2019-2020 Graduate Calendar

The information published in this Graduate Calendar outlines the rules, regulations, curricula, programs and fees for the 2019-2020 academic year, including the Summer Semester 2019, Fall Semester 2019 and the Winter Semester 2020.

For your convenience the Graduate Calendar is available in PDF format.

If you wish to link to the Graduate Calendar please refer to the Linking Guidelines.

The University is a full member of:

• Universities of Canada

Contact Information:

   University of Guelph
   Guelph, Ontario, Canada
   N1G 2W1
   519-824-4120

Revision Information:

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 1, 2019</td>
<td>Initial Publication</td>
</tr>
<tr>
<td>June 28, 2019</td>
<td>Revision 1</td>
</tr>
</tbody>
</table>
Disclaimer
The Office of Graduate and Postdoctoral Studies has attempted to ensure the accuracy of this on-line Graduate Calendar. However, the publication of information in this document does not bind the university to the provision of courses, programs, schedules of studies, fees, or facilities as listed herein.

Limitations
The University of Guelph reserves the right to change without notice any information contained in this calendar, including any rule or regulation pertaining to the standards for admission to, the requirements for the continuation of study in, and the requirements for the granting of degrees or diplomas in any or all of its programs. The university will not be liable for any interruption in, or cancellation of, any academic activities as set forth in this calendar and related information where such interruption is caused by fire, strike, lock-out, inability to procure materials or trades, restrictive laws or governmental regulations, actions taken by the faculty, staff or students of the university or by others, civil unrest or disobedience, Public Health Emergencies, or any other cause of any kind beyond the reasonable control of the university.

The University of Guelph reaffirms section 1 of the Ontario Human Rights Code, 1981, which prohibits discrimination on the grounds of race, ancestry, place of origin, colour, ethnic origin, citizenship, creed, sex, sexual orientation, handicap, age, marital status or family status.

The university encourages applications from women, aboriginal peoples, visible minorities, persons with disabilities, and members of other under-represented groups.
Introduction

Collection, Use and Disclosure of Personal Information

Personal information is collected under the authority of the University of Guelph Act (1964), and in accordance with Ontario's Freedom of Information and Protection of Privacy Act (FIPPA) http://www.e-laws.gov.on.ca/DB1_Laws/Statutes/English/90f31_e.htm. This information is used by University officials in order to carry out their authorized academic and administrative responsibilities and also to establish a relationship for alumni and development purposes. Certain personal information is disclosed to external agencies, including the Ontario Universities Application Centre, the Ministry of Advanced Education and Skills Development, and Statistics Canada, for statistical and planning purposes, and is disclosed to other individuals or organizations in accordance with the Office of Registrarial Services Departmental Policy on the Release of Student Information. For details on the use and disclosure of this information call the Office of Registrarial Services at the University at (519) 824-4120 or see https://www.uoguelph.ca/registrar/.

Statistics Canada - Notification of Disclosure

For further information, please see Statistics Canada's website at http://www.statcan.gc.ca and Section XIV Statistics Canada.

Address for University Communication

Depending on the nature and timing of the communication, the University may use one of these addresses to communicate with students. Students are, therefore, responsible for checking all of the following on a regular basis:

Email Address

The University issued email address is considered an official means of communication with the student and will be used for correspondence from the University. Students are responsible for monitoring their University-issued email account regularly.

Home Address

Students are responsible for maintaining a current mailing address with the University. Address changes can be made, in writing, through Registrarial Services.

Name Changes

The University of Guelph is committed to the integrity of its student records, therefore, each student is required to provide either on application for admission or on personal data forms required for registration, their complete, legal name. Any requests to change a name, by means of alteration, deletion, substitution or addition, must be accompanied by appropriate supporting documentation.

Student Confidentiality and Release of Student Information Policy Excerpt

The University undertakes to protect the privacy of each student and the confidentiality of their record. To this end the University shall refuse to disclose personal information to any person other than the individual to whom the information relates where disclosure would constitute an unjustified invasion of the personal privacy of that person or of any other individual. All members of the University community must respect the confidential nature of the student information which they acquire in the course of their work.

Complete policy at https://www.uoguelph.ca/secretariat/office-services/university-secretariat/university-policies.
## Learning Outcomes

### Graduate Degree Learning Outcomes

On May 27, 2013, the University of Guelph Senate approved the following five University-wide Learning Outcomes as the basis from which to guide the development of graduate degree programs, specializations and courses:

1. Critical and Creative Thinking
2. Literacy
3. Global Understanding
4. Communication
5. Professional and Ethical Behaviour

These learning outcomes are also intended to serve as a framework through which our educational expectations are clear to students and the broader public; and to inform the process of outcomes assessment through the quality assurance process (regular reviews) of programs and departments.

An on-line guide to the learning outcomes, links to the associated skills, and detailed rubrics designed to support the development and assessment of additional program and discipline-specific outcomes, are available for reference on the Learning Outcomes website.

### Critical and Creative Thinking

Critical and creative thinking is a concept in which one applies logical principles, after much inquiry and analysis, to solve problems with a high degree of innovation, divergent thinking and risk taking. Those mastering this outcome show evidence of integrating knowledge and applying this knowledge across disciplinary boundaries. Depth and breadth of understanding of disciplines is essential to this outcome. At the graduate level, originality in the application of knowledge (master’s) and undertaking of research (doctoral) is expected.

In addition, Critical and Creative Thinking includes, but is not limited to, the following outcomes: Independent Inquiry and Analysis; Problem Solving; Creativity; and Depth and Breadth of Understanding.

### Literacy

Literacy is the ability to extract information from a variety of resources, assess the quality and validity of the material, and use it to discover new knowledge. The comfort in using quantitative literacy also exists in this definition, as does using technology effectively and developing visual literacy.

In addition, Literacy includes, but is not limited to, the following outcomes: Information Literacy, Quantitative Literacy, Technological Literacy, and Visual Literacy.

### Global Understanding

Global understanding encompasses the knowledge of cultural similarities and differences, the context (historical, geographical, political and environmental) from which these arise, and how they are manifest in modern society. Global understanding is exercised as civic engagement, intercultural competence and the ability to understand an academic discipline outside of the domestic context.

In addition, Global Understanding includes, but is not limited to, the following outcomes: Global Understanding, Sense of Historical Development, Civic Knowledge and Engagement, and Intercultural Competence.

### Communication

Communication is the ability to interact effectively with a variety of individuals and groups, and convey information successfully in a variety of formats including oral and written communication. Communication also comprises attentiveness and listening, as well as reading comprehension. It includes the ability to communicate and synthesize information, arguments, and analyses accurately and reliably.

In addition, Communication includes, but is not limited to, the following outcomes: Oral Communication, Written Communication, Reading Comprehension, and Integrative Communication.

### Professional and Ethical Behaviour

Professional and ethical behaviour requires the ability to accomplish the tasks at hand with proficient skills in teamwork and leadership, while remembering ethical reasoning behind all decisions. The ability for organizational and time management skills is essential in bringing together all aspects of managing self and others. Academic integrity is central to mastery in this outcome. At the graduate level, intellectual independence is needed for professional and academic development and engagement.

In addition, Professional and Ethical Behaviour includes, but is not limited to, the following outcomes: Teamwork, Ethical Reasoning, Leadership, Personal Organization and Time Management, and Intellectual Independence.
# Table of Contents

<table>
<thead>
<tr>
<th>Environmental Sciences</th>
<th>82</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative Staff</td>
<td>82</td>
</tr>
<tr>
<td>Graduate Faculty</td>
<td>82</td>
</tr>
<tr>
<td>Associated Graduate Faculty</td>
<td>82</td>
</tr>
<tr>
<td>MSc Program</td>
<td>83</td>
</tr>
<tr>
<td>MES Program</td>
<td>83</td>
</tr>
<tr>
<td>PhD Program</td>
<td>83</td>
</tr>
<tr>
<td>Collaborative Specializations</td>
<td>83</td>
</tr>
<tr>
<td>Courses</td>
<td>84</td>
</tr>
</tbody>
</table>
Environmental Sciences

The School of Environmental Sciences offers program of study leading to MSc, MES, PhD, and Graduate Diploma degrees. Graduate Studies in the Environmental Sciences programs are designed to train people to work independently and imaginatively with a high level of technical skill and scientific acumen. It is expected that the graduates of the SES program will provide leadership in research and training in academic, government, and industrial sectors of society and who will participate in the formulation and implementation of constructive national and international science policy.

The PhD program has three fields of specialization: 1) earth and atmospheric sciences; 2) ecosystem science and biodiversity; and 3) plant and environmental health.

- Earth and Atmospheric Sciences – Research areas include: soil biology and soil physics, sedimentology, geobiology, soil chemistry, geochemistry, micrometeorology and air quality, soil and land resource management
- Ecosystem Science and Biodiversity – Research areas include: toxicology, pest management, management of agroecosystems, microbiology, forest systems, agroforestry, climate change biology, ecology, and insect systematics and taxonomy
- Plant & Environmental Health – Research areas include: plant biology, plant pathology, epidemiology, soil-plant interactions, biotechnology, molecular biology, forest systems, agroforestry, and climate change biology

Administrative Staff

Director, School of Environmental Sciences
Jon Warland (108 Alexander Hall, Ext. 56374)
jarward@uoguelph.ca

Associate Director, Graduate Studies, School of Environmental Sciences
Emmanuelle Arnaud (126 Alexander Hall, Ext. 58087)
grdchair@uoguelph.ca

Graduate Program Assistant
Jennifer LaPorte (275 Alexander Hall, Ext. 53937)

Graduate Faculty

Madhur Anand
BSc, PhD Western Ontario - Professor

Emmanuelle Arnaud
BA McMaster, MSc UBC, PhD McMaster - Associate Professor

Asim Biswas
BSc Bidhan Chandra, MSc Bangalore, PhD Saskatchewan - Assistant Professor

Michael A. Dixon
BSc, MSc Mount Allison, PhD Edinburgh - Professor

Kari Dunfield
BSc Calgary, MSc, PhD Saskatchewan - Associate Professor

Brandon Gilroyed
BSc Alberta, PhD Calgary - Assistant Professor

Susan Gasauer
BSc, MSc California, PhD Munich - Associate Professor

Paul H. Goodwin
BS Villanova, MSc Minnesota, PhD California (Davis) - Professor

Ernesto Guzman
DVM Mexico, MSc, PhD California (Davis) - Professor

Marc Habash
BSc Toronto, MSc Western, PhD Guelph - Associate Professor

Beverley Hale
BSc, MSc Toronto, PhD Guelph - Professor and Associate Dean (Research & Innovation), Ontario Agricultural College

Rebecca Hallett
BSc Toronto, MPM, PhD Simon Fraser - Professor

Richard J. Heck
BSA, MSc, PhD Saskatchewan - Associate Professor

Thomas Hsiang
BSc, MSc British Columbia, PhD Washington - Professor and Graduate Studies Coordinator

Shelley L. Hunt
BSc, PhD Guelph - Associate Professor and Director of the Arboretum

John D. Lauzon
BSc, MSc, PhD Guelph - Associate Professor

Hung Lee
BSc British Columbia, PhD McGill - Professor

James Longstaffe
BSc Western, MSc Dalhousie, PhD Toronto - Assistant Professor

Steven A. Marshall
BSc (Agr) Guelph, MSc Carleton, PhD Guelph - Professor

Ivan O’Halloran
BSc, MSc Guelph, PhD Saskatchewan - Associate Professor

Gard W. Otis
BS Duke, PhD Kansas - Professor

Gary W. Parkin
BSc, MSc Western, PhD Guelph - Associate Professor

Ryan Prosser
BEd Wollongong, BSc, PhD Guelph - Assistant Professor

Nigel Raine
BA, PhD Oxford - Professor

Neil Rooney
BSc, MSc Western Ontario - Assistant Professor

Jonathan M. Schmidt
BSc, PhD Toronto - Associate Professor and Associate Dean (Academic), Ontario Agricultural College

Cynthia D. Scott-Dupree
BSc Brandon, MPM, PhD Simon Fraser - Professor

Paul K. Sibley
BSc, MSc Guelph, PhD Waterloo - Professor

Laura Van Eerd
MSc, PhD Guelph - Associate Professor

R. Paul Voroney
BSc Calgary, MSc, PhD Saskatchewan - Professor

Claudia Wagner-Riddle
BSc, MSc Sao Paulo, PhD Guelph - Professor

Jon S. Warland
BSc Cornell, MSc UBC, PhD Guelph - Associate Professor and Acting Director, School of Environmental Sciences

Youbin Zheng
BSc, MSc South West Agricultural, MPhil, PhD Newcastle - Associate Professor

Associated Graduate Faculty

Pedro Antunes
BSc Evora, PhD Guelph - Associate Professor, Algoma University

Chris Cutler
BSc Memorial, MPM Simon Fraser, PhD Guelph - Associate Professor, Department of Agriculture, Dalhousie University

Deena Errampalli
MSc Banaras, MBA, Osmania, PhD Oklahoma - Research Scientist, AAFC, Vineland

Les Evans
BSc Southampton, PhD Wales - University Professor Emeritus, Environmental Sciences, University of Guelph

Terry Gillespie
BSc British Columbia, MA Toronto, PhD Guelph - Professor Emeritus, University of Guelph

Robert Gordon
BSc Guelph, MSc McGill, PhD Guelph - Vice President, Research, Wilfrid Laurier University

Pieter Groenevelt
BSc, MSc, PhD Wageningen - Professor Emeritus, Environmental Sciences, University of Guelph

Christopher Hall
BSc, MSc Guelph, PhD Alberta - Retired Faculty, Environmental Sciences, University of Guelph

Peter Kevan
BSc McGill, PhD Alberta - Professor Emeritus, Environmental Sciences, University of Guelph

Eric Krayenhoff
BSc., MSc Lethbridge, PhD British Columbia - Assistant Professor

David Kreutzweiser
BSc Lake Superior, MSc, PhD Laurentian - Research Scientist, Canadian Forest Service

Simon Lachance
BSc, MSc Laval, PhD Guelph - College Professor, Ridgetown Campus, University of Guelph

Merrin Macrae
BES, MSc York, PhD Wilfrid Laurier - Associate Professor, Geography and Environmental Management, University of Waterloo

Gary Parkin
Retired Faculty, Environmental Sciences, University of Guelph - BSc, MSc Western, PhD Guelph

Keith Solomon

2019-2020 Graduate Calendar

June 28, 2019
The objective of the MSc program is to develop and train graduate students that possess a high level of knowledge about the field of environmental science, expertise in specific aspects of environmental science (their thesis research focus), training in laboratory and field techniques, and excellence in writing and oral communication. With these skills, MSc students will possess a strong foundation on which they can be highly successful in science-related positions in government, industry, and consulting, or carry out high quality research at the PhD level.

Admission Requirements
The School’s admission standard for the MSc program is the same as the University and requires a four-year, honours science degree with a minimum B- (70-72%) average during the final two years (4 semesters) of full time undergraduate study. Meeting the minimum requirement (B-) does not guarantee entrance; depending on other criteria (e.g., letters of reference, standardized test scores, academic background relevant to the area to which the applicant has applied, degree of work experience in related fields of study) students may be considered for admission with provisional status. Students on provisional status must obtain a “B” average (70%) in at least two graduate courses during their first two semesters of study to continue in the program. Provisional students will be funded at the same level as regular students.

Program Requirements
The MSc thesis program requires:
• At least 1.5 graduate course credits, including one mandatory 0.50 credit course (Research Seminar in Environmental Sciences).
• Completion and defense of a thesis on research carried out under the direct supervision of a core faculty member.

MES Program
The MES (coursework Master’s) degree enables students to study the most recent theoretical and technical advances in the environmental sciences through multidisciplinary teaching and research. There are two options to the MES in Environmental Sciences: by coursework + research project and by coursework-only. The MES will promote critical thinking and enhance oral and written communication skills so that graduates can excel in industry, government and other sectors of civil society (e.g., environmental risk assessors/managers, political advisors on policy/law issues in government, senior positions in national and international agencies, etc.).

Admission Requirements
The School’s admission standard for the MES program is the same as the University and requires a four-year, honours science degree with a minimum B- (70-72%) average during the final two years (4 semesters) of full time undergraduate study. Meeting the minimum requirement (B-) does not guarantee entrance; depending on other criteria (e.g., letters of reference, standardized test scores, academic background relevant to the area to which the applicant has applied, degree of work experience in related fields of study) students may be considered for admission with provisional status. Students on provisional status must obtain a “B” average (70%) in at least two graduate courses during their first semester of study to continue in the program. Provisional students will be funded at the same level as regular students.

MES Program Requirements
Course Work and Major Research Project (MRP)
Candidates must complete a minimum of 4.0 credits
• ENV*6500 [1.0] The Environmental Science Research Project
• ENV*6501 F [0.5] Advanced Topics in Environmental Science
• ENV*6502 W [0.5] Seminar in Environmental Science
• Two additional credits from Environmental Sciences courses

The research project may be completed at the University or as part of a placement with an approved non-academic agency. The project may include analysis of a data set (derived from lab, field, or computer simulation) related to the specialization chosen by the student including analyses and interpretations of relevant data (the student may or may not be involved in collecting the data), or major, critical literature review. The outcome of the research project will be a written report and a seminar presented to the department.

Course Work
Candidates must complete a minimum of 4.0 credits
• ENV*6501 F [0.5] Advanced Topics in Environmental Science
• ENV*6502 W [0.5] Seminar in Environmental Science
• Three additional credits from Environmental Sciences courses

Students in either option may select courses from other departments on campus but are advised that access may be restricted and permission may be required by course instructors. A maximum of 1.0 credits may be taken from senior undergraduate courses, with permission of the Graduate Coordinator.

PhD Program
The PhD is offered in the following fields: 1) earth and atmospheric sciences; 2) ecosystems science and biodiversity; and 3) plant and environmental health. The objectives of the PhD program are to develop highly competent, independent, creative, and critical scientists. Doctoral students of the SES graduate program will provide leadership as scholars in academic institutions, as managers and officers in the industrial research and development sector, research and policy branches within the government sector and in other social institutions. Research in the PhD program is expected to be original and novel, contribute significantly to the relevant research field, and published in high-quality peer-reviewed journals.

Admission Requirements
Admission to the PhD program is generally restricted to students with a recognized MSc degree in a related field obtained with a minimum academic standing of “A-” (80%) in their postgraduate studies. Students who meet the minimum University requirement (73-76%) but not the School requirement (80%) may be considered depending on other criteria (e.g., letters of reference, standardized test scores, academic background relevant to the area to which the applicant has applied, degree of work experience in related field of study) for admission with provisional status. Students on provisional status must obtain an “A-” (80%) average in at least two graduate courses during their first two semesters of study to continue in the program. Provisional students will be funded at the same level as regular students. In exceptional cases, students may enter the PhD program directly from a BSc (Hons) if they have the minimum requirements as defined by the Office of Studies, University of Guelph.

Program Requirements
The PhD program requires:
• Completion of one mandatory 0.50 credit course (Research Seminar in Environmental Sciences).
• Successful completion of a qualifying exam within five semesters of first registration in the program.
• Successful defense of a thesis describing original research, carried out under the direct supervision of a core faculty member.

In the PhD program, the qualifying exam, thesis and the oral defense of the thesis are evaluated on a pass/fail basis. An acceptable PhD thesis consists of an authoritative report in the field of study involving intellectual property, it is recognized that publication may not always be “in-press”, one or more papers in peer-reviewed journals prior to the defense. In cases judged to be sufficiently meritorious to warrant publication in reputable, peer-reviewed journals in its field. PhD students are normally expected to have published, or have “in-press”, one or more papers in peer-reviewed journals prior to the defense. In cases involving intellectual property, it is recognized that publication may not always be immediately possible. In such cases, a Pass will require that the committee is satisfied that, in their opinion, the work is of sufficient quality and originality that it would meet the standards for peer-reviewed publications.

Collaborative Specializations
International Development Studies
The School of Environmental Sciences participates in the MSc collaborative specialization in International Development Studies.

Please consult the International Development Studies listing for a detailed description of this collaborative specialization.

June 28, 2019
Toxicology
The School of Environmental Sciences participates in the masters/doctoral collaborative specialization in toxicology. The faculty members' research and teaching expertise includes aspects of toxicology; they may serve as advisors for MSc and PhD students. Please consult the Toxicology listing for a detailed description of the masters/doctoral collaborative specialization.

Courses

**ENVS*6000 Physical Environment of Crops and Forests F [0.50]**
Recent literature on temperature, humidity, radiation, wind, gases and particles in crop and forest environments; evapotranspiration and photosynthesis of plant communities; modification of microclimates; applied micrometeorology.
Offering(s): Offered in even-numbered years.
Department(s): School of Environmental Sciences

**ENVS*6050 Micrometeorology W [0.50]**
Exchanges of mass, momentum and energy between the surface and the atmosphere will be studied in the context of larger-scale meteorology. Diffusion and turbulence in and above plant canopies will be examined from theoretical and practical perspectives. Topics include time-series analysis, micrometeorological measurement theory, and basic principles of atmospheric science.
Offering(s): Offered in even-numbered years.
Department(s): School of Environmental Sciences

**ENVS*6060 Meteorological Instrumentation W [0.50]**
Theoretical and practical aspects of electronic circuits, sensors, and equipment used in meteorological research.
Prerequisite(s): ENVS*4210 or equivalent
Department(s): School of Environmental Sciences

**ENVS*6190 Environmental Microbial Technology U [0.50]**
Current topics in selected areas of environmental microbial technology. An emphasis will be placed on the physiology and genetics of microorganisms useful in environmental biotechnology. The course involves extensive use of current journal articles.
Restriction(s): Undergraduate degree in microbiology or related discipline.
Department(s): School of Environmental Sciences

**ENVS*6242 Special Topics in Atmospheric Science F,W,S [0.50]**
Students will explore topics within atmospheric science such as climatology, animal biometeorology, air pollution meteorology, and hydrometeorology. Normally, an independent course of study will be developed with a faculty advisor and one or more students in the semester prior to enrollment. Occasionally, the course will be offered as a lecture/seminar in a particular area, to be advertised in the semester prior to offering. Typically, students will produce a major paper or scientific report.
Restriction(s): Instructor consent required.
Department(s): School of Environmental Sciences

**ENVS*6280 Soil Physics W [0.50]**
The soil as a physical system with special regard to soil water movement and the diffusion and dispersion of chemical substances. Numerical techniques and computer solutions will be developed.
Department(s): School of Environmental Sciences

**ENVS*6300 Quantitative Pedology F [0.50]**
Pedology considers the morphology, survey, geography, characterization and analysis, development, classification, and interpretation of soil. This course focuses on the quantification of pedology, employing modern digital instrumentation, computational capacity and analytical strategies. Students explore how such multi-scale, spatial-temporal information is used in critical zone modeling.
Prerequisite(s): At least an introductory soil, ecology or physical geography course.
Co-requisite(s): Students with only an introductory level soil course are encouraged to audit ENVS*4390.
Department(s): School of Environmental Sciences

**ENVS*6340 Colloquium in Insect Systematics W [0.25]**
Weekly discussions and seminars dealing with current topics in systematic entomology.
Offering(s): Offered in odd-numbered years.
Department(s): School of Environmental Sciences

**ENVS*6350 Soil Organic Matter and Biochemistry F [0.50]**
(1) Soil organic matter characterization, (2) dynamics of soil organic matter, (0.5) nutrient cycling.
Offering(s): Offered in odd-numbered years.
Department(s): School of Environmental Sciences

**ENVS*6360 Soils and Water Chemistry F [0.50]**
Thermodynamics of soil solutions; solution-solid phase equilibria; reaction kinetics; computer modelling of solute-mineral interactions.
Department(s): School of Environmental Sciences

**ENVS*6400 Soil Nitrogen Fertility and Crop Production W [0.50]**
Emphasis will be placed on soil N transformations and processes, and N sources for crops; field experimentation methods; environmental issues.
Department(s): School of Environmental Sciences

**ENVS*6440 Field Sampling Strategies and Geostatistics W [0.50]**
Concepts and practical aspects of collecting, synthesizing and interpreting data from spatially and temporally variable and/or correlated fields. Hands-on experience in describing spatial structure of large data sets (supplied by student or instructor) using available software.
Offering(s): Offered in even-numbered years.
Department(s): School of Environmental Sciences

**ENVS*6452 Special Topics in Ecosystem Science and Biodiversity F,W,S [0.50]**
Students will explore topics within ecosystem science such as terrestrial ecology, forest science, aquatic systems and environmental biology. Normally, an independent course of study will be developed with a faculty advisor and one or more students in the semester prior to enrollment. Occasionally, the course will be offered as a lecture/seminar in a particular area, to be advertised in the semester prior to offering. Typically, students will produce a major paper or scientific report.
Restriction(s): Instructor consent required.
Department(s): School of Environmental Sciences

**ENVS*6460 Environmental Remediation W [0.50]**
This course will discuss environmental remediation topics including, but not limited to, using plants, microorganisms and substrates (e.g., soil and engineered materials) to improve air, water and soil quality. For example, this course will explore the current sciences and technologies of living walls to improve indoor air quality, green roofs to manage storm water and air pollutants, and constructed wetlands to treat wastewater. Environmental remediation is, by nature, multidisciplinary, involving chemistry, physics, biology, engineering, landscape design, etc.
Department(s): School of Environmental Sciences

**ENVS*6470 The Science and Management of Multiple Stressors in the Great Lakes W [0.50]**
In this two-week lecture-field course, students will learn about historical and current environmental issues affecting the Great Lakes basin from the perspective of multiple stressors and their cumulative impacts. The importance of linking science and policy, and the role important of governments, are emphasized.
Restriction(s): Instructor consent required.
Department(s): School of Environmental Sciences

**ENVS*6500 Environmental Sciences Research Project U [1.00]**
A concise, critical review of an area of study related to the field chosen by the student including analyses and interpretation of relevant data. The project will be written in the form of a scientific paper and presented to the department as a seminar.
Restriction(s): Available only to students registered in the Environmental Sciences: MES program.
Department(s): School of Environmental Sciences

**ENVS*6501 Integrating Science and Policy in Environmental Science F [0.50]**
A case-study approach, based on current and historical issues, and involving presentations from faculty, professionals and students, will be used to develop an advanced understanding of current issues in the environmental sciences, including examination of the underlying science and management of the issues, and the effectiveness of associated policies.
Restriction(s): Preference will be given to students in the MES, ENVS.L.
Department(s): School of Environmental Sciences

**ENVS*6502 Seminar in Environmental Sciences W [0.50]**
This course will provide an interactive and critical forum for students to participate in an advanced discussion and debate on current environmental issues, and to learn about the practical skill set(s) required by various employment sectors in solving these issues.
Restriction(s): Instructor consent required. Preference will be given to students in the MES program.
Department(s): School of Environmental Sciences
### IX. Graduate Programs, Environmental Sciences

#### ENVS*6503 Biogeochemistry of Wetlands F [0.50]
This course is focused on the role of wetlands in maintaining healthy ecosystems and in controlling contaminant fluxes to water. Lectures complement field and laboratory assessments of wetlands to understand element biogeochemical cycles in these transitional environments. The course includes field trips to Ontario wetlands.

**Restriction(s):** Preference will be given to students in MES.ENVS:L, MSc.ENVS and PhD.ENVS.

**Department(s):** School of Environmental Sciences

#### ENVS*6505 Soil Survey and Interpretation S [0.50]
Students will learn concepts, techniques and analysis related to the characterization of soil in the landscape. Focus will be given to soilscapes encountered in southern Ontario. Course involves multiple field excursions to examine the distribution of soils in this region.

**Restriction(s):** Preference will be given to students in MES.ENVS:L, MSc.ENVS, PhD.ENVS

**Department(s):** School of Environmental Sciences

#### ENVS*6506 Forest Ecosystem Patterns and Processes S [0.50]
Students will learn concepts, techniques and analysis related to the ecological characterization of forests. Focus will be on southern and mid-central Ontario forests and will involve periodic excursions to various locations for the purpose of demonstrating theoretical principles, sampling techniques, in-field measurements, and collecting samples for in-lab assessment.

**Restriction(s):** Preference will be given to students in MES.ENVS:L, MSc.ENVS, PhD.ENVS

**Department(s):** School of Environmental Sciences

#### ENVS*6520 Pollinator Biology F [0.50]
The biology of pollinators will be discussed in lectures and seminars stressing fundamental and applied aspects. The honey bee will be used as the model system.

**Offering(s):** Offered in odd-numbered years.

**Department(s):** School of Environmental Sciences

#### ENVS*6530 Pollinator Conservation W [0.50]
In this course students will explore the ecology of pollination with an emphasis on the factors affecting declines in pollinating insects as well as potential mitigation strategies to ensure long-term stability of food production and maintenance of biodiverse wild plant communities. Offered in conjunction with ENVS*4070. Extra work is required of graduate students.

**Restriction(s):** Credit may be obtained for only one of ENVS*6530 or ENVS*4070.

**Department(s):** School of Environmental Sciences

#### ENVS*6540 Integrated Pest Management - Insects W [0.50]
Concepts associated with integrated pest management of insect pests of various plant hosts will be introduced to students in an interactive lecture and laboratory format. Experiential learning and skill development, associated with economic entomology, will also be emphasized.

**Offering(s):** Offered annually

**Restriction(s):** Credit may be obtained for only one of ENVS*6540 and ENVS*4100

**Department(s):** School of Environmental Sciences

#### ENVS*6550 Bioactivity and Metabolism of Insecticides W [0.50]
The basis of insecticide bioactivity will be examined, with emphasis on mode of action, structure-activity relationships and analytical methods. Students will choose a specific insecticide or class of insecticides as their primary topic of study for the semester. Students will participate in seminars, prepare a conference poster and complete a research paper.

**Offering(s):** Offered in even-numbered years.

**Department(s):** School of Environmental Sciences

#### ENVS*6560 Forest Ecosystem Dynamics F [0.50]
An exploration of energy flow and distribution in forest ecosystems. Both components will be examined in the context of biomass and productivity, perturbations and resilience. Some aspects of modelling will be covered.

**Offering(s):** Offered in odd-numbered years.

**Department(s):** School of Environmental Sciences

#### ENVS*6582 Special Topics in Soil Science F, W, S [0.50]
Students will explore topics within soil science such as soil physics, pedology, soil chemistry and microbiology. Normally, an independent course of study will be developed with a faculty advisor and one or more students in the semester prior to enrollment. Occasionally, the course will be offered as a lecture/seminar in a particular area, to be advertised in the semester prior to offering. Typically, students will produce a major paper or scientific report.

**Restriction(s):** Instructor consent required.

**Department(s):** School of Environmental Sciences

#### ENVS*6700 Glacial Sedimentary Environments U [0.50]
Students will learn about the processes and deposits of glacial environments as well as the use of sedimentary records to reconstruct past glacial environments. Case studies from modern to ancient glacial sedimentary environments will be used. Field trip included.

**Offering(s):** Offered only as needed

**Department(s):** School of Environmental Sciences

#### ENVS*6710 Advanced Sedimentology U [0.50]
Topics covered through case studies of sedimentary deposits and environments include facies analysis, large scale controls, and novel techniques in sedimentology. Topics may also include specific sedimentary environments or specific sedimentary deposits such as turbidites, cross-bedded strata or seismic sequences depending on student interest. (Offered only as needed)

**Offering(s):** Offered only as needed

**Department(s):** School of Environmental Sciences

#### ENVS*6720 Geology of Groundwater Systems W [0.50]
This course will examine the geological characteristics and processes that influence groundwater flow systems and contaminant transport and fate in different geological settings. The course will include seminar discussions of readings, guest speakers from industry and government agencies as well as hands-on exercises in class.

**Offering(s):** Offered in alternate years

**Department(s):** School of Environmental Sciences

#### ENVS*6730 Special Topics in Environmental Earth Science F, W, S [0.50]
Students will explore topics within environmental earth science such as glacial geology, environmental geophysics and hydrogeology. Normally, an independent course of study will be developed with a faculty advisor and one or more students in the semester prior to enrollment. Occasionally, the course will be offered as a lecture/seminar in a particular area, to be advertised in the semester prior to offering. Typically, students will produce a major paper or scientific report.

**Restriction(s):** Instructor consent required.

**Department(s):** School of Environmental Sciences

#### ENVS*6740 Environmental Organic Chemistry W [0.50]
This course explores the chemical processes that influence organic compounds in the environment. Topics discussed include: the transformation of anthropogenic organic contaminants, the form and function of natural organic matter, and analytical methods including compound specific stable isotope analysis and environmental nuclear magnetic resonance. Offered in conjunction with ENVS*4370. Extra work is required of graduate students.

**Restriction(s):** Credit may be obtained for only one of ENVS*6740 or ENVS*4370.

**Department(s):** School of Environmental Sciences

#### ENVS*6882 Special Topics in Plant and Environmental Health F, W, S [0.50]
Students will explore topics within plant and environmental health such as integrated pest management, apiculture and environmental microbiology. Normally, an independent course of study will be developed with a faculty advisor and one or more students in the semester prior to enrollment. Occasionally, the course will be offered as a lecture/seminar in a particular area, to be advertised in the semester prior to offering. Typically, students will produce a major paper or scientific report.

**Restriction(s):** Instructor consent required.

**Department(s):** School of Environmental Sciences

#### ENVS*6900 Research Seminar in Environmental Sciences F-W [0.50]
This course provides information and training in scientific presentations for thesis-based Environmental Sciences (ENVS) programs. Students will prepare a written research proposal and make an oral presentation of their proposed studies. Students are expected to complete this course in their second or third semester of study.

**Restriction(s):** Offered only to MSC.ENVS and PhD.ENVS students

**Department(s):** School of Environmental Sciences