UNIVERSITY OF TORONTO SCARBOROUGH

OFFICE OF THE CAMPUS COUNCIL

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

TO: UTSC Academic Affairs Committee

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DATE: March 16, 2022 for March 23, 2022

AGENDA ITEM: 6

ITEM IDENTIFICATION:

Minor Modifications: Undergraduate Curriculum Changes, 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, 2021, 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] (March 23, 2022)**

PREVIOUS ACTION TAKEN:

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

HIGHLIGHTS:

This package includes minor modifications to the undergraduate curriculum, submitted by the UTSC Sciences academic units identified below, 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 Department of Biological Sciences (Report: Department of Biological Sciences)
    - 3 new courses
        - BIOB20H3: Introduction to Computational Biology
        - BIOC29H3: Introductory Mycology
        - BIOC70H3: An Introduction to Bias in the Sciences
- The Department of Physical and Environmental Sciences (Report: Department of Physical and Environmental Sciences)
    - 5 new courses
        - EESC25H3: Urban Climatology
        - EESD28H3: Fundamentals of Environmental Modelling
        - ESTB04H3: Addressing the Climate Crisis
        - ESTC40H3: Technical Methods for Climate Change Mitigation
        - ESTD20H3: Integrated Natural Resource and Climate Change Governance

FINANCIAL IMPLICATIONS:

There are no significant financial implications to the campus operating budget.

RECOMMENDATION:

Be It Resolved,

THAT the proposed Sciences undergraduate curriculum changes for the 2022-23 academic year, as detailed in the respective curriculum reports, dated March 23, 2022, be approved.

DOCUMENTATION PROVIDED:

1. 2022-23 Curriculum Cycle Undergraduate Minor Curriculum Modifications for Approval Report: Department of Biological Sciences, dated March 23, 2022.

2. 2022-23 Curriculum Cycle Undergraduate Minor Curriculum Modifications for Approval Report: Department of Physical and Environmental Sciences, dated March 23, 2022.

2022-23 Curriculum Cycle
Undergraduate Minor Curriculum Modifications for Approval
Report: Department of Biological Sciences

March 23, 20222

Biological Sciences (UTSC), Department of

3 New Courses:

BIOB20H3: Introduction to Computational Biology

Description:

This course explains the fundamental methods of quantitative reasoning, with applications in medicine, natural sciences, ecology and evolutionary biology. It covers the major aspects of statistics by working through concrete biological problems. The course will help students develop an understanding of key concepts through computer simulations, problem solving and interactive data visualisation using the R programming language (no prior skills with R or specialized math concepts are required).

Prerequisites: BIOA01H3 and BIOA02H3

Exclusions: BIO259H5

Learning Outcomes:

Upon completion of the course, students will be able to:

1. Define the types of randomness
2. Describe common statistical tests
3. Justify the use of common statistical distributions
4. Explain the two major approaches to statistics
5. Communicate numerical information with graphics
6. Use common functions of the R programming language
7. Write Monte Carlo computer programs
8. Conduct random polls and double-blind experiments
9. Criticize experimental protocols in medicine and biology
10. Discuss the validity of scientific experiments
11. Design analyses to answer scientific questions
12. Relate inference strategies to major scientific theories
13. Frame quantitative problems with partial information
14. Reflect on the limits of personal and scientific knowledge

This course will generally reinforce and carry forward the program-level learning outcomes (PLOs). For instance, the course naturally builds around the outcome “Utilize and develop basic computational tools to analyze biological data”, a PLO shared by the Specialist Programs in Integrative Biology and Molecular Biology and Biotechnology programs. It also represents a cornerstone to achieve degree-level learning outcomes, such as “Apply quantitative reasoning and scientific principles to describe or explain phenomena in the natural world and to conserving the diversity of life”.

Topics Covered:

The course consists of 20–30 minute video lectures to watch alone, and in-class (or online) session of 2 hours where the students solve an exercise with the instructor. The sessions with the instructor follow a "flipped classroom" approach. There will be a synchronous online broadcast alongside the in-class component, allowing students to attend online or in person.
The exercises are based on key experiments or datasets in biology. The resolution will take the following approach: 1) frame the question in a quantitative way, 2) formulate hypotheses 3) write a computer program to model the random outcomes under different hypotheses 4) compare expectations with observations and conclude.
Example #1: In the class on randomized clinical trials, students discuss the double-blind design, then 1) they agree on an observable outcome — e.g., the difference in COVID-19-positive between placebo and vaccinated participants — 2) they postulate that there is no difference 3) they use R to randomize the results and see what the plausible differences are under their hypothesis 4) they compare the true difference to expectations and conclude about the validity of their hypothesis.
Example #2: In the class on circadian rhythms, students discuss the data of Seymour Benzer on fly hatching in constant darkness, then 1) they agree on an observable outcome — e.g., the number of flies hatching in the morning — 2) they postulate that hatching can occur at any time, 3) they use R to randomize the results and see what the plausible amounts are under their hypothesis or 4) they compare the true amount to expectations and conclude about the validity of their hypothesis.
The main themes covered by this program include statistical distributions (uniform, binomial, Poisson, Gaussian, Gamma / chi-square), statistical tests (chi-square, Student's t, Wilcoxon, Pearson, Fisher-Snedecor, Kaplan-Meier), the classical approach, the Bayesian approach, p-values, confidence intervals, posterior distributions.
In addition, the program introduces the biomedical notions of randomized clinical trials, circadian rhythms, Mendelian genetics, mutations and evolution, ATP metabolism, memory and free will, the genetic code and translation, atmospheric CO_2, trinucleotide repeat disorders, microbiome ecology, population genetics and cancer.
Week 1: Random shuffling's / randomized clinical trials
Week 2: The uniform distribution / circadian rhythms
Week 3: The binomial distribution / Mendelian genetics
Week 4: The Poisson distribution / mutations and evolution
Week 5: The Gaussian distribution / ATP metabolism
Week 6: The Gamma distribution / memory
Week 7: The Chi-square test / the genetic code
Week 8: Correlation test / atmospheric CO_2
Week 9: The Wilcoxon test / trinucleotide repeat disorders
Week 10: Student's t test / microbiome ecology
Week 11: Analysis of variance / human gene flow
Week 12: Survival tests / cancer therapies

Methods of Assessment:
1. Weekly low-stakes quizzes to reinforce the acquisition of the concepts (cumulated weight 15%).
2. Weekly reflection questions — follow-up questions from the in-class exercises — to reinforce the ability to use the new concepts on practical cases (cumulated weight 15%).
3. Take-home midterm exam with some questions to test understanding and a problem on the model of the course (e.g., twin studies to determine if schizophrenia is genetic) in order to recognize and apply the solving pattern (30%)
4. Take-home final exam to solve harder problems — with fewer instructions — on the model of the course and criticize given protocols (40%)

The weekly quizzes support learning outcomes 1–3, the weekly questions of reflection support learning outcomes 3–7, the midterm exam supports learning outcomes 3–10 and the final exams support learning outcomes 5–14.

Mode of Delivery: Hybrid

Breadth Requirements: Quantitative Reasoning

Rationale:
This course fills a gap in the department's curriculum where quantitative/probabilistic thinking is underdeveloped. It adds a new focus to the slate of courses at UTSC that encourage quantitative thinking. This course builds on the democratization of programming in the last 15–20 years to replace formulas with simulated concrete events, thus, exploring a new way to teach statistical reasoning in biology. In addition, this course will lay a solid foundational basis for advanced D-level courses in the biology curriculum, such as BIOD25H3, BIOD59H3 and BIOD98H3. Finally, the skills developed in the course are helpful for the broad mindset that biology programs strive to instill in students.
The course has been marked Hybrid because it will be simultaneously in-person and broadcasted online. Students will choose to attend one way or another. The purpose is to make the course more accessible to students and allow higher enrollments. The theoretical content will be pre-recorded videos that the students must watch before the lectures. Students

will solve problems in front of their computers during the lectures, receiving occasional guidance from the instructor. This is a computer-based problem-solving approach. For some students, learning will be easier at home (better setup at home, disabilities, commuting constraints etc.). Assessments would also be completed online.

Consultation:
DCC Approval: September 10, 2021
RO Approval: September 15, 2021

Resources:
The course will be taught by Dr. Guillaume Filion, a full-time faculty member in the department, as part of his regular teaching load. The course will require 70 hours of TA support. The TA funds will be covered by the departments existing budget. No additional space/infrastructure/equipment is needed.

BIOC29H3: Introductory Mycology

Description:

This course will lead students through an exploration of the Kingdom of Fungi, covering topics in biodiversity, ecology, and evolution. Lectures will also discuss the broad application of fungi in agriculture, industry, medicine, and visual arts. In the laboratory sessions, students will learn to observe, isolate, and identify fungi using microscopy and modern biological techniques. Field trips will be opportunities to observe fungi in their native habitats and to discuss the real-world applications of diverse fungal organisms.

Prerequisites: BIOB50H3 and BIOB51H3

Enrolment Limits: 48

Learning Outcomes:
Upon the completion of this course, students will be able to:
a. Recognize fungi and expand their general knowledge of natural science and biodiversity
b. Categorize fungi in the natural environment and illustrate various roles of fungi in nature and modern society
c. Use technical skills to isolate fungal species from the field
d. Apply molecular barcoding techniques to identify fungal species.
e. Develop writing and presentation skills in the class.

Topics Covered:
Lecture topics:
a. Introduction: fungi in the history, present, and future
b. Fungal Kingdom: what are fungi, and how do we study them?
c. Zoosporic fungi I: Cryptomycota & Microsporidia—early-diverging fungal endoparasites
d. Zoosporic fungi II: Blastocladiomycota & Chytridiomycota—true Fungi with flagella
e. Neocallimastigomycota: the fungus living in the rumen of herbivores
f. Zoopagomycota and fungus-animal interactions
g. Mucoromycota and fungus-plant interactions
h. Ascomycota: the sac fungi
i. Basidiomycota: the club fungi
j. Fungus-like organisms
Laboratory topics:
a. Fungal collection on UTSC campus: moist chambers and baits for fungi (Coemansia, Conidiobolus, Mortierella, and Mucor)
b. Field trip to Rouge National Park: trichomycetes and dung fungi (Pilobolus)
c. Interactions between fungi and other organisms (Basidiobolus, Smittium, and Stylopage)
d. DNA extraction from fungal cultures
e. PCR techniques and gel electrophoresis
f. DNA sequencing and molecular phylogenetics

Methods of Assessment:
The assessment will be based on:
a. one midterm exam (30%): the exam will use multiple-choice and short-essay questions to assess students' knowledge on lecture content, including fungal classification and their various roles in both natural environment and modern society. [Assesses LOs 1 & 2]

b. laboratory involvement (30%): A detailed lab report and/or quizzes will be completed by each group (2 students per group) before the end of each individual lab. A lab report template with a clear structure will be provided at the beginning of the course. Lab skills of each student will be evaluated by the course instructor and teaching assistants. [Assesses LOs 3 and 4]
c. course paper (20%) and group presentation (20%): both writing and presenting skills will be evaluated by the end of the course. Students will work in groups to write a course paper to summarize and highlight the findings during the course and laboratories, which will also be presented to the entire class before the end of the course. Both written papers and oral presentations will be graded by the instructor and teaching assistants according to rubrics provided at the beginning of the class. [Assesses LO 5]

Mode of Delivery: In Class

Breadth Requirements: Natural Sciences

Rationale:
The proposed course will help fill a curriculum-related gap. The proposed course will contribute differentiation of the department's programs by providing a course that includes advanced lab techniques in a novel area of application. This course will be added to the Specialist Program Integrative Biology and Conservation and Biodiversity. In addition, the course could be of interest to students seeking electives of particular interest in fungal biology. The department anticipates that the course may be of interest to students at UTM and UTSG as well. An enrolment cap of 48 students is being proposed as this is the capacity of two teaching labs that are being made available to this course, amidst our busy roster of laboratory-based instruction.

Consultation:
DCC Approval: August 9, 2021
RO Approval: July 5, 2021

Resources:
This course will be taught by Dr. Yan Wang, a full-time faculty member in the department as part of his regular teaching load. This course will require 140 hours of TA support (70 hrs per lab). The TA funds will be covered by the department's existing budget. The Department will make every effort to absorb the laboratory expenses related to this course.

BIOC70H3: An Introduction to Bias in the Sciences

Description:

Research and practice in the sciences often rests on the unquestioned assertion of impartial analyses of facts. This course will take a data-informed approach to understanding how human biases can, and have, affected progress in the sciences in general, and in biology in particular. Case studies may include reviews of how science has been used to justify or sustain racism, colonialism, slavery, and the exploitation of marginalized groups. Links will be drawn to contemporary societal challenges and practices. Topics will include how biases can shape science in terms of those doing the research, the questions under study, and the types of knowledge that inform practice and teaching. Data on bias and societal costs of bias will be reviewed, as well as evidence-informed practices, structures, and individual actions which could ensure that science disrupts, rather than enables, social inequities.

Prerequisites: [Any of the following A-level courses: ANTA01H3, [BIOA01H3 and BIOA02H3], BIOA11H3, [HLTA02H3 and HLTA03H3] or [PSYA01H3 and PSYA02H3]] and [Any of the following B-level courses: any B-level BIO course, any B-level PSY course, ANTB14H3, ANTB15H3, HLTB20H3 or HLTB22H3]

Enrolment Limits: Enrolment limit would be 100

Learning Outcomes:
By the end of this course, students will be able to:
1.Outline and apply guidelines for engaging in professional, civil discourse on topics where STEMM intersects with high stakes, emotionally charged topics
2.Explain how human decision making and interpretation of facts (including scientific facts) are affected by unconscious biases and stereotypes
3.Describe how common stereotypes and biases of STEMM researchers, practitioners, and teachers can shape their research agenda and methods
4.Critique historical (and current) approaches to STEMM research with vulnerable communities in terms of social justice
5.Propose how histories of bias in STEMM may link to current social inequities and challenges

6.Formulate approaches to teaching, discussing, and practicing STEMM that could disrupt or decrease the perpetuation of scientific discrimination (= discrimination arising from flawed scientific justifications)

Depth & Breadth of Knowledge: Program-level LO's

1.Engage in scientific inquiry, and explain how scientific knowledge is discovered and validated.
2.Outline the principles of inheritance that govern phenotypes and the evolution of traits
3.Discuss interdisciplinary foundations that inform human actions in environmental, technological and societal issues.
e.g., Develop an understanding of how personal and societal stereotypes and schema can affect progress in the sciences

Degree level LO for Biological Sciences

Application of knowledge

Contribute to interdisciplinary research exchange.
e.g., Develop an appreciation for how a social sciences lens and data collection can inform practice in the sciences

Awareness of Limits of Knowledge

1.Evaluate recent advances in biological knowledge, and recognize the limits of the scientific process, including the inherent uncertainty in scientific knowledge, data and models.
2.Differentiate between objective and subjective interpretation of data.
e.g., instill the awareness that knowledge and its applications are influenced by and contribute to society (one of the key outcomes of the study of bias and scientific knowledge generation)

Communication skills

Work effectively and collaboratively with others (from diverse varied academic and cultural backgrounds).
e.g., Develop the skills and self-awareness required to engage in civil/professional discourse on difficult, high-stakes topics with diverse classmates

Autonomy & Professional Capacity.

1.Demonstrate both professional work habits and ethical conduct, when working individually, or as part of a team.
2.Explain how some social media or online sites can misrepresent science and influence policies.

Topics Covered:

1. Terminology, Framing, & Civil discussion of challenging topics (Unconscious bias, Human rights, Awareness of bias & good science)
2. History & Concepts A: Eugenics, Scientific Racism, Fisher & Rushton
3. History & Concepts B: Exploitation & Experimentation on vulnerable groups, links to current debates
4. Science as an enabler or disrupter of Bias A. Teaching & outreach in the sciences
5. Science as an enabler or disrupter of Bias B. AI, Algorithms, Gender & Race
6. Inclusion & Justice in the sciences: Practices & Benefits

Methods of Assessment:

1. 5%. Class community contract contributions/commentary
2. 15%. 3 Reflection papers (solo effort, 1 page)- (5% each). Reflection papers are short written engagements with key concepts, examples, or issues that arise in a given week's content. Students may discuss in depth their understanding, personal response, or they may outline how the topic links to issues outside of class content. Students may opt to have all or part of their anonymized reflections published on the class discussion board (at the discretion of the instructor)
a)each week, students will be randomly selected to complete this assignment; each student must do 3 for the term
b)each student will have one 'pass' which they can deploy to indicate that they do not wish to write on a particular topic. If this is the case, they will be expected to write on the following week's topic.
3. 5%. Reflection response. Once during the term, each student must submit a response to one published reflection. Students will have the option of their anonymized response being published on the class discussion board (at the discretion of the instructor)
4. 30%.

A. Task Force Project (group project) OR B. Briefing document (solo) – Students must commit to one of these by the end of the 3rd week of classes.

A. Task Force Project. Each student, together with their group, must submit one 'Bias in STEMM Task force' communication & recommendation. Task force problems will be based on videos/podcasts/commentary which offer enriched content related to the main topics in the course, and students will be asked to draw together insights from lecture material and other resources to create an educational vehicle and at least one recommendation for change based on the assigned topic.

The format of the final project will be flexible and may include: written, podcast, video, poster, public service announcement, etc. Students must identify their preferred audience, ranging from high school students or other undergraduates to science researchers or the general public.

All task force groups will be randomly assigned at the start of the term and provided with their discussion topic, then led through the development of the project in weekly tutorials/group meetings. Students may choose and rank their two top

choices for the type of group in which to work:
e.g., BIPOC & Allies; LGBTQ2S+ & Allies; Ability-Disability spectrum & Allies; Intersectional identities & Allies; New EDI learners & Allies, EDI Activists & Allies
This group work structure aims to encourage open and productive discussion within groups while minimizing the risk of potential harm to group members. For example, students who identify as BIPOC, LGBTQ2S+ Intersectional, or persons with disabilities may have a very different understanding of the effects of bias than students who are new in their EDI learning journey. Similarly, students who are unique in their journey may feel fearful of making mistakes and be less willing to engage in open conversations if in the presence of others with more knowledge or lived experience. Our community agreement will help outline a framework for engaging openly while seeking to avoid causing harm to others, regardless of the group's choice, and we will mindfully develop these skills over the course of the semester.
OR
B. Briefing document (solo project)
Students must choose a popular science book that examines a topic related to Bias in STEM and create a briefing document for a fictitious decision-maker. The briefing document must engage with the question: how can STEM research, teaching or practice be more inclusive concerning the identity groups that focus on the chosen book. The brief should summarize the current challenges, discuss some relevant points related to that issue as introduced in the book, and other supporting references, and make recommendations to the decision-maker about how effective change. The student may choose the decision-maker (e.g., teacher or professor; school or university administrator; research administrator; researcher, policy-maker; politician).
The nature of the focus issue will depend on which book is chosen. Students are free to suggest their own book and to refine the question, but the instructor must approve these prior to the end of the 4th week of classes.
Partial list of books (others will be provided on Quercus):
a)Superior: The Return of Race Science. Angela Saini
b)Inferior: How Science got Women Wrong. Angela Saini
c)STEM of Desire : Queer Theories and Science Education. Letts & Fifield, eds.
d)The Challenged Scientists: Disabilities & the Triumph of excellence. Weisberger
e)Invisible Women: Data Bias in a World Designed for Men. Perez
5. 15%. Midterm. Format will depend on class size and TA support.
6. 30%. Final exam. Format will depend on class size and TA support.

Mode of Delivery: In Class

Breadth Requirements: Natural Sciences

Rationale:
This course supports UTSC’s aspiration to be a leader for Inclusive Excellence in post-secondary education. How principles of equity, diversity, inclusion, and belonging apply to the sciences are currently unclear to many students in these fields, as very few courses directly address such issues. Discrimination based on stereotypes and bias is common in society, and the underlying attitudes shape every field, including the sciences. This course is designed to illuminate historical and current attitudes and practices perpetuating discrimination while shrouded in the legitimacy of scientific credentials. This course will be novel at UTSC and aligns with Strategic Direction 1.1 in UTSC’s Strategic Plan: “Provide all students with transformative, experiential and holistic curricular, co-curricular and extra-curricular learning opportunities.” Given the department’s request for an enrolment limit of 100 for the first year this course is offered and the department’s vision for a broad interdisciplinary student body, this course will only be added as an elective option to every Specialist program in Biological Sciences. However, the department also plans to add this course to the Major programs in the future.

Consultation:
DCC Approval: September 10, 2021
RO Approval: September 15, 2021

Resources:
This course will be taught by Dr. Maydianne Andrade, a full-time faculty member in the department, as part of her regular teaching load. The course will require 105 hours of TA support. The TA funds will be covered by the departments existing budget. No additional space/infrastructure/equipment is needed.

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

March 23, 2022

Physical & Environmental Sciences (UTSC), Department of

5 New Courses:

EESC25H3: Urban Climatology

Description:

This course will focus on how urban areas modify the local environment, particularly the climates of cities. The physical basis of urban climatology will be examined considering the energy balance of urban surfaces. The urban heat island phenomenon and its modelling will be studied based on conceptual and applied urban-climate research. The impact of climate change on urban sectors such as urban energy systems, water and wastewater systems, and urban transportation and health systems will be examined through case studies. Students will have the opportunity to choose their own areas of interest to apply the knowledge they learn throughout the course and demonstrate their understanding in tutorial-based discussions. The students will be required to work with community or industry partners on a project to assess the impacts or urban climate change.

Prerequisites: A minimum of 6.0 credits, including at least 2.0 credits in EES courses

Recommended Preparation: EESA09H3 or EESB03H3

Learning Outcomes:

Upon completion of the course, students will be able to:

1. Understand the physical basis of climate change in cities
2. Use the knowledge of the factors and processes affecting urban climate to examine the surface energy balances
3. Develop a methodological understanding of how to evaluate the urban climate change at various scales from roof to the entire city
4. Develop knowledge and critical understanding of the impact of urban climate on various urban sectors and improve the urban environment with appropriate planning of the urban landscape based on community experience

Topics Covered:

- Physical processes associated with urban climate
- Methodological aspects of Urban Climatological Research
- The radiation budget in urban areas
- Urban Heat Island effect
- Urban air pollution
- Urban weather
- Urban energy system and climate change
- Urban transportation systems and climate change
- Human Health in cities and climate change

- Urban areas and more significant scale climates
- Assessments of learning outcomes with community involvement

Methods of Assessment:
Elements to evaluate Percentage to final grade
Assignment #1 10%
Assignment#2 20%
Project - paper 35%
Project - presentation 20%
Participation 15%

Assignment 1: Students will select a research article from urban climate literature that describes the fundamental physical basis of urban climate and write a critical analysis on the method to evaluate urban environment by focusing on at least one of the Lowry methods. This will help students understand the in-depth physical processes associated with urban areas.

Assignment 2: Students will find from the literature the data sources for urban climate researchers and select a location to analyze the past changes. Two methods (identified in assignment#1) must be set to answer the same question related to an urban climate issue/problem. The students will then critically analyze if one method is better based on the climatological assumptions and limitations.

Research Project: Students will choose a project topic based on their areas of interest in Urban Climate with the approval of the instructor. The two assignments' knowledge can be applied for the project, such as a simple modelling approach to study an aspect of the urban environment by working with an industry/community partner. This will allow the students to explore how climate change plays a role in various sectors in urban areas in the context of their academic/career field of interest. Students will have to write a research paper and present their work based on the research findings.

Participation: Class participation will encourage students to value and judge other's opinions and get various viewpoints on specific urban climate issues

Mode of Delivery: In Class

Breadth Requirements: Natural Sciences

Rationale:
This course will give students the opportunity to explore the factors and processes associated with the development of urban climate. With this course, students can choose their own areas of interest to apply the knowledge they learn throughout the course by working on a project led by community/industry partners. This course can be used towards the new Minor program in Applied Climatology, and will also appeal to students in other Environmental Science programs.

Consultation:
RO Approval: May 20, 2021
DCC Approval: September 9, 2021

Resources:
The course will be taught by existing faculty as part of their regular teaching load. No additional resources are required.

EESD28H3: Fundamentals of Environmental Modelling

Description:

This course introduces the rapidly growing field of environmental and earth system modelling. Emphasis will be placed on the rationale of model development, the objective of model evaluation and validation, and the extraction of the optimal complexity from complicated/intertwined environmental processes. By focusing on the intersections between climate change and ecological systems, students will develop the ability to integrate information from a variety of disciplines, including geosciences, biology, ecology, chemistry, and other areas of interest. The course will also involve practical training in the computer lab. Students will develop an intermediate complexity mathematical model, calibrate the model and assess the goodness-of-fit against observed data, identify the most influential model parameters (sensitivity analysis), and present their results.

Jointly offered with EES1118H

Prerequisites: [MATA30H3 and STAB22H3 (or equivalent)] and [an additional 6.0 credits, including at least 0.5 credit at the C-level in EES courses]

Exclusions: EES1118H

Learning Outcomes:
Upon completion of the course, students will be able to:
1. Understand the terminology and tools of the Earth System and Ecological modelling
2. Communicate information about the earth system and environmental processes in a quantitative manner
3. Utilize the essential elements to create a model with mathematical and quantitative reasoning
4. Analyze model uncertainties and influence of model parameters on the results

Topics Covered:
- Basic mathematical tools for modelling
- Uncertainty analysis of mathematical models
- Sensitivity analysis and optimization
- Catastrophic shifts in ecosystems
- Modeling climate impacts on ecosystem phenology

Methods of Assessment:
1. Modelling Project Proposal- 15%
2. Midterm Test – 40%
3. Final Modelling project – 35% (20% report + 15% presentation)
4. Class participation – 10%

1. The modelling project proposal will allow the students to apply the knowledge of the physical basis of creating a model and generate a framework based on the basic modelling steps.
2. The midterm test is designed in such a manner to test the students' understanding of the earth system modelling approaches and how to decide on a model, how to address model uncertainty and assess the influence of the model parameter on the inferences and final outcomes.
3. The final modelling project and the presentation of the project (will be judged by the peers) will help the students develop critical thinking skills in terms of implementing mathematical and quantitative reasoning.
4. Class participations will encourage students to value and judge other's opinions and get different viewpoints on a specific modelling task. In addition, this will allow students to do self -assessment of their learning as the course progresses.

Mode of Delivery: In Class

Breadth Requirements: Natural Sciences

Rationale:
This course will provide students with an advanced understanding of the complex interplay among physical, chemical, and biological processes that shape ecosystem phonology in the context of climate change. The course will discuss how these processes are mathematically depicted in the most commonly used numerical models. Emphasis will also be placed on methods to rigorously evaluate and validate models, extract the optimal complexity from complicated/intertwined ecosystem processes and quantify the uncertainty in ecological forecasting and its implications for environmental management under changing climate conditions. This course will be an elective for students in the Minor program in Applied Climatology and is also jointly offered with the graduate-level course EES1118H.

Consultation:
RO Approval: May 20, 2021
DCC approval: Sept 09, 2021

Resources:
The course will be taught by existing faculty as part of their regular teaching load. Additional TA support, if required, t will be covered by the Department's existing TA budget. No other resources are required.

ESTB04H3: Addressing the Climate Crisis

Description:
Addressing the climate crisis is a profound challenge for society. This course explores climate change and what people are doing about it. This course emphasizes the human dimensions of the climate crisis. It introduces students to potential solutions, ethical and justice considerations, climate change policies and politics, and barriers standing in the way of effective action. With an emphasis on potential solutions, students will learn how society can eliminate greenhouse gas emissions through potential climate change mitigation actions and about adaptation actions that can help reduce the

impacts of climate change on humans. This course is intended for students from all backgrounds interested in understanding the human dimensions of the climate crisis and developing their ability to explain potential solutions.

Prerequisites: **A**ny 4.0 credits

Exclusions: GGR314H1

Learning Outcomes:
Upon completion of the course, students will be able to:
- Describe the scientific evidence for climate change and projected impacts
- Understand and explain the barriers to effective response actions, including climate change denial and delay
- Understand and explain issues of equity and justice related to the climate crisis and potential response measures
- Evaluate and communicate potential mitigation solutions to reduce and eliminate greenhouse gas emissions
- Evaluate and communicate potential adaptation solutions to reduce the impact of climate change

Topics Covered:
- Introduction to climate change and climate science 101
- Introduction to models and scenarios
- Impacts on natural systems and human societies
- Issues of equity (international, intergenerational etc.)
- What's stopping us? Challenges and barriers
- Mitigation measures and case studies of action: energy systems, transportation, agriculture and land use, products and consumption, industry, aviation and shipping, negative emissions
- Adaptation measures and case studies of action: impacts on humans and ecosystems, response measures for food, water and health, assessing vulnerability, ethics and inequity
- The politics of climate action (governance, policy tools, shifting finance, protest and organizing)
- Avoiding despair, ecological grief and commanding hope
- Transformative change: decarbonization, disruptive change, just transitions

Methods of Assessment:
Assignment #1 – Policy Brief on Mitigating Climate Change (20%)
For this assignment, students act as advisors to a government official and must produce a short policy brief describing relevant greenhouse gas emissions and recommended mitigation response actions. Students must choose at least two mitigation actions and explain why they recommend implementing the measures. Students can choose a place that they are familiar with, and the government can be at the federal, provincial, or municipal level. The policy brief should be a maximum of 2 pages, excluding references.
Learning outcomes:
- Describe the scientific evidence for climate change and projected impacts
- Evaluate and communicate potential mitigation solutions to reduce and eliminate greenhouse gas emissions

Assignment #2 – Policy Brief on Adapting to Climate Change Impacts (20%)
This policy brief is for the same government department as students selected for Assignment 1. This time, the policy brief focuses on the actions that should be taken in this jurisdiction to adapt to the impacts of climate change. Students must explain the projected impacts relevant to the jurisdiction, choose at least two adaptation actions, and explain why they recommend that the actions be implemented. The policy brief should be a maximum of 2 pages, excluding references.
Learning outcomes:
- Describe the scientific evidence for climate change and projected impacts
- Evaluate and communicate potential adaptation solutions to reduce the impact of climate change

Midterm (20%)
Short and long answer questions on the course content to date.
Learning outcomes:
- Describe the scientific evidence for climate change and projected impacts
- Understand and explain the barriers to practical response actions, including climate change denial and delay
- Understand and explain issues of equity and justice related to the climate crisis and potential response measures
- Evaluate and communicate potential adaptation solutions to reduce the impact of climate change

Final Exam (40%)
Short and long answer questions on the entirety of the course content
Learning outcomes:
- Describe the scientific evidence for climate change and projected impacts
- Understand and explain the barriers to practical response actions, including climate change denial and delay

- Understand and explain issues of equity and justice related to the climate crisis and potential response measures
- Evaluate and communicate potential mitigation solutions to reduce and eliminate greenhouse gas emissions
- Evaluate and communicate potential adaptation solutions to reduce the impact of climate change

Mode of Delivery: In Class

Breadth Requirements: Social & Behavioural Sciences

Rationale:
This course will provide students with a foundation in the human dimensions of climate change. A B-level course will introduce students to climate change knowledge, particularly related to potential solutions to the climate crisis, ethical and justice considerations, policy, politics and governance of climate action, and barriers standing in the way of effective action. This course will be of interest to all students at UTSC. This course will interest a broad cross-section of UTSC students and will develop their understanding of and ability to communicate potential solutions to the climate crisis. It will also become a core course in the new Major in Climate Change currently in development.

Consultation:
- Committee of DPES faculty (EES and EST) on undergraduate climate change programs
- Course code approved May 4 2021
- DPES Curriculum Committee approval: May 25, 2021

Resources:
- This course will be taught by currently faculty (Dr. Tozer)
- TA Support: 1 hr per student enrolled for grading, 6 hrs training, 24 hrs for TAs to attend lectures, 6 hrs contact time with students to help with assignments. These costs will be covered by the Unit's existing TA budget.

ESTC40H3: Technical Methods for Climate Change Mitigation

Description:

Addressing the climate crisis requires designing and implementing effective climate change mitigation targets, strategies, policies and actions to eliminate human-caused greenhouse gas emissions. In this course, students will learn the various technical methods required in climate change mitigation. Students will explore the opportunities, barriers, and tools that exist to implement effective climate change mitigation in the energy, industry, waste, and agriculture, forestry and land-use sectors. The emphasis of the course is on the technical methods that climate change mitigation experts require.

Prerequisites: 10.0 credits including ESTB04H3

Enrolment Limits: 60

Learning Outcomes:
Upon completion of the course, students will be able to:
1. Understand what the role of climate change mitigation is.
2. Design and enhance greenhouse gas (GHG) reduction targets at any governance level
3. Use the tools and methodologies used by mitigation experts to design and implement mitigation policies and measures and measure their GHG and non-GHG effects.
4. Identify and use international methodologies for the design of mitigation action policies and measures.
5. Understand the opportunities and limitations of climate change mitigation in the energy, industry, waste, agriculture, forestry, and land-use (AFOLU) sectors.

Topics Covered:
Part I: Introduction
Week 1: Introduction to the course and climate change mitigation
Week 2: Justice, equity, and responsibility: Intragenerational versus intergenerational equity
Week 3: GHG emissions inventories and historical emissions
First tutorial: Estimating GHG emissions at a city level
Part II: From target setting to policies and actions
Week 4: Setting climate change mitigation goals and targets.
Week 5: Designing and measuring the progress of climate change mitigation policies and actions.
Second tutorial: Kaya identity exercise in R

Week 6: Designing and measuring the progress of individual GHG projects.
Part III: Climate change mitigation by sector
Week 7: Climate change mitigation in the energy sector.
Week 8: Climate change mitigation in the industry sector (including waste).
Week 9: Climate change mitigation in the agriculture, forestry, and other land use (AFOLU) sector.
Week 10: Carbon capture and storage.
Third tutorial: Measuring a GHG reduction policy through time
Part IV: Achieving climate change strategies
Week 11: Transformational pathways and climate finance.
Week 12: Decarbonization and climate neutrality.

Methods of Assessment:
Active participation (i.e., asking questions, participating in weekly class discussions, sharing thoughts) in class.
Students will be divided into groups and will prepare a short presentation of a GHG reduction project methodology. Each presentation will consist of an introduction to the selected methodology, a presentation of the baseline considered by the methodology, a summary of the primary sources, sinks and reservoirs (SSR) included and excluded, the type of GHGs, a summary of a justification of each primary SSR, and a summary of challenges and barriers that may hinder the effectiveness of a project
Students will work through four staged activities that will culminate in a climate action plan by the end of the course. The first stage of this assignment consists of an analysis of historical GHG emissions of a fictitious country. The second stage, students will design a GHG reduction target and justify the type of target chosen for their climate action plan. For the third stage, students will select and describe three to four mitigation measures under a specific sector and will and justify how each measure aligns with the GHG reduction target previously chosen. In the fourth stage, students will assemble each of the previous activities into one single climate action plan and will include an explanation of how the concepts of equity, equality, and justice should be considered during the implementation of climate action plan.
Each tutorial will include a short assignment. For the first tutorial, students will have to estimate the GHG emissions of a city and produce a report (3 pages max). For the second tutorial, students will explain how analysing GHG emission drivers can inform policy makers when designing GHG mitigation policies using the results of a Kaya identity exercise in R. For the third tutorial, students will have to map a causal chain and analyse a policy in Canada to identify GHG and non-GHG (i.e., co-benefits) effects of the mitigation policy.
Exam to evaluate the understanding of climate change mitigation concepts taught throughout the course.

Mode of Delivery: In Class

Breadth Requirements: Natural Sciences

Rationale:
The department offers undergraduate courses focused on climate change (e.g., EESD06H3 and EESB03H3), but there are currently no courses at UTSC that enable students to gain an in-depth understanding of climate change mitigation and the tools and options mitigation experts use in the public and private sector. This course will therefore help fill a curriculum related gap, and enable students to build the skills required for professionals and researchers to further pursue a career in climate change mitigation.

Consultation:
DCC Approval: May 25, 2021
RO Approval: May 31 2021

Resources:
This course will require a sessional/adjunct faculty and a TA. The resource will be covered by the department's existing stipend and TA budgets.

ESTD20H3: Integrated Natural Resource and Climate Change Governance

Description:
Climate change affects all sectors of society, natural ecosystems, and future generations. Addressing climate change, either in terms of mitigation or adaptation, is complex due to its pervasive scope, the heterogeneity of its impacts and the uneven distribution of responsibilities, resources and capacities to respond to it between different levels of government, stakeholder groups, and rightholder groups. This course focuses on nexus approaches in climate policy development and assessment across different public policy domains. In this course, students will learn about how different levels of government frame climate change and climate policy objectives, how they interact with stakeholders

(e.g., economic interests and environmental groups) and rightholders (Indigenous people), and how to approach complexity in climate governance.

Prerequisites: 14.0 credits including ESTB04H3

Learning Outcomes:
Upon completion of this course, students will be able to:
- Describe the roles of the federal, provincial and municipal governments in climate policy.
- Understand climate policy instruments and how they are deployed in different societal sectors.
- Understand what is meant by a nexus approach to climate policy mainstreaming and the complex ways in which climate policy intersects with other public policy domains.
- Conduct a literature review, write a research paper and a policy brief.
- Practice dialogical skills and complexity thinking skills

Topics Covered:
- Pan-Canadian carbon pricing;
- Gender and farm work in a changing climate
- Urban heat island as agricultural opportunity
- Low-carbon livestock
- Forests as carbon sinks and carbon foes; and
- Justice in the energy sector.

Methods of Assessment:
1. Class participation 9% of overall mark (9 reflective responses @ 1% each)
Students are required to participate in class discussions and submit weekly reflective response to class discussions. A reflective response is not a summary of class discussions, but rather a means to write about tensions, counter-arguments, outstanding questions, taken-for-granted assumptions, and unresolved matters of concern that were raised or silenced within workshop discussions. Students should write about how complexity is dealt with in the climate policy domain discussed in the workshop and different perspectives from which to frame the climate policy problem and its potential solutions. This reflective response is also an opportunity for students to write about a perspective that is new to them and which made them think differently about the policy problem discussed.
Learning outcomes:
- Describe the roles of the federal, provincial and municipal governments in climate policy.
- Understand climate policy instruments and how they are deployed in different societal sectors.
- Practice dialogical skills and complexity thinking skills
2. Reading assignment 36% of overall mark (9 assignments @ 4% each)
2A. (1000 words)
- Identify the public policy problems discussed in the readings
- Identify the nexus sectors involved
- Identify what factors are involved in decision-making (e.g., interests, economics, politics, culture, gender, stakeholders, rightholders, values, institutional norms, precedents, contextual specificities, court cases, risk perception, scientific uncertainty, different government agencies' mandate
- Identify the policy instruments mentioned in the readings (market-based, informational, regulation, cooperative arrangement, voluntary, technology)
2B. (1000 words) Develop a nexus framework to discuss the readings:
- Describe connections, synergies and trade-offs between the different policy sectors covered in the readings.
- Describe how the sociopolitical and climate biophysical processes interlink across sectors.
- Identify potential opportunities to reduce negative surprises and promote integrated planning, management and governance that across climate change and other policy sectors.
- Identify the role of stakeholders and rightholders in achieving policy objectives
Learning outcomes:
- Describe the roles of the federal, provincial and municipal governments in climate policy.
- Understand climate policy instruments and how they are deployed in different societal sectors.
- Understand what is meant by a nexus approach to climate policy mainstreaming and the complex ways in which climate policy intersects with other public policy domains.
3. Collaborative research assignment 55%
The topic of the assignment is a complex climate policy problem and requires collaborative research and writing. The assignment consists of two parts: The first part consists of a literature review, and the second part consists of a case study and a policy brief.

Learning outcomes - Describe the roles of the federal, provincial and municipal governments in climate policy. - Understand climate policy instruments and how they are deployed in different societal sectors. - Understand what is meant by a nexus approach to climate policy mainstreaming and the complex ways in which climate policy intersects with other public policy domains. - Conduct a literature review, write a research paper and a policy brief
Mode of Delivery: In Class
Breadth Requirements: Social & Behavioural Sciences
Rationale: ESTD20H3 integrates knowledge gained from the required courses on climate change and gives students the opportunity to apply this foundational knowledge to problem-solving in a context of uncertainty, risk and complexity—the hallmarks of climate governance. It allows students to develop research skills and practice the skill of complexity thinking. It will be of interest to students in Environmental Science and Environmental Studies programs, including a new Major in Climate Change that is currently in development.
Consultation: - DPES committee (EES and EST) on undergraduate climate change programs - Course code approved April 27 2021 - DPES Curriculum Committee approval: May 25, 2021
Resources: - The course will be taught by existing faculty (Dr Klenk) and will be cycled. - TA support: 1 hr per student enrolled for grading, 12 hrs of contact with students to provide support for the group assignment; 6 hours of training. These costs will be covered by the Unit's existing TA budget.