FOR APPROVAL **PUBLIC** **OPEN SESSION**

TO: UTSC Academic Affairs Committee

SPONSOR: Prof. William A. Gough, Vice-Principal Academic and Dean
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PRESENTER: Prof. Mary T Silcox, Vice-Dean Graduate and Postdoctoral Studies
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DATE: February 2, 2022 for February 9, 2022

AGENDA ITEM: 4

ITEM IDENTIFICATION:

Minor Modifications: Graduate Curriculum Changes – Graduate Department of Physical and Environmental Sciences, UTSC

JURISDICTIONAL INFORMATION:

University of Toronto Scarborough Academic Affairs Committee (AAC) "is concerned with matters affecting the teaching, learning and research functions of the Campus" (*AAC Terms of Reference, Section 4*). Under section 5.6 of its terms of reference, the Committee is responsible for approval of "Major and minor modifications to existing degree programs." The AAC has responsibility for the approval of Major and Minor modifications to existing programs as defined by the University of Toronto Quality Assurance Process (*UTQAP, Section 3.1*).

GOVERNANCE PATH:

1. **UTSC Academic Affairs Committee [For Approval] (February 9, 2022)**

PREVIOUS ACTION TAKEN:

No previous action in governance has been taken on this item.

HIGHLIGHTS:

This package includes minor modifications to graduate curriculum, submitted by the Graduate Department of Physical and Environmental Sciences (GDPES), which require governance approval. Minor modifications to curriculum are understood as those that do not have a significant impact on program or course learning outcomes. They require governance approval when they modestly change the nature of a program or course.

The following changes are being made:

1. New Course: EES1139H Perspectives in Environmental Health: Mechanisms of Toxicity
   - The course fills gap in the current curriculum, specifically regarding more advanced interactions between environmental contaminants and human health, and mechanisms of toxicity associated with environmental and occupational exposure to chemicals. Especially for students enrolled in the PhD program (and the MSc program, once approved).
2. Course Change: EES1116Y Internship
   - The credit value is being changed from variable to fixed, with a credit weight of 2.0 FCE. In practice the course has had a fixed credit value of 2.0 FCE for many years. The course record is being revised to reflect this reality.
3. Course Change: EES1118H Fundamentals of Ecological Modelling
   - Revised course description and exclusions. A new undergraduate course - EESD28H3 - has been proposed that will be jointly offered with EES 1118H. The course description and exclusions for EES 1118H are being updated to reflect this change.
4. Course Change: EES1134H Climate Change Policy
   - Revised course description to provide students with a clearer idea of what the course covers.

There has been wide consultation within the GDPES.

FINANCIAL IMPLICATIONS:

There are no net implications to the campus operating budget.

RECOMMENDATION:

Be It Resolved,

THAT the proposed Graduate Department of Physical and Environmental Sciences graduate curriculum changes for the 2022-23 academic year, as detailed in the respective curriculum report, dated January 25, 2022, be approved.

DOCUMENTATION PROVIDED:

1. 2022-23 Curriculum Cycle: Graduate Minor Curriculum Modifications for Approval Report 1: Graduate Department of Physical and Environmental Sciences, dated January 25, 2022.

UNIVERSITY OF TORONTO SCARBOROUGH

2022-23 Curriculum Cycle
Graduate Curriculum Modifications for Approval
Report 1: Graduate Department of Physical and Environmental Sciences

January 25, 2022

Physical and Environmental Sciences (UTSC), Department of

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1 New Course:

EES1139H: Perspectives in Environmental Health: Mechanisms of Toxicity

Contact Hours:
Description: This course is designed to provide an in-depth understanding of the potential effects, on human health, of exposure to environmental contaminants and the underlying mechanisms of toxicity, with special attention to population groups bearing a disproportionate exposure burden. In this course, students will learn about methods used to investigate the health effects of environmental contaminants, and specific classes of environmental contaminants (sources, pathways of exposure, human health effects, mechanisms of toxicity). To understand the complexity of factors influencing environmental quality and health, students will work with real air quality data collected from various Canadian regions and will assess the interplay between the sociodemographic and built environment and levels of exposure to contaminants.
Prerequisites: At least one undergraduate course in each of the following areas: Introduction to Human Biology, or equivalent; Biological Determinants of Health, or equivalent; Introduction to Epidemiology, or equivalent, and; Environmental Health or Toxicology, or equivalent.
Corequisites:
Exclusions:
Recommended Preparation:
Enrolment Limits:
Note:
Learning Outcomes:
Topics Covered: Through lectures, case studies and a seminar, the course will cover these specific topics: 1) Methods for the evaluation of environmental health 2) Environmental exposure and vulnerability 3) Classes of contaminants: sources, pathways, health effects and mechanisms of toxicity Furthermore, students will become familiar with research that illustrates the role of interdisciplinary research in studying complex environmental health problematics.

Skills developed and fine-tuned by students in this course include: use of the scientific method; science communication; design a proposal, conduct research, interpret data and implement findings; interdisciplinary collaboration.

Methods of Assessment:
1. Bi-weekly quizzes (10% total)
2. Midterm test (25%)
3. Disparities in air quality report (35%): for this assignment, students will use the CANUE data portal to describe the air quality of two different postal codes in Canada by analyzing the levels of various air pollutants. They will also highlight at least three factors that might be associated with air quality in the selected postal codes (e.g., greenness, proximity to major roads, socio-economic status, etc)
4. Mechanisms of toxicity Seminar (30%): Students will select a peer-reviewed publication that investigated the mechanisms of toxicity of at least one environmental contaminants. During the seminar, the students will present their paper in a 20 minute presentation. Students will have to demonstrate their understanding of the study's objectives, methods used to investigate the mechanisms of toxicity of interest, and the significance of the results and conclusions.

Mode of Delivery:
In Class

Breadth Requirements:

Rationale:
This course is aimed at graduate students enrolled in the MEnvSc or PhD in Environmental Science programs (and will also be suitable for students in the proposed MSc in Environmental Science program, once it has been approved). It fills a gap in the current curriculum, specifically regarding more advanced interactions between environmental contaminants and human health, and mechanisms of toxicity associated with environmental and occupational exposure to chemicals. Especially for students enrolled in the PhD program (and the MSc program, once approved), this course will help fulfill the research mission of these programs by preparing the students to analyze complex environmental health issues from an interdisciplinary perspective. Furthermore, this new course will complement EES 1135H Environmental Change and Human Health.

Consultation:
There has been consultation with the Dalla Lana School of Public Health and the School of the Environment in November 2021 to ensure the proposed graduate course would not overlap with their other offerings in environmental health. Professors Clare Wiseman, Tanhum Yoreh (School of the Environment) and Aviv Shachak (DLSPH) fully support this new graduate course and do not foresee any problems in terms of overlapping.

Resources:
This course will be taught by existing faculty. The course will be lecture and seminar based requiring no additional budget for material or equipment.

3 Course Modifications:

EES1116Y: Internship

Credit Value
Previous: ~~Variable~~
New: Fixed

Fixed Credit Value
Previous:
New: 2.0

Rationale:
Although the course record shows that it has a variable credit value between 0.5 and 2.0 FCE, in practice the course has had a fixed credit value of 2.0 FCE for many years. The course record is being revised to reflect this reality. There are no impacts on the program requirements, which already indicate a credit value of 2.0 FCEs for this course.

Consultation:
Discussion of issue with members of DPES graduate administrative team - Oct 18, 2021
Approval of Graduate Chair October 23, 2021

Note: The issue of the fixed credit has been raised with and has the approval of both the DPES Graduate team and Graduate Chair.

Resources:
None

EES1118H: Fundamentals of Ecological Modelling

Description:

This course provides an introduction to the rapidly growing field of ecological and environmental modelling. Students will become familiar with most of the basic equations used to represent ecological processes. The course will also provide a comprehensive overview of the population and dynamic biogeochemical models; prey-predator, resource competition and eutrophication models will be used as illustrations. Emphasis will be placed on the rational model development, objective model evaluation and validation, extraction of the optimal complexity from complicated/intertwined ecological processes, explicit acknowledgment of the uncertainty in ecological forecasting and its implications for environmental management.

Jointly offered with EESD28H3

~~management.~~

Exclusions:
Previous:
New: EESD28H3

Rationale:
A new undergraduate course - EESD28H3 - has been proposed that will be jointly offered with EES 1118H. The course description and exclusions for EES 1118H are being updated to reflect this change.

Consultation:
Approved by the Graduate Department of Physical and Environmental Sciences:

Resources:
None

EES1134H: Climate Change Policy

Description:

Previous:
~~Students in this graduate course will pursue an understanding of the human dimensions of climate change, and the associated international, national and subnational policy responses. In the context of climate policy, it is important to understand why a topic that can be settled by science alone has been so heavily politicized and contested for more than two decades. An observer of policy making can easily notice that good science is not always followed by good policy. The aim of this course is to provide a framework for evaluating why climate change represents a major and difficult problem – socially, economically and environmentally, with differing perspectives on policy solutions. The course will follow a thematic approach, in an attempt to understand how climate change policy is made at various levels of governance, in different jurisdictions and institutional frameworks, and what kind of policies and policy instruments are employed. Overall, the course will try to provide a comprehensive approach to climate change policy, and will draw on both domestic and international examples and case studies, which will be illustrated with both unsuccessful and successful climate policies.~~

New:

All policy is climate change policy . The challenges and solutions for climate change span across society and the economy, which means that addressing the climate crisis requires transformative change to both eliminate greenhouse gas emissions

and adapt to the impacts of climate change. Global greenhouse gas emissions need to reduce rapidly in the next ten years and reach net zero around mid-century in order to have a chance of avoiding dangerous climate change. At the same time, climate change is exacerbating existing societal vulnerabilities and is having deep impacts across natural and social systems. This course focuses on the governance of the transformation necessary to address this crisis and covers theories behind and practical approaches to the multilevel governance of climate change. The course covers a range of public policy areas related to climate change mitigation and adaptation, including energy supply, energy use and demand, carbon markets and economic tools, food and agriculture, and transportation. In this course, students will learn about dealing with complexity in climate policy-making and the range of actors involved in climate change policy spanning multiple levels of government as well as non-state actors. The primary focus is on policy-making in Canada, but the course also incorporates international policy and global North case studies.

Rationale:
Course description revised to provide students with a clearer idea of what the course covers.

Consultation:
revised description reviewed and approved by the Chair, George Arhonditsis Dec 13, 2021

Resources:
None

2021-22 SGS Calendar: Physical and Environmental Sciences

Exported on June 14, 2021. For editing purposes only.

Physical and Environmental Sciences: Introduction

Faculty Affiliation

University of Toronto Scarborough (UTSC)

Degree Programs

Environmental Science

MEnvSc

- Fields:
  - Climate Change Impacts and Adaptation;
  - Conservation and Biodiversity;
  - Terrestrial and Aquatic Systems

PhD

- Concentrations:
  - Climate Change and the Environment;
  - Contaminant Flux;
  - Environmental Science in Transitional Economies;
  - Great Lakes Ecosystems;
  - Remediation and Restoration of Degraded Environmental Systems;
  - Urban Geoscience

Combined Degree Programs

- UTSC, Conservation and Biodiversity (Specialist), HBSc / MEnvSc
- UTSC, Environmental Biology (Specialist), HBSc / MEnvSc
- UTSC, Environmental Biology (Specialist Co-op), HBSc / MEnvSc
- UTSC, Environmental Chemistry (Specialist), HBSc / MEnvSc
- UTSC, Environmental Chemistry (Specialist Co-op), HBSc / MEnvSc
- UTSC, Environmental Geoscience (Specialist), HBSc / MEnvSc
- UTSC, Environmental Geoscience (Specialist Co-op), HBSc / MEnvSc
- UTSC, Environmental Physics (Specialist), HBSc / MEnvSc
- UTSC, Environmental Physics (Specialist Co-op), HBSc / MEnvSc
- UTSC, Integrative Biology (Specialist), HBSc / MEnvSc

Collaborative Specializations

The following collaborative specializations are available to students in the participating degree programs as listed below:

- Development Policy and Power
  - Environmental Science, MEnvSc
- Environmental Studies
  - Environmental Science, MEnvSc, PhD
- Environment and Health
  - Environmental Science, MEnvSc, PhD
- Food Studies
  - Environmental Science, PhD

Overview

The Graduate Department of Physical and Environmental Sciences offers opportunities for graduate studies in environmental science, leading to the degrees of **Master of Environmental Science** (MEnvSc) and **Doctor of Philosophy** (PhD) **in Environmental Science**.

Contact and Address

Web: www.utsc.utoronto.ca/gradpes
MEnvSc email: dpes-mesc-program@utsc.utoronto.ca
PhD email: dpes-phd-program@utsc.utoronto.ca
MEnvSc telephone: (416) 287-7205
PhD telephone: (416) 208-2910
Fax: (416) 287-7204

Graduate Department of Physical and Environmental Sciences
University of Toronto Scarborough
1265 Military Trail, EV254
Toronto, Ontario M1C 1A4
Canada

Physical and Environmental Sciences: Environmental Science MEnvSc

Master of Environmental Science

Program Description

The MEnvSc is a 12-month degree program committed to the development of well-trained practitioners in environmental science in all fields, primarily to meet the needs of industry, governments, and environmental policy/education organizations.

The MEnvSc offers three enrolment options — research, internship, and part-time studies — in each of the three fields. The three designated fields of study are:

- **Climate Change Impacts and Adaptation**: Students are trained in the science, data analysis, and rigorous assessment process for the impacts of climate change on a wide range of natural and human systems.
- **Conservation and Biodiversity**: A major focus is the application of ecological theory and principles to real-world conservation challenges.
- **Terrestrial and Aquatic Systems**: A major focus is understanding the flux of contaminants and excess nutrients through surface and sub-surface environments and the methods/solutions needed to remediate contaminated or damaged environmental systems.

In all three fields, students can opt for an internship or a research option after eight months of coursework. The Department of Physical and Environmental Sciences has the support of two dedicated internship coordinators who help students find and successfully complete an internship by providing them with professional skills training and in-class workshops on topics that include job search preparation and skills such as: environmental labour market, workplace expectations, professionalism, networking, and more. The MEnvSc program works closely with a broad employer base for internship opportunities. Research-stream MEnvSc students receive intensive and individualized academic and research support from mentors of their choice.

Full-time and part-time study options are available in all fields of study.

Field: Climate Change Impacts and Adaptation

Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy the Graduate Department of Physical and Environmental Sciences' additional admission requirements stated below.
- Applicants whose primary language is not English and who graduated from a university where the language of instruction and examination was not English must demonstrate proficiency in English. See General Regulations section 4.3 for requirements.
- A minimum mid-B grade average in the last two years of the undergraduate program.
- Applicants must submit a written statement explaining their objectives for entering the program and the suitability of their background. Appropriate post-graduate work experiences will be considered as part of the admission application.

- A science or engineering undergraduate degree including at least two half courses or one full course in each of chemistry, physics, calculus, and biology.

Program Requirements

- **Coursework** consists of **5.5 full-course equivalents (FCEs)** as follows:
  - EES1100H *Advanced Seminar in Environmental Science* (0.5 FCE)
  - EES1117H *Climate Change Impact Assessment* (0.5 FCE)
  - EES1132H *Climate Data Analysis* (0.5 FCE).
    - Note: students who have completed EESD21H3 as part of their undergraduate degree, and achieved a minimum grade of 70%, should replace EES1132H with another elective graduate course of the same credit weight (0.5 FCE).
  - EES1133H *Climate Change Science and Modelling* (0.5 FCE)
  - Completion of two of the following three courses:
    - EES1131H *Applied Climatology* (0.5 FCE)
      - Note: students who have completed EESD31H3 as part of their undergraduate degree, and achieved a minimum grade of 70%, cannot complete EES1131H as part of the MEnvSc program; they should complete EES1134H and EES1136H.
    - EES1134H *Climate Change Policy* (0.5 FCE)
    - EES1136H *Climate Change Adaptation* (0.5 FCE)
  - Completion of either:
    - 0.5 FCE in elective courses (see course list) and 2.0 FCEs for the internship (EES1116Y), **or**
    - 1.0 FCE in elective courses (see course list) and 1.5 FCEs for the research paper (EES1101Y). Students planning to complete the research paper option must complete the prerequisite (EES1114H).
- Students will choose either a research or internship option.
  - **Research option:** Each student is required to have a research supervisor. For full-time students, the intensive research necessary for the research paper will normally be completed in the final Summer session. The final research paper needs to be written in scientific journal format and will be presented and defended orally in front of an examination committee. The committee will include the supervisor and two other members of the graduate faculty.
  - **Internship option:** For full-time students, the internship in private industry, government, or a non-governmental organization (NGO) will normally be completed in the final Summer session. It will consist of a minimum of four consecutive months. Successful completion of the internship is based on an assessment completed by the student's work supervisor, the satisfactory completion of a written experience report, and the satisfactory completion and presentation of a poster highlighting the internship experience.
- A final grade below 70% in any course equates to an FZ, which is an insufficient grade. A MEnvSc student who receives more than one final grade of FZ (i.e., two or more) will be recommended for termination of registration from the MEnvSc program.

Program Length

3 sessions full-time (typical registration sequence: F/W/S);
6 sessions part-time

Time Limit

3 years full-time;
6 years part-time

Field: Conservation and Biodiversity

Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy the Graduate Department of Physical and Environmental Sciences' additional admission requirements stated below.
- Applicants whose primary language is not English and who graduated from a university where the language of instruction and examination was not English must demonstrate proficiency in English. See General Regulations section 4.3 for requirements.
- A minimum mid-B grade average in the last two years of the undergraduate program.
- Applicants must submit a written statement explaining their objectives for entering the program and the suitability of their background. Appropriate post-graduate work experiences will be considered as part of the admission application.
- An undergraduate degree in biology or a closely related field, and successful completion of an undergraduate course in conservation biology. Students who have not successfully completed an undergraduate course in conservation biology will be required to complete an undergraduate course, BIOC63H3 *Conservation Biology* (0.5 FCE), as an extra (EXT) course.

Program Requirements

- **Coursework** consists of **5.5 full-course equivalents (FCEs)** as follows:
  - EES1100H *Advanced Seminar in Environmental Science* (0.5 FCE)
  - EES3000H *Applied Conservation Biology* (0.5 FCE)
  - EES3001H *Professional Scientific Literacy* (0.5 FCE)
  - EES3002H *Conservation Policy* (0.5 FCE)
  - EES3003H *Topics in Applied Biodiversity* (0.5 FCE)
  - Completion of either:
    - 1.0 FCE in elective courses (see the course list) and 2.0 FCEs for the internship (EES1116Y) **or**
    - 1.5 FCEs in elective courses (see the course list) and 1.5 FCEs for the research paper (EES1101Y).
- Students will choose either a research or internship option.
  - **Research option:** Each student is required to have a research supervisor. For full-time students, the intensive research necessary for the research paper will normally be completed in the final Summer session. The final research paper needs to be written in scientific journal format and will be presented

and defended orally in front of an examination committee. The committee will include the supervisor and two other members of the graduate faculty.
    - **Internship option:** For full-time students, the internship in private industry, government, or a non-governmental organization (NGO) will normally be completed in the final Summer session. It will consist of a minimum of four consecutive months. Successful completion of the internship is based on an assessment completed by the student's work supervisor, the satisfactory completion of a written experience report, and the satisfactory completion and presentation of a poster highlighting the internship experience.
- A final grade below 70% in any course equates to an FZ, which is an insufficient grade. A MEnvSc student who receives more than one final grade of FZ (i.e., two or more) will be recommended for termination of registration from the MEnvSc program.

Program Length

3 sessions full-time (typical registration sequence: F/W/S);
6 sessions part-time

Time Limit

3 years full-time;
6 years part-time

Field: Terrestrial and Aquatic Systems

Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy the Graduate Department of Physical and Environmental Sciences' additional admission requirements stated below.
- Applicants whose primary language is not English, and who graduated from a university where the language of instruction and examination was not English, must demonstrate proficiency in English. See General Regulations section 4.3 for requirements.
- A minimum mid-B grade average in the last two years of the undergraduate program.
- Applicants must submit a written statement explaining their objectives for entering the program and the suitability of their background. Appropriate post-graduate work experiences will be considered as part of the admission application.
- A science or engineering undergraduate degree including at least two half courses or one full course in each of chemistry, physics, calculus, and biology.

Program Requirements

- **Coursework** consists of **5.5 full-course equivalents (FCEs)** as follows:
    - EES1100H *Advanced Seminar in Environmental Science* (0.5 FCE)

- Complete either:
  - 3.0 FCEs in elective courses (see the course list) and 2.0 FCEs for the internship (EES1116Y) **or**
  - 3.5 FCEs in elective courses (see the course list) and 1.5 FCEs for the research paper (EES1101Y). Students planning to complete the research paper option must complete the prerequisite EES1114H.
- Students will choose either a research or internship option.
  - **Research option:** Each student is required to have a research supervisor. For full-time students, the intensive research necessary for the research paper will normally be completed in the final Summer session. The final research paper needs to be written in scientific journal format and will be presented and defended orally in front of an examination committee. The committee will include the supervisor and two other members of the graduate faculty.
  - **Internship option:** For full-time students, the internship in private industry, government, or a non-governmental organization (NGO) will normally be completed in the final Summer session. It will consist of a minimum of four consecutive months. Successful completion of the internship is based on an assessment completed by the student's work supervisor, the satisfactory completion of a written experience report, and the satisfactory completion and presentation of a poster highlighting the internship experience.
- A final grade below 70% in any course equates to an FZ, which is an insufficient grade. A MEnvSc student who receives more than one final grade of FZ (i.e., two or more) will be recommended for termination of registration from the MEnvSc program.

Program Length

3 sessions full-time (typical registration sequence: F/W/S);
6 sessions part-time

Time Limit

3 years full-time;
6 years part-time

Physical and Environmental Sciences: Environmental Science MEnvSc Courses

Please note that not all courses are offered every year.

EES1100H	Advanced Seminar in Environmental Science
EES1101Y	Research Paper in Environmental Science
EES1102H	Analytical Chemistry for Geoscientists
EES1103H	Field Measurements and Sampling: The Essentials
EES1104H	Microorganisms and the Environment

EES1105H	Soil Contamination Chemistry
EES1106H	Geological Evolution and Environmental History of North America
EES1108H	Environmental Science Field Camp
EES1109H	Advanced Techniques in Geographic Information Systems
EES1111H	Freshwater Ecology and Biomonitoring
EES1112H	Boundary Layer Climates and Contaminant Fate
EES1113H	Groundwater Hydrochemistry and Contaminant Transport
EES1114H	Directed Readings in Environmental Science I
EES1115H	Directed Readings in Environmental Science II
EES1116Y	Internship
EES1117H	Climate Change Impact Assessment
EES1118H	Fundamentals of Ecological Modelling (exclusion: EESD28H3)
EES1119H	Quantitative Environmental Analysis
EES1120H	Fluid Dynamics of Contaminant Transport
EES1121H	Modelling the Fate of Organic Chemicals in the Environment
EES1122H	Global Environmental Security and Sustainable Development
EES1123H	Environmental Regulations
EES1124H	Environmental Project Management
EES1125H	Contaminated Site Remediation
EES1126H	Hydrology and Watershed Management
EES1127H	Applied Biogeochemistry and Geomicrobiology
EES1128H	Biophysical Interactions in Managed Environments
EES1129H	Brownfields Redevelopment
EES1130H	Ontario BioGeospheres Field Course
EES1131H	Applied Climatology (exclusion: EESD31H3)
EES1132H	Climate Data Analysis (exclusion: EESD21H3)
EES1133H	Climate Change Science and Modelling

EES1134H	Climate Change Policy
EES1135H	Environmental Change and Human Health
EES1136H	Climate Change Adaptation
EES1137H	Quantitative Applications for Data Analysis
EES1701H	Environmental Legislation and Policy
EES1704H	Environmental Risk Assessment
EES3000H	Applied Conservation Biology
EES3001H	Professional Scientific Literacy
EES3002H	Conservation Policy
EES3003H	Topics in Applied Biodiversity
EES3111H	Conservation Genetics
EES3113H	Topics in Population and Community Ecology
EES3114H	Topics in Urban and Rural Ecology
EES4001H	Internship Training 1 (restricted to students enrolled in one of the approved combined degree programs with the MEnvSc)
EES4003H	Academic Training 1 (restricted to students enrolled in one of the approved combined degree programs with the MEnvSc)

Physical and Environmental Sciences: Environmental Science PhD

Doctor of Philosophy

Program Description

Research and teaching are focused on the interfaces between traditional disciplines in dealing with fundamental scientific issues. Faculty members are cross-appointed from several departments including: chemistry, earth sciences, geography, ecology and evolutionary biology, cell and systems biology, engineering, forestry, physics, and social sciences. Research is clustered into six major concentrations:

- Climate Change and the Environment
- Contaminant Flux
- Environmental Science in Transitional Economies
- Great Lakes Ecosystems

- Remediation and Restoration of Degraded Environmental Systems
- Urban Geoscience

Applicants may be accepted into the PhD program via one of three routes: 1) following completion of an appropriate master's degree; 2) transfer from an appropriate master's program; or 3) direct entry following completion of an appropriate BSc degree.

PhD Program

Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy the Graduate Department of Physical and Environmental Sciences' additional admission requirements stated below.
- Applicants may be accepted into the PhD program:
  - Following completion of the MEnvSc degree, an MSc degree in environmental science, or a related discipline, or the MASc degree in environmental engineering or related discipline, or equivalent from a recognized university with a minimum of B+ average in all work completed in the master's program.
  - By requesting transfer from a suitable master's program (see above); students may reclassify from the master's program after 12 months of full-time study. Transfer from the MEnvSc program is not permitted

Program Requirements

- **Coursework.** A total of **2.0 full-course equivalents (FCEs)** as follows:
  - A mandatory 0.5 FCE (EES2200H *Advanced Seminar in Environmental Science*) plus 1.5 FCEs to provide background for the student's research. Courses selected must be approved by the student's supervisor and the Graduate Chair. In some cases, additional courses may be required if a student's preparedness is assessed as being insufficient.
  - Students may apply to take a number of PhD-level courses taught by the core faculty, both within the Graduate Department of Physical and Environmental Sciences and outside the Graduate Department of Physical and Environmental Sciences as part of their 1.5 FCEs for the degree. However, all courses for the PhD degree must be approved by the student's supervisor and the Graduate Chair.
- **Thesis.** The execution of an original piece of research in environmental science carried out under faculty supervision and presented in thesis form. The program requires the development and submission of a thesis proposal, and its examination in an oral thesis proposal appraisal (before the end of Year 2), a departmental oral examination of the completed thesis, and a Doctoral Final Oral Examination (FOE) carried out under the auspices of the School of Graduate Studies (SGS) involving examination by an appropriate at-arms-length external examiner.
  - The PhD proposal appraisal consists of a 20-minute presentation given by the student on the proposed thesis work followed by a question period where the student is examined on their proposal and their

mastery of concepts in environmental science. The emphasis will be on the theory and proposed approach, rather than on progress to date. A negative outcome requires that the student retake the exam within four months after incorporating recommendations from the committee for improving the thesis research proposal. The outcome of the second exam will be either a pass or withdrawal from the program.

- The Graduate Department of Physical and Environmental Sciences' PhD program requires that all PhD candidates complete two thesis defences: a Departmental Thesis Defence and an FOE with SGS. Normally, the Departmental Thesis Defence will be held at least eight weeks prior to the FOE. The committee will notify the Graduate Chair that the thesis is ready to be forwarded to SGS for the FOE. If the PhD candidate does not pass the Departmental Thesis Defence, the committee may recommend that the PhD candidate postpone their FOE.

Program Length

4 years full-time; 5 years transfer-from-master's

Time Limit

6 years full-time; 7 years transfer-from-master's

PhD Program (Direct-Entry)

Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy the Graduate Department of Physical and Environmental Sciences' additional admission requirements stated below.
- In the case of exceptional students, applicants may be accepted into the PhD program by direct entry; that is, after completing an honours BSc degree in a related discipline with a minimum University of Toronto average of A– or equivalent.

Program Requirements

- **Coursework.** A total of **3.0 full-course equivalents (FCEs)** as follows:
  - A mandatory 0.5 FCE (EES2200H *Advanced Seminar in Environmental Science*) plus 2.5 FCEs to provide background for the student's research. Courses selected must be approved by the student's supervisor and the Graduate Chair. In some cases, additional courses may be required if a student's preparedness is assessed as being insufficient.
  - Students may apply to take a number of PhD-level courses taught by the core faculty, both within the Graduate Department of Physical and Environmental Sciences and outside the Graduate Department of Physical and Environmental Sciences as part of their 2.5 FCEs for the degree. However, all courses for the PhD degree must be approved by the student's supervisor and the Graduate Chair.

- **Thesis.** The execution of an original piece of research in environmental science carried out under faculty supervision and presented in thesis form. The program requires the development and submission of a thesis proposal, and its examination in an oral thesis proposal appraisal (before the end of Year 2), a departmental oral examination of the completed thesis, and a Doctoral Final Oral Examination (FOE) carried out under the auspices of the School of Graduate Studies (SGS) involving examination by an appropriate at-arms-length external examiner.
  - The PhD proposal appraisal consists of a 20-minute presentation given by the student on the proposed thesis work followed by a question period where the student is examined on their proposal and their mastery of concepts in environmental science. The emphasis will be on the theory and proposed approach, rather than on progress to date. A negative outcome requires that the student retake the exam within four months after incorporating recommendations from the committee for improving the thesis research proposal. The outcome of the second exam will be either a pass or withdrawal from the program.
  - The Graduate Department of Physical and Environmental Sciences' PhD program requires that all PhD candidates complete two thesis defences: a Departmental Thesis Defence and an FOE with SGS. Normally, the Departmental Thesis Defence will be held at least eight weeks prior to the FOE. The committee will notify the Graduate Chair that the thesis is ready to be forwarded to SGS for the FOE. If the PhD candidate does not pass the Departmental Thesis Defence, the committee may recommend that the PhD candidate postpone their FOE.

Program Length

5 years full-time

Time Limit

7 years full-time

Physical and Environmental Sciences: Environmental Science PhD Courses

Core Course

EES2200H	Advanced Seminar in Environmental Science

The following are courses offered within the Department of Physical and Environmental Sciences. With the approval of the Graduate Chair, relevant courses from other graduate departments can be applied to the required full-course equivalents. Not all courses are offered every year.

Elective Courses

EES1102H	Analytical Chemistry for Geoscientists

EES1103H	Field Measurements and Sampling: The Essentials
EES1104H	Microorganisms and the Environment
EES1105H	Soil Contamination Chemistry
EES1106H	Geological Evolution and Environmental History of North America
EES1109H	Advanced Techniques in Geographic Information Systems
EES1111H	Freshwater Ecology and Biomonitoring
EES1112H	Boundary Layer Climates and Contaminant Fate
EES1113H	Groundwater Hydrochemistry and Contaminant Transport
EES1117H	Climate Change Impact Assessment
EES1118H	Fundamentals of Ecological Modelling
EES1119H	Quantitative Environmental Analysis
EES1120H	Fluid Dynamics of Contaminant Transport
EES1121H	Modeling the Fate of Organic Chemicals in the Environment
EES1122H	Global Environmental Security and Sustainable Development
EES1126H	Hydrology and Watershed Management
EES1127H	Applied Biogeochemistry and Geomicrobiology
EES1128H	Biophysical Interactions in Managed Environments
EES1131H	Applied Climatology (exclusion: EESD31H3)
EES1132H	Climate Data Analysis (exclusion: EESD21H3)
EES1133H	Climate Change Science and Modelling
EES1134H	Climate Change Policy
EES1135H	Environmental Change and Human Health
EES1136H	Climate Change Adaptation
EES1137H	Quantitative Applications for Data Analysis
EES1139H	Perspectives in Environmental Health: Mechanisms of Toxicity
EES2201H	Advanced Readings in Environmental Science
EES3000H	Applied Conservation Biology

EES3001H	Professional Scientific Literacy
EES3002H	Conservation Policy
EES3003H	Topics in Applied Biodiversity
EES3111H	Conservation Genetics
EES3113H	Topics in Population and Community Ecology
EES3114H	Topics in Urban and Rural Ecology