in chemistry. Two and one-half lecture hours per week, one tutorial hour per week, six three-hour laboratory sessions. One term. Three credits.
Prerequisites: One of OAC Calculus, OAC Algebra and Geometry, 12U Advanced Functions and Introductory Calculus, 12U Geometry & Discrete Math, or AS/SC/MATH 1515 3.0; OAC Physics or 12U Physics, or SC/PHYS 1510 4.0.
Course Credit Exclusions: SC/CHEM 1000 6.0, SC/CHEM 1010 6.0, CHEM 2000 6.0

SC/CSE 1520 3.0 Computer Use: Fundamentals. An introduction to the use of computers focusing on concepts of computer technology and organization (hardware and software) and the use of applications such as spreadsheets, database and information retrieval tools for problem solving. The course requires extensive laboratory work. This course is designed for students who are not computer science majors. Students who plan to major in computer science are advised to take AK/AS/SC/CSE 1020 3.0. Course credit exclusions: AK/AS/SC/CSE 1520 3.0, AK/CSE 1200 3.0, AK/CSE 1210 3.0. NCR Note: This course is not open to any student who has passed or is taking AK/AS/SC/CSE 1020 3.0, AK/AS/SC/CSE 1020 3.0, AK/CSE 2411 3.0 or AK/AS/ITEC 1020 3.0.

AP/SC/CSE 1540 3.0 Computer Use for the Natural Sciences.

Introduction to problem solving using computers - top down and modular design; implementation in a procedural programming language - control structures, data structures, subprograms; application to simple numerical methods, modelling and simulation in the

sciences; use of library subprograms. Course credit exclusions: AK/AS/SC/CSE 1540 3.0, AK/AS/SC/CSE 1530 3.0, AK/AS/SC/CSE 1530 3.0. NCR Note: This course is not open to any student who has passed or is taking AK/AS/SC/CSE 1020 3.0 or AK/AS/SC/CSE 1020 3.0 or AK/CSE 2411 3.0 or AS/AK/ITEC 1020 3.0 or AK/AS/ITEC 1620 3.0.

SC/EATS 1010 3.0 The Dynamic Earth and Space Geodesy. An overview of modern geophysics: origin of the Earth, impact cratering, internal structure and rheology, earthquakes, plate tectonics, geomagnetism. Space geodetic positioning techniques such as VLBI, SLR and GPS are introduced as means of detecting and monitoring tectonic movements. One term. Prerequisites: One of OAC calculus, OAC algebra and geometry, 12U advanced functions and introductory calculus, 12U geometry and discrete mathematics, or AS/SC/MATH 1515 3.0; OAC physics or 12U physics or SC/PHYS 1510 4.00. Course credit exclusions: SC/EATS 1010 6.0, SC/NATS 1750 6.0.

SC/EATS 1011 3.0 Introduction to Atmospheric Science. The origin, composition and vertical structure of the Earth's atmosphere and those of other planets. The present global atmospheric circulation. Weather systems, measurements and weather maps; atmospheric chemistry; the ozone layer and atmospheric pollution. Three lecture hours per week, five three-hour laboratory sessions. One term. Three credits. Prerequisites: OAC calculus, OAC algebra and geometry, 12U advanced functions and introductory calculus, 12U geometry and discrete mathematics or AS/SC/MATH 1515 3.0; OAC physics or 12U physics or SC/PHYS 1510 4.00. Course credit exclusions: SC/EATS 1010 6.0, SC/NATS 1750 6.0.

AP/SC/GEOG 1400 6.0 Physical Geography. A study of the physical-biotic environment through a consideration of the character and processes of its components - atmosphere, hydrosphere, biosphere and lithosphere - and of the spatial distributions which reflect interaction among these components. Two lecture hours per week, three laboratory hours normally every second week. Two terms.
Equivalent and Course Credit Exclusion: AK/GEOG 2510 6.0.

SC/MATH 1013 3.0 Applied Calculus I. Introduction to the theory and applications of both differential and integral calculus. Limits. Derivatives of algebraic and trigonometric functions. Riemann sums, definite integrals and the Fundamental Theorem of Calculus. Logarithms and exponentials, Extreme value problems, Related rates, Areas and Volumes. Prerequisite: AS/SC/MATH 1515 3.0 or AS/SC/MATH 1520 3.0, or a high school calculus course. Course credit exclusions: AS/SC/MATH 1000 3.0, AK/AS/SC/MATH 1300 3.0, AS/SC/MATH 1505 6.0, AS/SC/MATH 1513 6.0, AS/MATH 1530 3.0, AK/AS/MATH 1550 6.0, GL/MATH/MODR 1930 3.0, AS/ECON 1530 3.0.

SC/MATH 1014 3.0 Applied Calculus II. Calculus in Polar Coordinates. Techniques of Integration. Indeterminate Forms. Improper Integrals. Sequences, infinite series and power series. Approximations. Introduction to ordinary differential equations. Prerequisite(s): One of AS/SC/MATH 1000 3.0, AS/SC/MATH 1013 3.0, AK/AS/SC/MATH 1300 3.0, or AS/SC/MATH 1513 6.0; for non-science students only, six credits from AS/MATH 1530 3.0 and AS/MATH 1540 3.0, AK/AS/MATH 1550 6.0, AS/ECON 1530 3.0 and AS/ECON 1540 3.0. Course credit exclusions: AS/SC/MATH 1010 3.0, AK/AS/SC/MATH 1310 3.0, AS/SC/MATH 1505 6.0, GL/MATH/MODR 1940 3.0.

SC/MATH 1025 3.0 Applied Linear Algebra. Topics include spherical and cylindrical coordinates in Euclidean 3-space, general matrix algebra, determinants, vector space concepts for Euclidean n-space (e.g. linear dependence and independence, basis, dimension, linear transformations etc.), an introduction to eigenvalues and eigenvectors.
Prerequisite: One 12U or OAC mathematics course or equivalent. Course credit exclusions: AK/AS/SC/MATH 1021 3.0, AS/SC/MATH 2021 3.0, AK/AS/SC/MATH 2221 3.0, GL/MATH/MODR 2650 3.0.

SC/MATH 1505 6.0 Mathematics for the Life and Social Sciences. A presentation of the elements of single-variable differential and integral calculus, elementary linear algebra and introductory probability and statistics. This course is designed to provide a comprehensive mathematical background for students of the biological and social sciences. Emphasis is placed on basic mathematical skills and their applications.
Prerequisite: At least one 12U or OAC in mathematics or AS/SC/MATH 1510 6.0.
Course Credit Exclusions: AS/SC/MATH 1000 3.0, AS/SC/MATH 1010 3.0, AS/SC/MATH 1013 3.0, AS/SC/MATH 1014 3.0, AS/SC/AK/MATH 1300 3.0, AS/SC/AK/MATH 1310 3.0, AS/SC/MATH 1513 6.0, AS/MATH 1530 3.0, AS/MATH 1540 3.0, AS/AK/MATH 1550 6.0, GL/MATH/MODR 1930 3.0, AS/ECON 1530 3.0, AS/ECON 1540 3.0.

SC/PHYS 1010 6.0 Physics. Topics include linear, rotational and oscillatory motion; Newtonian mechanics; electrostatics; magnetostatics; electric current and induction; heat; geometrical and physical optics and sound. Differential and integral calculus and vector algebra are used. This course covers fewer topics than SC/PHYS 1410 6.0, but covers them in greater depth. It should be taken by all those likely to enrol in 2000-level PHYS courses. Includes three hour laboratory component normally in alternating weeks.
Prerequisite: OAC Physics or 12U Physics or SC/PHYS 1510 4.0.
Corequisite(s): AS/SC/MATH 1013 3.0 and AS/SC/MATH 1014 3.0 or AS/SC/MATH 1505 6.0, or equivalents.
Course Credit Exclusions: SC/PHYS 1410 6.0.

SC/PHYS 1410 6.0 Physical Science. Topics include kinematics, dynamics, momentum and energy for linear and rotational motion; elementary kinetic theory and thermodynamics; static and current electricity; waves and physical and geometrical optics, elements of modern physics. Recommended for students unlikely to enrol in 2000-level PHYS courses. Includes three hour laboratory component normally in alternating weeks.
Prerequisite: OAC Physics or 12U Physics or SC/PHYS 1510 4.0, OAC Algebra and OAC Calculus or 12U Advanced Functions and Introductory Calculus This is a calculus-based course making use of elementary differential and integral calculus.
Course Credit Exclusions: SC/PHYS 1010 6.0.

2000 Level Courses

Biology

SC/BIOL 2010 4.0 Plant Biology. Current advances in plant biology research, highlighting plant structure, physiology, development and diversity. Three lecture hours, three laboratory hours. One term. Four credits.
Prerequisite: SC/BIOL 1010 6.0.

SC/BIOL 2030 4.0 Animals A study of the diversity of animals, their structure, physiology and evolution. Three lecture hours, three laboratory hours. One term. Four credits.
Prerequisite: SC/BIOL 1010 6.0.
Course Credit Exclusions: SC/BIOL 2030 5.0, SC/BIOL 2031 4.0, SC/BIOL 2031 3.0

SC/BIOL 2050 4.0 Ecology A study of the interactions between organisms and their abiotic environments, presented in an evolutionary context. Includes processes of evolution, ecosystems and communities, competition, predation, population ecology, and current environmental problems such as habitat loss and extinction. Three lecture hours, three laboratory hours. One term. Four credits.
Prerequisite: SC/BIOL 1010 6.0.
Prerequisite or corequisite: SC/BIOL 2060 3.0.
Course Credit Exclusion: SC/BIOL 2050 3.0.

SC/BIOL 2060 3.0 Statistics for Biologists – Statistical problem solving for biologists. Basic theory for the analysis of parametric and non-parametric data. A project period is devoted to discussion and solving of statistical problems. Two lecture hours, one project period. One term. Three credits.
Prerequisites: AK/AS/SC/CSE 1520 3.0 or AK/AS/SC/CSE 1530 3.0 or AK/AS/SC/CSE 1540 3.0; AS/SC/MATH 1014 3.0, or AS/SC/MATH 1505 6.0, or both AS/SC/MATH 1013 3.0 and AS/SC/MATH 1025 3.0, or equivalents.
Course Credit Exclusions: SC/BIOL 3090 3.0, AS/ECON 2500 3.0, AS/ECON 3210 3.0, AK/ECON 3470 3.0, AK/ECON 3480 3.0, AS/ECON 3500 3.0, ES/ENVS 2010 6.0, ES/ENVS 2010 3.0, AS/SC/GEOG 2420 3.0, AS/SC/KINE 2050 3.0, AS/SC/KINE 3150 3.0, AS/SC/AK/MATH 2560 3.0, AS/SC/AK/MATH 2570 3.0, AS/POLS 3300 6.0, AK/AS/SC/PSYC 2020 6.0, AK/AS/SC/PSYC 2021 3.0, AK/AS/SC/PSYC 2022 3.0, AK/PSYC 2510 3.0, AK/PSYC 3110 3.0, AS/SOCI 3030 6.0.

Chemistry

SC/CHEM 2030 3.0 Basic Inorganic Chemistry. The descriptive chemistry of the more common elements is discussed within the context of qualitative inorganic analysis. Principles of ionic equilibria in aqueous solution, elementary coordination chemistry and electrochemical potentials are presented. Three lecture hours, three laboratory hours, one tutorial hour. One term. Three Credits
Prerequisite(s): Both SC/CHEM 1000 3.0 and SC/CHEM 1001 3.0, or SC/CHEM 1000 6.0.

EARTH AND ATMOSPHERIC SCIENCE

SC/EATS 2010 3.0 Introductory Meteorology. An introduction to atmospheric radiation and thermodynamics, clouds and precipitation. Vertical soundings and an introduction to the analysis and interpretation of tephigrams. Atmospheric motion on the global, synoptic, meso- and micro-scales. Two lecture hours and three laboratory hours, or three lecture hours per week. One term. Three credits.
Prerequisites: AK/AS/SC/CSE 1540 3.0; AS/SC/MATH 1013 3.0 and AS/SC/MATH 1014 3.0, or equivalents; SC/PHYS 1010 6.0 or SC/PHYS 1410 6.0.

SC/EATS 2470 3.0 Introduction to Continuum Mechanics.

Introductory tensor algebra and calculus. Stress and strain analysis. Symmetry of stress tensor, equilibrium conditions. Lagrangian and Eulerian descriptions of strain. Physical interpretation of stress, strain and strain rate tensors. Conservation laws in continua. Consistency and compatibility considerations. Constitutive relations. Two lecture hours and a tutorial or problems laboratory session. One term. Three credits. Prerequisites: AK/AS/SC/CSE 1540 3.0 (formerly CSE); AS/SC/MATH 1025 3.0; AS/SC/MATH 2015 3.0; SC/PHYS 1010 6.0, or a minimum grade of C in SC/PHYS 1410 6.0. Course credit exclusion: SC/EATS 2470 4.00.

GEOGRAPHY

AP/SC/GEOG 2350 3.0 Introduction to Geoinformatics. This special topics course is suitable to Education students majoring in Geography, who will require a course in Geomatics beginning in September 2002 and Geography students in either Arts or Science. This integrated course will cover fundamental concepts and approaches of geographical information systems and remote sensing together with air photo interpretation. Students will acquire knowledge and skills in descriptive statistics, global positioning systems and basic computer cartography. Computers will be used in the lab sessions but no prior knowledge of computers or specific computer programs is assumed.
Format: Two lecture hours per week; two-hour lab per week
Prerequisite: AS/GEOG 1410 6.0 or AS/GEOG 1400 6.0 or AS/GEOG 1000 6.0 or AK/GEOG 2500 6.0 or AK/GEOG 2510 6.0 or written permission of Course Director
Course Credit Exclusions: AS/SC/GEOG 2390G 3.0, SC/EATS 2610 2.0 (Geomatics and Space Engineering)

AP/SC/**GEOG 2400 6.0 The Hydrosphere.** This course examines the physical processes and the environmental factors that govern the movement of water and energy in lakes, rivers, oceans and the soil-plant-atmosphere continuum. Boundary-layer climates and mechanisms of water movement and storage are emphasized. Two lecture hours per week, sixteen three-hour laboratories over two terms.
Prerequisite: AS/SC/GEOG 1400 6.0 or AK/GEOG 2510 6.0.

AP/SC/GEOG 2420 3.0 Introductory Statistical Analysis in Geography. This introductory course aims to provide a working knowledge of several statistical techniques which are widely used in many branches of geography. Some attention is also given to broader questions concerning the nature of the scientific method. Two lecture hours per week, nine two-hour laboratory sessions. One term.
Prerequisites: 24 credits passed. This course is intended primarily for students majoring in Geography and is normally taken during the second year of study.
Course Credit Exclusions: AS/ECON 2500 3.0, AS/SC/KINE 2050 3.0 (Prior to Fall/Winter 2007-08), HH/KINE 2050 3.0, AS/SC/KINE 3150 3.0 (Prior to Fall/Winter 2007-08), HH/KINE 3150 3.0, AS/SC/MATH 1132 3.0, AS/POLS 3300 6.0, AS/SOCI 3030 6.0, AK/ADMS 3320 3.0 (prior to Fall/Winter 2005-2006), AK/MATH 2430 3.0, AK/AS/SC/MATH 2560 3.0, AK/AS/SC/MATH 2565 3.0, AK/AS/SC/MATH 2570 3.0, AK/MATH 2720 3.0, AK/AS/SC/PSYC 2020 6.0 (Prior to Fall/Winter 2007-08), HH/PSYC 2020 6.0, AK/AS/SC/PSYC 2021 3.0 (Prior to Fall/Winter 2007-08), HH/PSYC 2021 3.0, AK/PSYC 2510 3.0, ES/ENVS 2010 6.0, ES/ENVS 2010 3.0, SC/BIOL 2060 3.0.

AP/SC/GEOG 2500 3.0 Introduction to Vegetation and Soils. An introduction to the structure and functioning of vegetation and soil systems, emphasizing local patterns and processes, methods of description and sampling, dynamic processes, response to environmental change and human disturbance. Field work is emphasized in laboratories. Two lecture hours and two laboratory hours per week, a one-day field trip. One term.
Prerequisite: AS/SC/GEOG 1400 6.0 or AK/GEOG 2510 6.0 or ES/ENVS 2500 6.0.

AP/SC/GEOG 2600 3.0 Geomorphology I. The course opens with a brief survey of the history of geomorphology as a science. It then surveys modes of formulating significant geomorphological questions and predominant modes of investigation. The course then concentrates on basic principles and fundamental concepts in geomorphology (with a particular emphasis on Canadian examples). Being process-oriented, the course is based on a quantitative approach. The main topics addressed include energy flows in geomorphic systems, hillslope forms, and materials, weathering and landforms, drainage basin geomorphology and hydrology, and the glaciation of Canada. Lectures, illustrations and related data are compiled on a course website (WebCT). Three lecture hours per week.
Prerequisite: One of AS/SC/GEOG 1400 6.0, AK/GEOG 2510 6.0, SC/EATS 1010 6.0 or SC/EATS 1010 3.0 or written permission of course director
Course Credit Exclusion: AS/SC/GEOG 2700 3.0 Introduction to Geomorphology

AP/SC/GEOG 2610 3.0 Geomorphology II. This course concentrates on geomorphic processes and landforms. It is built on the fundamental knowledge introduced in AS/SC/GEOG 2600 3.0 Geomorphology I. This course is also process-oriented and is therefore based on a quantitative treatment of geomorphic agents and processes (with a particular emphasis on Canadian examples). Five main areas will be explored: fluvial forms and processes, glacial mechanics, periglacial geomorphology, aeolian processes, and coastal processes and landforms. Lectures, illustrations and related data are compiled on a course website (WebCT). Three lecture hours.
Prerequisite: AS/SC/GEOG 2600 3.0 Geomorphology I, AS/SC/GEOG 2700 3.0 or written permission of course director
Course Credit Exclusion: AS/SC/GEOG 3600 3.0 Process Geomorphology

MATHEMATICS

SC/MATH 2015 3.0 Applied Multivariate and Vector Calculus.

Topics covered include partial derivatives; grad, div, curl and Laplacian operators; line and surface integrals; theorems of Gauss and Stokes; double and triple integrals in various coordinate systems; extrema and Taylor series for multivariate functions. Prerequisite: One of AS/SC/MATH 1010 3.0, AS/SC/MATH 1014 3.0, AK/AS/SC/MATH 1310 3.0; or AS/SC/MATH 1505 6.0 plus permission of the course coordinator. Course credit exclusions: AS/SC/MATH 2010 3.0, AK/AS/SC/MATH 2310 3.0, GL/MATH/MODR 2670 3.0, GL/MATH 3200 3.0.

AP/SC/MATH 2270 3.0 Differential Equations. Introduction to differential equations, including a discussion of the formation of mathematical models for real phenomena; solution by special techniques; applications; linear equations; solutions in series; other topics if time permits.
Prerequisites: AS/SC/MATH 2010 3.0 or AS/SC/MATH 2015 3.0 or AS/SC/AK/MATH 2310 3.0; AS/SC/MATH 1021 3.0 or AS/SC/MATH 1025 3.0 or AS/SC/MATH 2021 3.0 or AS/SC/AK/MATH 2221 3.0.
Course credit exclusion: AS/SC/MATH 2271 3.0, GL/MATH 3400 3.0

PHYSICS

SC/PHYS 2020 3.0 Electricity and Magnetism. The elements of electric and magnetic fields are developed together with DC and AC circuit theory. Electromagnetic waves are introduced if time permits.
Prerequisites: SC/PHYS 1010 6.0, or a minimum grade of C in SC/PHYS 1410 6.0. Corequisite: AS/SC/MATH 2015 3.0.

3000 AND 4000 LEVEL COURSES

BIOLOGY

Note: Biology courses whose numbers begin with the digit "4" are normally offered in alternate years—with the exception of SC/BIOL4000 8.0 (4000 3.0), SC/BIOL 4245 3.0 and SC/BIOL 4255 3.0.

SC/BIOL 3001 3.0 (3001 2.0) Field Course. A course given at one of several biological stations, the objective of which is to give the student the opportunity to study plants and animals in their natural surroundings. The departmental brochure should be consulted for further details. Two-week field course. Three credits (3001 3.0). One-week field course. Two credits (3001 2.0).
Prerequisites: SC/BIOL 2010 4.0; one of SC/BIOL 2030 4.0, SC/BIOL 2031 3.0; plus special prerequisites where specified for some modules.
Note: **Students must be manually enrolled in this course through the Biology Department early in the January prior to the session in which the course is offered. Enrolment is not possible at any other time of year.** In addition to the tuition fee levied by the University, each student must pay for transportation, room and board.

SC/BIOL 3002 3.0 (3002 2.0) Field Course. This is a second field course, which may be taken for credit, the contents of which must differ materially from SC/BIOL 3001 3.0 (3001 2.0) as determined by the course director. The departmental brochure should be consulted for further details. Two-week field course. Three credits (3002 3.0). One-week field course. Two credits (3002 2.0).
Prerequisite: SC/BIOL 3001 3.0 or SC/BIOL 3001 2.0 or permission of the course director; plus special prerequisites where specified for some modules.

Note: **Students must be manually enrolled in this course through the Biology Department early in the January prior to the session in which the course is offered. Enrolment is not possible at any other time of year.** In addition to the tuition fee levied by the University, each student must pay for transportation, room and board.

SC/BIOL 3003 3.0 (3003 2.0) Field Course. This is a third field course, which may be taken for credit, the contents of which must differ materially from SC/BIOL 3001 3.0 (3001 2.0) and SC/BIOL 3002 3.0 (3002 2.0), as determined by the course director. The departmental brochure should be
consulted for further details. Two-week field course. Three credits (3003 3.0). One-week field course. Two credits (3003 2.0).
Prerequisite: SC/BIOL 3002 3.0 or SC/BIOL 3002 2.0 or permission of the course director; plus special prerequisites where specified for some modules.
Note: **Students must be manually enrolled in this course through the Biology Department early in the January prior to the session in which the course is offered. Enrolment is not possible at any other time of year.** In addition to the tuition fee levied by the University, each student must pay for transportation, room and board.

SC/BIOL 3170 3.0 Population Ecology. Reviews recent studies in population ecology with special emphasis on processes that lead to population decline and recovery. Lecture topics include population growth curve models, competition, dispersal, predator/prey interactions, disease and parasites. The laboratories stress field studies and data analysis. Two lecture hours, three laboratory hours. One term. Three credits.
Prerequisites: One of SC/BIOL 2030 4.0, SC/BIOL 2031 3.0, SC/BIOL 2050 4.0, AK/AS/SC/CSE 1520 3.0 or AK/AS/SC/CSE 1530 3.0 or AK/AS/SC/CSE 1540 3.0.

SC/BIOL 4000 3.0 Honours Thesis. A substantial review essay based on library investigations under the supervision of a faculty member. Rules governing this course are outlined in the Department of Biology undergraduate handbook. One term. Three credits.
Prerequisites: Normally, students who take SC/BIOL 3100 2.0 as a degree requirement will take it as a prerequisite for SC/BIO: 4000 8.0. In exceptional circumstances, SC/BIOL 3100 2.0 may be taken as a corequisite with the permission of the BIOL 4000 course director. Open only to honours students majoring in biology and environmental science students (life sciences stream).

SC/BIOL 4000 8.0 Honours Thesis. A research thesis based on laboratory and/or field investigations under the supervision of a faculty member. Rules governing this course are outlined in the Department of Biology undergraduate handbook. Two terms. Eight credits.
Prerequisites: Normally, students who take SC/BIOL 3100 2.0 as a degree requirement will take it as a prerequisite for SC/BIOL 4000 8.0. In exceptional circumstances, SC/BIOL 3100 2.0 may

be taken as a corequisite with the permission of the BIOL 4000 course director. Open only to honours students majoring in biology and environmental science students (life sciences stream).

SC/BIOL 4070 3.0 Behavioural Ecology. Interactions between the behaviour and ecology of animals are discussed from several points of view, including feeding, use of space, mate selection, mother-young interactions, social behaviour, learning and communication. Laboratories include techniques for studying behaviour and seminars reviewing recent research. Two lecture hours, three laboratory hours. One term. Three credits.
Prerequisite: One of SC/BIOL 2030 4.0, SC/BIOL 2031 3.0.

SC/BIOL 4080 3.0 Limnology and Aquatic Ecology. The study of physical, chemical and biological aspects of freshwater aquatic ecosystems, with a focus on lake systems. Laboratory deals with taxonomy of freshwater organisms, use of limnological equipment, and analysis/interpretation of aquatic data. Two lecture hours, three laboratory hours. One term. Three credits.
Prerequisites: SC/CHEM 1000 3.0 AND SC/CHEM 1001 3.0; SC/BIOL 2050 4.0 or permission of instructor. SC/PHYS 1510 4.0 or similar (OAC Physics, 12U Physics) is strongly recommended.

SC/BIOL 4090 4.0 Plant Ecology. This course reflects the diversity of topics that makes up the field of plant ecology: ecosystems, plant population ecology, physiological and evolutionary ecology, plant-herbivore interactions and applied ecology. Laboratories cover field and laboratory techniques,
including sampling methods. Three lecture hours, three laboratory hours. One term. Four credits.
Prerequisites: SC/BIOL 2010 4.0; SC/BIOL 2050 4.0.

SC/BIOL 4095 3.0 Applied Plant Ecology. This course concentrates on how pollution, including acid precipitation and climatic change, and activities such as overgrazing have affected plant growth and productivity. Three lecture hours. One term. Three credits.
Prerequisite: SC/BIOL 2050 4.0 or permission of the instructor; SC/BIOL 4090 4.0 is recommended.

SC/BIOL 4100 3.0 Natural History. A study of the life histories of selected flora and fauna in major ecosystems, with special emphasis on local species and interrelationships within ecosystems. Two lecture hours, three laboratory hours. One term. Three credits.
Prerequisites: SC/BIOL 2010 4.0; SC/BIOL 2030 4.0; SC/BIOL 2050 4.0.

SC/BIOL 4130 3.0 Plant Evolution. An analysis of patterns of variation among plants, emphasizing the evolutionary processes which brought them about. Topics include biosystematics, speciation, hybridization, isolating mechanisms and mating systems. Two lecture hours, three laboratory hours. One term. Three credits.
Prerequisites: SC/BIOL 2010 4.0; SC/BIOL 2050 4.0.

SC/BIOL 4230 4.0 General Entomology. The distinguishing characteristics, biology and economic importance of the major orders and families of insects. Three lecture hours, three laboratory hours. One term. Four credits.

Prerequisite: SC/BIOL 2030 5.0.

SC/BIOL 4240 3.0 Mammalian Systematics and Ecology (Mammalogy). (formerly SC/BIOL 4240 4.0 - before 2003-2004) The systematics, life history and ecology of mammals. Emphasis is on North American genera and the species of eastern Canada. Field and laboratory techniques are an integral part of the course. Three lecture hours and three laboratory hours per week, one required weekend field trip. One term. Four credits.
Prerequisites: SC/BIOL 2030 4.0; SC/BIOL 2050 4.0.

SC/BIOL 4245 3.0 Conservation Biology. This course explores the role of biological science in efforts to conserve natural resources, systems and the organisms therein. Two lecture hours, three laboratory hours. One term. Three credits.
Cross-listed to: ES/ENVS 4110 3.0.
Prerequisites: SC/BIOL 2010 4.0; one of SC/BIOL 2030 4.0, SC/BIOL 2031 3.0, or SC/BIOL 2040 4.0; SC/BIOL 2050 4.0; or permission of the instructor.
Course Credit Exclusion: ES/ENVS 4110 3.0.

SC/BIOL 4250 3.0 Birds and the Environment. A review of the adaptations of birds to different environments, behaviour and ecology, biodiversity and evolution, and current threats to the world's birds. Laboratories include field trips, a study of bird anatomy and examination of museum specimens. Two lecture hours, three laboratory hours. One term. Three credits.
Prerequisite: One of SC/BIOL 2030 4.0, SC/BIOL 2031 3.0.

SC/BIOL 4255 3.0 Biodiversity. We do not know the number of species on Earth, even to the nearest order of magnitude. This course discusses the factors that influence the number of species in
an area and the importance of biodiversity to humanity. Two lecture hours, three laboratory hours. One term. Three credits.
Cross-listed to: ES/ENVS 4111 3.0.
Prerequisite: Completion of 60 credits towards a degree in Biology or Environmental Science or Environmental Studies, or permission of the instructor.
Course Credit Exclusion: ES/ENVS 4111 3.0.

SC/BIOL 4260 3.0 Systematic Biology in Theory and Practice. Systematics is the science of describing and categorizing biological diversity at all levels. It is central to most areas of biological inquiry. This course teaches students the history of systematics, its methods and their applications throughout biology. Two lecture hours, one three-hour laboratory/computer session. One term. Three credits.
Prerequisites: SC/BIOL 2010 4.0; one of SC/BIOL 2030 4.0, SC/BIOL 2031 3.0.

SC/BIOL 4265 3.0 Biology in Environmental Management This course summarizes our progress in conceptualizing, understanding and in solving large-scale ecological problems caused by the introduction of pollutants and exotic species to the environment. Three lecture hours. One term. Three credits.
Prerequisites: SC/BIOL 2050 4.0; SC/BIOL 2060 3.0 or permission of the instructor.

SC/BIOL 4340 3.0 Fish Biology. A study of fish biology (ichthyology), including anatomy, systematics, physiology, behaviour, and ecology of freshwater and marine fishes. Special

emphasis is placed on the unique features of fishes and their functional adaptation to aquatic environments. Three lecture hours. One term. Three credits.
Prerequisite: SC/BIOL 2030 4.0.

SC/BIOL 4400 3.0 Behavioural Genetics. Differences in behaviour are analyzed through evolutionary and mechanistic approaches. Hypotheses, models, experimental and field data are used to address the importance of heredity and environment in the development of individual differences, social systems, communication, habitat and sexual selection. Two lecture hours, three laboratory hours. One term. Three credits.
Prerequisites: SC/BIOL 2040 4.0; SC/BIOL 2050 4.0; SC/BIOL 2060 3.0

SC/BIOL 4420 3.0 Herpetology. A detailed presentation of the biology of amphibians and reptiles (herpetology) is given. Topics include taxonomy, reproduction, feeding, defence, environmental physiology of living forms. Special emphasis is placed on identification and life history of Canadian herpetofauna. Two lecture hours, three laboratory hours. One term. Three credits.
Prerequisites: SC/BIOL 2030 4.0; SC/BIOL 2050 4.0.

EARTH AND ATMOSPHERIC SCIENCE

SC/EATS 3030 3.0 Atmospheric Radiation and Thermodynamics. Applications of basic thermodynamic principles to dry and moist atmospheric situations. Solar (short wave) and terrestrial (long wave) radiation with respect to absorption and scattering processes involving atmospheric atoms, molecules, aerosol particles and clouds. Three lecture hours. One term. Three credits.
Cross-listed to: SC/PHYS 3080 3.0.
Prerequisites: AS/SC/MATH 2015 3.0; AS/SC/AK/MATH 2271 3.0; SC/PHYS 1010 6.0, or a minimum grade of C in SC/PHYS 1410 6.0.
Course Credit Exclusion: SC/PHYS 3080 3.0.

SC/EATS 3040 3.0 Atmospheric Dynamics I. Dynamics of large-scale weather systems. Development of the equations of motion, geostrophy, thermal wind, vorticity and divergence, Ekman layers, and the quasi-geostrophic theory. Three lecture hours. One term. Three credits.
Prerequisites: SC/EATS 2010 3.0; SC/EATS 2470 4.0 or SC/PHYS 2010 3.0; AS/SC/MATH 2015 3.0; AS/SC/AK/MATH 2271 3.0.

SC/EATS 3130 3.0 Introductory Atmospheric Chemistry. An introductory course linking chemistry and atmospheric science. Topics include atmospheric evolution; biogeochemical cycles; sources, transformations and sinks of atmospheric species; human impacts such as acid rain, photochemical smog, and depletion of the ozone layer. Three lecture hours. One term. Three credits.
Cross-listed to: SC/CHEM 3060 3.0.
Prerequisites: SC/CHEM 1000 3.0 and SC/CHEM 1001 3.0; one of AS/SC/MATH 1010 3.0, AS/SC/MATH 1014 3.0, AS/SC/AK/MATH 1310 3.0, AS/SC/MATH 1505 6.0.
Course Credit Exclusions: SC/CHEM 3060 3.0, SC/CHEM 3160 3.0.

SC/EATS 4050 3.0 Synoptic Meteorology I. Analysis of mid-latitude synoptic scale weather systems: an introduction to storm tracks, fronts and air masses, and diagnostic methods.

Analysis and interpretation of surface weather maps and upper-air charts. Two lecture hours, three laboratory hours. Fall Term. Three credits.
Prerequisite or corequisite: SC/EATS 3040 3.0.
Course Credit Exclusion: SC/EATS 4050 6.0.

SC/EATS 4051 3.0 Synoptic Meteorology II Synoptic and mesoscale weather systems with emphasis on prediction: focus on forecasting with emphasis on the interpretation of numerical weather prediction models such as the GEM, MC2 and SEF models. Satellite and radar image interpretation for nowcasting. Two lecture hours, three laboratory hours. Winter term. Three credits.
Prerequisite: SC/EATS 4050 3.0.
Course Credit Exclusion: SC/EATS 4050 6.0.

SC/EATS 4120 3.0 Cloud Physics and Radar Meteorology. Thermodynamics of cloud processes. Buoyancy and convection. Weather radar. Storms and associated precipitation. Cloud droplet formation and growth of ice crystals. Snow, graupel and hail. Microphysical processes and climate. Normally offered in alternate years. Three lecture hours. One term. Three credits.
Prerequisite or corequisite: SC/EATS 3030 3.0.

SC/EATS 4130 3.0 Atmospheric Dynamics II. The theory and behaviour of Rossby, baroclinic and internal gravity waves in the atmosphere, including their origin, structure and propagation. Barotropic and baroclinic instability and the global circulation of the atmosphere. Normally offered in alternate years. Three lecture hours. One term. Three credits.
Prerequisite: SC/EATS 3040 3.0.

SC/EATS 4140 3.0 Numerical Weather Prediction. The development of computational techniques for the solution of problems in atmospheric dynamics. The construction of numerical models for the prediction of weather. Three lecture hours per week, eight three-hour laboratory sessions held in consecutive weeks (scheduled in the middle of term to coincide with lecture material). One term. Three credits.
Prerequisites: SC/EATS 3040 3.0; AK/AS/SC/CSE 1540 3.0 or equivalent FORTRAN programming experience.
Prerequisite or corequisite: SC/EATS 4130 3.0 strongly recommended.

SC/EATS 4160 3.0 Climate and Climate Change. The Earth's climate and the general circulation of the atmosphere. Climate models. Long-term stability of the Earth's climate. Anthropogenic impact on the climate, carbon dioxide and other climate change issues. Normally offered in alternate years. Three lecture hours. One term. Three credits.
Prerequisite: SC/EATS 2010 3.0 or SC/EATS 3040 3.0 or permission of the instructor.

SC/EATS 4220 3.0 Remote Sensing of the Earth's Surface. The physical principles of remote sensing are presented along with detailed discussion of Earth-observing sensors which detect e.m. energy in the ultraviolet to microwave spectral regions. Both passive and active techniques are examined with application examples drawn from many of the disciplines associated with remote sensing of Earth resources. Laboratory experiments involve spectral reflectance measurements of typical natural surfaces and interpretation of spectra from air borne imagery, as well as reflectance model runs. Two lecture hours, three laboratory hours. One term. Three credits.
Prerequisite(s): SC/PHYS 2020 3.0, or SC/PHYS 2060 3.0, or both SC/PHYS 2211 1.0 and SC/PHYS 2212 1.0.

SC/EATS 4230 3.0 Remote Sensing of the Atmosphere. An introduction to and summary of the area of remote sensing of the atmosphere from space platforms and from the ground. Topics include atmospheric radiation, atmospheric spectroscopy, inversion theory, instrumentation, satellites, space platforms and future technology. Three lecture hours per week, occasional laboratory sessions. One term. Three credits.
Prerequisites: SC/EATS 2010 3.0 or SC/PHYS 2060 3.0; AS/SC/MATH 1025 3.0; AS/SC/MATH 2015 3.0; AS/SC/AK/MATH 2271 3.0.
Prerequisite or corequisite: SC/EATS 3030 3.0 or permission of the course director.

SC/EATS 4240 3.0 Storms and Weather Systems. The study of mesoscale circulations and precipitating storm systems. Basic governing equations and instabilities. Nature and evolution of isolated convection, thunderstorms, mesoscale convective systems, precipitation bands, extratropical cyclones, fronts and frontogenesis, hurricanes, blizzards, polar lows, and orographic storms. Normally offered in alternate years. Three lecture hours. One term. Three credits.
Prerequisites or corequisites: SC/EATS 3040 3.0; SC/EATS 4120 3.0.

GEOGRAPHY

Prerequisites: Unless otherwise indicated, 3000-level Geography courses are open only to students who have successfully completed at least 24 credits, including any specific course prerequisites noted in the following course outlines.

AP/SC/GEOG 3180 3.0 Introduction to Geographic Information Systems (GIS). An introduction to the application of GIS to geographical/environmental problems. A broad conceptual overview of GIS approaches and their strengths and limitations. Students gain hands-on experience in the use of raster-based GIS technology with particular reference to resource management and planning topics. One and one half lecture hours, one and one half laboratory hours. One term.
Prerequisite: AS/SC/GEOG 2420 3.0.
Equivalents and Course Credit Exclusions: AK/GEOG 3600 3.0, ES/ENVS 3520 3.0.

AP/SC/GEOG 3200 3.0 Terrestrial Ecosystems. An examination of the structure and function of vegetation and soil systems. The course focuses on such topics as the adjustment of ecosystems to
human modification and the role of biogeography in conservation and resource management. Three lecture hours. One term.
Prerequisites: 54 credits successfully completed, including one of AS/SC/GEOG 1400 6.0, AK/GEOG 2510 6.0, SC/BIOL 2050 4.0, ES/ENVS 2420 3.0.

SC/GEOG 3420 is no longer offered. Students can take AS/SC/GEOG 4540 3.0 or AS/SC GEOG 4541 3.0 for additional SC/GEOG credits at the 2000 level or higher.

AP/SC/GEOG 3440 3.0 Environmental Remote Sensing. This course intends to give students an overview of remote sensing concepts, the ways in which remote sensing systems are used to acquire data, how these data may be analyzed digitally and how the information is used in studies of the natural and human environments. At the end of the course, students should have a good knowledge of the different types of remote sensing imagery that are available and the digital processing and analysis procedures that are used for environmental applications. Students should also be capable of undertaking basic computer-assisted image analysis. This course is composed of lectures, laboratories, readings and student presentations.
Cross-listed to: ES/ENVS3521 3.0
Prerequisite: AS/SC/GEOG 2420 3.0; or ES/ENVS 2010 6.0 and one 2000-level Environmental Studies Theme Foundation course; or written permission of the Course Director.
Course Credit Exclusion*:* AS/SC/GEOG 4390T 3.0

AP/SC/GEOG 3500 3.0 Biogeography. An analysis of the geography of plants and animals, emphasizing processes that operate at the population level, the origin and diversity of plants and animals, geographic patterns of diversity, and dynamics of species populations from local and continental scales. Two lecture hours, two laboratory hours. One term.
Cross-listed to: SC/BIOL 3500 3.0.
Prerequisite: AS/SC/GEOG 2500 3.0 or SC/BIOL 2050 4.
Course Credit Exclusion: SC/BIOL 3500 3.0.

AP/SC/GEOG 3900 3.0 Physical Geography of the City. This course explores the natural and physical systems of the city, focusing on the climate, water, geomorphology, biogeography of the urban landscape, including its built environment. Three lecture hours.
Prerequisites: One of AS/SC/GEOG 1400 6.0 or AS/SC GEOG 2510 6.0.
This course has been included in the group of SC/GEOG courses from which environmental science students can take additional SC/GEOG credits at the 2000 level or higher.

Prerequisites: Unless otherwise indicated, 4000-level Geography courses are open only to students who have successfully completed at least 54 credits, including any specific course prerequisites noted in the following course outlines.

AP/SC/GEOG 4000 6.0 Honours Thesis. An independent piece of research done under the supervision of a faculty adviser. The thesis must be submitted before the end of classes in the Winter Term; an exact date is established each year. There is an oral examination on the Honours Thesis. Only theses topics in physical geography are eligible for Science (SC) credit. One lecture hour per week at the beginning of the course. Two terms.
Prerequisite: 84 credits passed.

SC/GEOG 4180 4.0 Laboratory Analysis of Ecological Materials. This course introduces students to a comprehensive range of laboratory techniques for the analysis of plant, soil, and water samples. Laboratory sessions and projects provide students with experience in analytical procedures and the operation of major items of laboratory equipment. Four scheduled lecture/laboratory hours, three additional laboratory hours. One term.
Prerequisite(s): 6 credits in physical geography at the 3000 or 4000 level; or SC/EATS 1010 3.0; or SC/BIOL 2050 4.0 or ES/ENVS 2410 3.0 or ES/ENVS 2420 3.0.

AP/SC/GEOG 4200 3.0 Water Quality and Stream Ecosystems. The course focuses on selected aspects of river water quality, including hillslope hydrology and the transport of pollutants, the impacts of human activities on water chemistry, nutrient transformations within stream ecosystems, and the effects of water quality on stream biological communities. Two lecture hours, one laboratory hour. One term.
Prerequisites: One of AS/SC/GEOG 1400 6.0, AK/GEOG 2510 6.0, SC/BIOL 2050 4.0, ES/ENVS 2410 3.0.

AP/SC/GEOG 4205 3.0 Climatology of High Latitudes. A study of the processes of energy and moisture exchanges in polar regions with emphasis on the Canadian North. Topics include atmospheric and oceanic transport of energy, surface microclimate and the sensitivity of high latitude environments to climate change. Normally offered in alternate years. Three lecture hours. One term.
Prerequisite: AS/SC/GEOG 2400 6.0.
Equivalent and Course Credit Exclusion: AS/SC/GEOG 3210 3.0.

AP/SC/GEOG 4210 3.0 Hydrometeorology. A study of the relationship between the atmosphere and the hydrosphere with the emphasis on the process of evaporation. The course includes an in-depth review of evaporation models and the instrumentation necessary for data acquisition. Normally offered in alternate years. Three lecture hours per week, one full-day laboratory session. One term.

Prerequisite: AS/SC/GEOG 2400 6.0.

AP/SC GEOG 4215 3.0 Ecological Climatology. The field of Ecological Climatology provides an interdisciplinary framework for understanding how terrestrial ecosystems function in relation to climate systems. It examines the physical, chemical and biological processes by which landscapes affect and are affected by climate. The central theme is that ecosystems, through their cycling of energy, water, chemical elements and trace gases are important determinants of climate.The coupling between climate and vegetation is seen at spatial scales from the leaf to biomes and at timescales from seconds to millenia. Both natural vegetation dynamics and human induced land-use changes are mechanisms of climate change. The course combines a theoretical understanding of ecological climatology with applied experimentation to reinforce the principals involved.
Prerequisite: AP/SC GEOG 2400 6.0 Hydrosphere and either AP/SC GEOG 2500 3.0 Vegetation and Soils or SC/BIOL 2050 4.0 Ecology and either AP/SC GEOG 2420 3.0 Introductory Statistical Analysis in Geography or SC/BIOL 2060 3.0 Statistics for Biologists.

AP/SC/GEOG 4310 3.0 Dynamics of Snow and Ice. This course examines the formation, distribution, structure, and degradation of snow, as well as lake, river and sea ice. Two lecture hours and two lab hours. One term.
Prerequisite: AS/SC/GEOG 2400 6.0.

AP/SC/GEOG 4340 3.0 Geographic Information Systems. Advanced course in Geographic Information Systems (GIS), oriented around raster structures. Computer graphics for mapping introduced and work undertaken on finely divided surfaces. GIS considers both practical and theoretical questions of interpretation. Macintosh computers and raster-based software used for hands-on focus. Two lecture hours, two laboratory hours. One term.
Prerequisite: AS/SC/GEOG 3180 3.0 or AK/GEOG 3600 3.0.
Equivalent and Course Credit Exclusion: AK/GEOG 4220 3.0.

AP/SC/GEOG 4400 3.0 Physical Hydrology and Water Resources. An intermediate course in the physical principles of hydrological and water resource systems. Topics to be discussed include groundwater storage and flow, deterministic hydrological models and physical hydrological aspects of current water resource problems. Normally offered in alternate years. Two lecture hours, two laboratory hours. One term.
Prerequisite: AS/SC/GEOG 2400 6.0.

AP/SC/GEOG 4410 3.0 Desert Ecosystems. This course focuses on the vegetation of the desert, species adaptations to high temperature and aridity and the interactions between organisms, and between plants and their environment. Three lecture hours. One term.
Prerequisite: one of AS/SC/GEOG 1400 6.0; SC/BIOL 2050 4.0

AP/SC/GEOG 4440 3.0 Remote Sensing and Image Processing for Geographical Analysis and Environmental Monitoring. This course aims to provide every student with a working knowledge of sophisticated methods and techniques for collecting, processing and analyzing remote sensing data as well as the theory and practice of undertaking remote sensing-based projects. Throughout the course, emphasis will be placed on image processing, image analysis, image classification, remote sensing and GIS data integration, and applications of remote sensing in geographical analysis and environmental monitoring.
Two lecture hour and two laboratory hours. One term.
Cross-listed to: ES/ENVS 4521 3.0

Prerequisites: 54 credits passed; AS/SC/GEOG 3440 3.0 or ENVS 3521 3.0 or SC/EATS 4220 3.0 or written permission of the Course Director. Course Credit Exclusion*:* AS/SC/GEOG 4390T 3.0

AP/SC/GEOG 4500 3.0 is no longer offered.

AP/SC/GEOG 4540 3.0 Research Design and Field Studies in Physical Geography. The course is an introduction to research design and methodology in physical geography. The course integrates on-campus preparation and report writing with off-campus fieldwork during which data collection and preliminary analysis are carried out. The fieldwork relates to a geographic problem offering scope for the special interests of students in various aspects of physical geography.
Prerequisite: Students must be registered as Honours majors in Geography or Environmental Science and must have successfully completed AS/SC/GEOG 2420 3.0 and one of AS/SC/GEOG 2400 6.0, AS/SC/GEOG 2500 3.0 or AS/SC/GEOG 2600 3.0; or permission of the Course Director.
Course Credit Exclusions: AS/SC/GEOG 3420 3.0, AS/SC/GEOG 3390B 3.0.
Note: Additional fees may be incurred (Max. $150.00), to cover the expense of transportation and accommodation for out-of-town field trips.

AP/SC/GEOG 4541 3.0 Advanced Field Studies in Physical Geography. Application of geographical principles and techniques to problems in physical geography. Objectives include designing and completing a successful field research program within a designated research area outside of Ontario (10 to 14 day field trip, normally held at the end of summer). This will include reading selected articles for the trip, designing a proposal, obtaining and analyzing field data and presenting this information at the completion of the course. Students will also develop the skills to work within a team environment on a designated group project (e.g. mapping application). Students will also participate fully in the planning stages and problem solving of the field studies program (pre-field, field and post-field components). Students are encouraged to take GEOG 4540 3.0 prior to taking this course.
Prerequisite: AS/GEOG 2420 6.0; AS/GEOG 1400 6.0.
Note: Priority will be given to Geography Honours students having already completed 84 credits.

AP/SC/GEOG 4600 3.0 Rivers: Environment and Process. This course provides fundamental knowledge of river mechanics and related environmental conditions. The main objective of the course is to provide an understanding of river behaviour from an integration of environmental and spatial aspects as well as the fundamental physical process conditions. The course involves the application of principles of hydrology, geomorphology, sedimentology and fluid mechanics. It includes sections on water flow characteristics, sediment transport, river channels, aquatic habitats and global change impact on rivers. Two lecture hours and some seminar hours. Seminar hours are held in smaller groups and each student will attend three or four two hour sessions. One term.
Prerequisite: 54 credits passed, including one of AS/SC/GEOG 1400 6.0 AK/GEOG 2510 6.0. or written permission of instructor.

MATHEMATICS

SC/MATH 3241 3.0 Numerical Methods I. An introductory course in computational linear algebra. Topics include simple error analysis, linear systems of equations, non-linear equations, linear least squares and interpolation.
Cross-listed to: AK/AS/SC/CSE 3121 3.0.
Prerequisites: One of AS/SC/MATH 1010 3.0, AS/SC/MATH 1014 3.0, AS/SC/AK/MATH 1310 3.0; one of AS/SC/MATH 1021 3.0, AS/SC/MATH 1025 3.0, AS/SC/MATH 2021 3.0, AS/SC/AK/MATH 2221 3.0; one of AK/AS/SC/CSE 1540 3.0, AK/AS/SC/CSE 2011 3.0, AK/AS/SC/CSE 2031 3.0, AS/AK/ITEC 2011 3.0.
Course Credit Exclusion: AK/AS/SC/CSE 3121 3.0.

CERTIFICATE PROGRAM IN GEOGRAPHIC INFORMATION SYSTEMS (GIS) AND REMOTE SENSING

Registered York University degree candidates and Special Students may work towards a Certificate in Geographic Information Systems (GIS) and Remote Sensing offered jointly by the Department of Geography of the Faculty of Arts, the Department of Earth and Space Science and Engineering of the Faculty of Science & Engineering , and the Faculty of Environmental Studies.

In order to be awarded for the Certificate, students must achieved a minimum cumulative grade-point average of 6.0 over the 24 York University credits required in one of the three streams [Environmental Studies (ENST), Geography (GEOG), or Earth and Atmospheric Science (EATS)] as follows. [Degree candidates must also achieve and maintain honours standing (i.e., a minimum of cumulative grade-point average of 5.0 over all York University courses completed) in their academic degree program.]

Environmental Science students must complete the following credits:

- AP/SC/GEOG 1400 6.0*
- AP/SC/GEOG 2420 3.0
- AP/SC/GEOG 3180 3.0
- AP/GEOG 3440 3.0
- AP/SC/GEOG 4340 3.0
- AP/SC/GEOG 4440 3.0

Plus 3 additional elective credits from the following list, for an overall total of 24 York University credits in the Certificate Program.

Certificate Program elective courses

SC/EATS 4220 3.0
SC/EATS 4230 3.0
ES/ENVS 3011 3.0
AP/SC/GEOG 2130 3.0
AP/GEOG 3140 3.0
AP/GEOG 4240 3.0

Notes: 1. * Special Students who have successfully completed the equivalent of the 1000-level course, degree candidates who have been granted advanced standing with a Course Credit Exclusion of 1000-level course, or degree candidates who have been exempted from the 1000-level course as the result of a Faculty transfer, may substitute 6 additional credits (approved by the unit through which the student is taking the Certificate Program) from the Certificate Program elective list.

2. The Following courses in the lists above are cross-listed:
   ES/ENVS 3521 3.0 = AS/GEOG 3440 3.0
   ES/ENVS 4521 3.0 = AS/GEOG 4440 3.0

3. Environmental Science students who wish to complete the Certificate Program must seek approval from the Department of Geography and sign a certificate registration form. Please consult with the Environmental Science coordinator. Appointments are made at the Geography Office (N430 Ross Building)
   Students in the Physical Sciences stream can identify SC/EATS 4220 3.0 (a degree requirement for the Physical Sciences stream) as their elective course for the GIS and Remote Sensing Certificate.

   Students in the Life Sciences stream normally enrol in SC/BIOL 2060 3.0 Science Statistics and are permitted to substitute this course for SC/GEOG 2420 3.0 in the Geography stream requirements for the GIS and Remote Sensing Certificate.

COURSES DEALING WITH THE ECONOMIC, SOCIAL, POLITICAL AND POLICY ASPECTS OF ENVIRONMENTAL ISSUES

Students who wish to understand the breadth and interdisciplinary nature of environmental issues may wish to use some of the elective credits available in the environmental science program to take courses in the "non-science" aspects of environmental issues. A list of these courses is provided below:

FACULTY OF ENVIRONMENTAL STUDIES

ES/ENVS2150 3.0 Environment, Technology and Sustainable Society
ES/ENVS2400 6.0 Foundations of Environmental Management and Policy Resources and Conservation
ES/ENVS2410 3.0 The Science of Pollution: Impacts on the Environment and Human Health
ES/ENVS3110 3.0 Scientific Knowledge and Environmental Issues
ES/ENVS3120 3.0 Environmental History
ES/ENVS3230 3.0 Ecological Restoration
ES/ENVS3310 3.0 Tropical Conservation and Sustainable Development
ES/ENVS3330 3.0 Sustainable Global Development
ES/ENVS3410 3.0 Environment Policy I
ES/ENVS3420 3.0 Environmental Law
ES/ENVS3430 3.0 Environmental Assessment
ES/ENVS3440 3.0 Resource Management
ES/ENVS4140 3.0 Environmental Thought
ES/ENVS4410 3.0 Environmental Policy II
ES/ENVS4430 3.0 Impact Assessment Processes and Practice
ES/ENVS4440 3.0 Environmental Disasters
ES/ENVS4442 3.0 Environmental Monitoring and Auditing
ES/ENVS4445 3.0 Environmental Conservation in Ontario: Policy and Application

FACULTY MEMBERS IN ENVIRONMENTAL SCIENCE

Dawn R. Bazely - PhD (Oxford)

Associate Professor of Biology

I am interested in the nature of plant-herbivore interactions, particularly the impact of herbivores on vegetation and nutrient cycles, and the nutritional basis of diet selection by grazers.

Richard L. Bello - PhD (McMaster)

Associate Professor of Geography

Microclimate, with particular emphasis on evapotranspiration studies, bioclimatology, carbon dynamics in Arctic Canada.

Quiming Cheng - PhD (Ottawa)

Professor of Geomatics and Geography

The development and application of GIS for natural resources assessment.

Taly D. Drezner- PhD (Arizona State University)

Associate Professor of Geography

Biogeography focusing on desert environments, plant-climate interactions, disturbance and restoration in riparian areas.

Alan R.Hill - PhD (Belfast)

Professor, Emeritus of Geography

Biogeochemistry focusing on nutrient dynamics in streams and wetlands and on hydrologic flowpath-chemistry linkages in forest and agricultural watersheds.

Mary A. Jenkins - PhD (Toronto)

Associate Professor of Earth and Atmospheric Science

Theoretical investigations of large scale atmospheric dynamics and convectively driven systems.

Gary P. Klaassen - PhD (Toronto)

Associate Professor of Earth and Atmospheric Science

Numerical modeling of atmospheric dynamics.

Christopher J. Lortie – D. Phil (Br.Col.)

Associate Professor of Biology

Plant ecology, seedbank dynamics, invasion ecology, cushion plants.

John C. McConnell - PhD (Belfast)

Professor of Earth and Atmospheric Science

Modeling of *aurora* and atmospheric chemistry on the Earth and other planets.

Laurence D.M. Packer - PhD (Toronto)

Professor of Biology and Environmental Studies

Bee biology with special reference to the evolution of social behaviour. Insect phylogeny. Insect biodiversity. Evolutionary biology of pine sawflies.

Roberto Quinlan PhD (Queen's)

Assistant Professor of Biology

Research specialization involves examining the chitinous subfossil remains of midges (Diptera: Chironomidae, "chironomids") in lake and pond sediments, to generate paleoecological assessments of past aquatic ecosystem changes. However, my research interests are broad, as I am interested in a breadth of paleoecological and ecological methods to examine aquatic systems, ranging from lakes in the 'cottage-country' districts of southern Ontario, Canada to shallow ponds in the northern tip of the Canadian Arctic.

Tarmo K. Remmel PhD (Toronto)

Assistant Professor of Geography

Application of remote sensing GIS and GPS and spatial statistical tools to characterize measure and compare spatial patterns. Current research focus on linking spatial patterns with ecological processes of forest disturbance and recovery.

André Robert - PhD (Cambridge)

Associate Professor of Geography

Sediment transport in rivers; experimental fluvial studies; mathematical modeling of stream bedforms.

Joel S. Shore - PhD (Toronto)

Professor of Biology

I am interested in plant evolution including both the inference of evolutionary history and ecological genetics. More specifically, my research has focussed on the evolution of plant breeding systems and polyploidy.

Bridget J. Stutchbury - PhD (Yale)

Professor of Biology

I study the adaptive value of behavioural traits in birds, particularly reproductive tactics and communication. My research includes comparative studies, manipulative experiments in the field, and genetic "fingerprinting" to examine actual mating success. I also do field work on wintering migratory songbirds in the tropics; this is important for the conservation biology of migrants as well as understanding how breeding strategies are influenced by winter competition.

Susanne Tank – PhD (Simon Fraser)

Assistant Professor Geography

Biochemical cycling of nutrients and its relationship to carbon dynamics in aquatic systems in the Arctic.

Peter A. Taylor - PhD (Bristol)

Professor of Earth and Atmospheric Science

Micro- and meso-scale meteorology.

Norman D. Yan - PhD (Guelph)

Professor of Biology

I am interested in the effects for various stresses (acid rain, UV radiation, climate variablity, non-indigenous species) on the life, particularly the planktonic life, of Ontario's inland lakes.

Kathy L. Young - PhD (McMaster)

Professor of Geography

Arctic Hydrology and hydrometeorology; Arctic wetlands, Arctic environments.

Amro Zayed - **PhD (York)**

Assistant Professor of Biology

I am interested in understanding the genetic and environmental basis of insect behaviour and how it pertains to adaptation.