ENVE4200/5200: Climate Change and Engineering

Department of Civil and Environmental Engineering
Course Syllabus, Winter 2024

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Office Hours: TBD
TA Information: TBD

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1 Course Description and Requirements

1.1 Course Schedule

- Lectures are held Tuesdays from 18:05 to 20:55 (EST) in room TB 238.
- Tutorials are held on alternate Fridays from 08:35 to 11:25 (EST) in room TB 340 (starting January 26).

1.2 Course Description

Survey of the physical science of climate change, impacts on the built environment, and climate adaptation in engineering. Greenhouse gases, global warming, paleoclimatology, and Earth system responses. Climate change impacts on structural, water, transportation, and energy systems. Climate vulnerability assessment, case studies of design adaptation. Geoengineering methods.

1.3 Precluded Courses

ENVE4200 precludes ENVE5200 and vice versa.

1.4 Prerequisites

None.

Learning Outcomes

At the end of this course, students will be able to:

- explain the physical science of climate change and describe impacts on the natural world including feedbacks and assessments of climate in the past;
- describe the potential impacts of changes in climate on built systems, including structural, water, transportation, and energy systems;

- assess a design plan for risks related to changing climate variables and propose alterations to mitigate these risks;
- describe policy tools used in climate mitigation and understand the interaction of public policy with engineering and design; and,
- compare and contrast different methods of geo-engineering and assess their strengths and weaknesses.

1.5 Textbooks

This course does not draw from a single textbook, but from a broad set of sources including textbooks, reports, policies, and peer-reviewed research articles. Students are encouraged to read widely on the subjects covered in lectures, beginning with the references contained in each set of lecture slides. For students seeking further reading, the following set of materials will prove useful:

- Archer, D. (2012). *Global Warming: Understanding the Forecast*. 2nd edition. Wiley, Hoboken, NJ, USA.
- Bosher, L. and Chmutina, K. (2017). *Disaster Risk Reduction for the Built Environment*. Wiley Blackwell, West Sussex, UK.
- IPCC (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom.
- IPCC (2013). *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Environment and Climate Change Canada (2016). *Pan-Canadian Framework on Clean Growth and Climate Change: Canada's plan to address climate change and grow the economy*. Gatineau, PQ, Canada.
- Environment and Climate Change Canada (2017). *Pan-Canadian Framework on Clean Growth and Climate Change: First Annual Synthesis Report on the Status of Implementation – December 2017*. Gatineau, PQ, Canada.

1.6 Topics and Tentative Outline

Weeks 1-2: Physical science of climate change: Defining climate and weather, Earth's energy balance, natural and anthropogenic forcings, paleoclimate and modern observations, greenhouse gas sources and sinks, global warming potential, climate sensitivity.

Week 3: Impacts on the Earth system: Feedbacks (albedo, water vapour, clouds), air temperature rise, sea level rise, ocean acidification and ocean temperature rise, glacier,

permafrost, and sea ice loss, precipitation changes (frequency and intensity), changes in weather extremes.

Week 4: Mitigation and adaptation: Climate models, prediction, and uncertainty. Global carbon budget, committed warming, emissions mitigation strategies. Risk, vulnerability, and adaptation capacity.

Week 5: Interactions with energy and transportation systems: Role of energy and transportation sectors and mitigation. Changes in energy supply: hydroelectricity, thermal plant efficiency, and renewable sources. Changes in energy demand: heating vs cooling. Adaptation of existing road and rail under increased temperatures and inundation. Winter road networks and shifting foundations under permafrost. Heat stress on roads and maintenance.

Week 6: Impacts on water systems: Sea level rise, inundation, erosion, and coastal infrastructure. Freshwater availability, water resources management, changes to run-off and streamflow. Water quality, sediment and pollutant loads.

Week 7: Impacts on structures and land use: Changes to domestic and commercial occupancy, passive design options. Built heritage and the Venice declaration. Urban drainage, ecosystem services, green roofs. Transition from the sanitary city to the sustainable city.

Week 8: Impacts on public health: Direct changes in temperature, precipitation, and extremes (heat waves, droughts). Air quality co-benefits and short-lived climate forcers. Spread of disease vector ranges, including insect-, food-, and water-borne diseases. Heat warning systems and disease surveillance. Population displacement and migration.

Weeks 9-10: Climate vulnerability assessment: risk assessment, probability and severity and the risk matrix, disaster risk reduction methods, triple bottom line accounting (social, environmental, financial), case studies.

Week 11: Interactions of engineering with environmental policy: Existing international protocols (Paris, Kyoto), economic instruments (command-and-control, carbon pricing, cap-and-trade). Canadian policy context: national engineering guidelines, Pan-Canadian Framework on Clean Growth and Climate Change.

Week 12: Geo-engineering: Solar radiation management, carbon removal, carbon capture and storage, risks, costs, and policy discussions.

1.7 Evaluation and Marking Scheme

The final grade for the course will comprise evaluation of work done during tutorial sessions, take-home assignments, one project-length written report, and a final exam. Details on the individual graded components will be released at a later time. Weightings are as follows:

Component	Weight
Assignments	15
Tutorials	15
Project	30
Final Exam	40

Graduate students may be required to answer additional questions in assessments.

1.7.1 Final Examination

- Final exams are for evaluation purposes only and will not be returned to students.

- Final exam will be open book, with written notes and a scientific calculator permitted.
- The final exam constitutes 40% of the course grade.
- Deferred final examinations: Students who are unable to write the final examination because of a serious illness/emergency or other circumstance beyond their control may apply for accommodation by contacting the Registrar's office. Consult Section 4.3 of the University Calendar.

1.7.2 Examination Format and e-Proctoring Statement

The final exam will be written in person.

1.7.3 Term Work Late Submission Policy

Work submitted late will be penalized at a rate of 10% per day.

1.7.4 Self-Declaration Form and Deferred Term Work

Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for making alternate arrangements with the instructor and in all cases. This must occur no later than three (3) days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. Consult Section 4.4 of the University Calendar.

1.8 Academic Dates

Students should be aware of the academic dates (e.g., last day for academic withdrawal) posted on the Registrar's office web site.

2 Academic Integrity and Plagiarism

- Please consult the Faculty of Engineering and Design information page about the Academic Integrity policy and procedures. Violations of the Academic Integrity Policy will result in the assignment of a penalty such as reduced grades, the assignment of an F in a course, a suspension, or expulsion.
- One of the main objectives of the Academic Integrity Policy is to ensure that the work you submit is your own. As a result, it is important to write your own solutions when studying and preparing with other students and to avoid plagiarism in your submissions. The University Academic Integrity Policy defines plagiarism as "presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one's own." This includes reproducing or paraphrasing portions of someone else's published or unpublished material, regardless of the source, and presenting these as one's own without proper citation or reference to the original source.

  Examples of violations of the policy include, but are not limited to:

  - any submission prepared in whole or in part, by someone else or by a generative language model;
  - using another's data or research findings without appropriate acknowledgement;
  - submitting a computer program developed in whole or in part by someone else, with or without modifications, as one's own; and

- failing to acknowledge sources of information through the use of proper citations when using another's work and/or failing to use quotations marks.

3 Copyright

The materials (including the course outline and any slides, posted notes, videos, labs, projects, assignments, quizzes, exams and solutions) created for this course and posted on this web site are intended for personal use and may not be reproduced or redistributed or posted on any web site without prior written permission from the author(s).

4 Learning and Working Environment

The University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the Department of Equity and Inclusive Communities at equity@carleton.ca.

We will strive to create an environment of mutual respect for all through equity, diversity, and inclusion within this course. The space which we work in will be safe for everyone. Please be considerate of everyone's personal beliefs, choices, and opinions.

5 Academic Accommodations

Students with diverse learning styles and needs are welcome in this course. You may need special arrangements to meet your academic obligations during the term. For an accommodation request, the processes are as follows.

5.1 Accommodations for Students with Disabilities

The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca.

You should request your academic accommodations in the Ventus Student Portal, for each course at the beginning of every term. For in-term tests or midterms, please request accommodations at least two (2) weeks before the first test or midterm. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable).

5.2 Accommodation for Student Activities

Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after

the need for accommodation is known to exist. For more details, see the Senate Policy on Accommodation for Student Activities (PDF).

5.3 Pregnancy Obligation

Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the Student Guide to Academic Accommodation (PDF).

5.4 Religious Obligation

Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the Student Guide to Academic Accommodation (PDF).

5.5 Survivors of Sexual Violence

As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit the Sexual Violence Prevention & Survivor Support webpage.

6 Student Mental Health and Wellness

As a university student you may experience a range of mental health challenges that can significantly impact your academic success and overall well-being. Carleton's Wellness Services Navigator is designed to help students connect with mental health and wellness resources.

If you need to talk to someone from the department for more information and support with connecting to resources, you can contact the following faculty members, depending on your program.

ENVE: Prof. Shoeleh Shams
Email: shoeleh.shams@carleton.ca, Office: 4242 Mackenzie

Here is a list of on-campus and off-campus resources:

1. **Carleton's Health and Counselling Services**: To book an appointment contact the main clinic by calling (613) 520-6674. If urgent, let the Patient Care Coordinator know or go in person to the main clinic (2500 Carleton Technology and Training Centre Building) and indicate that they are in crisis and need to speak to someone right away. For more information, please see https://carleton.ca/health/
2. Emergencies and Crisis and Emergency Numbers.
3. **Good2Talk (1-866-925-5454)**: Good2Talk is a free, confidential helpline providing professional counselling and information and referrals for mental health, addictions and well-being to post-secondary students in Ontario, 24/7/36 https://good2talk.ca/
4. **Empower Me**: Undergraduate students have access to free counselling services in the community through Empower Me, either in person, by telephone, video-counselling or e-counselling. This free service is accessible 24/7, 365 days per year. Call 1-844-741-6389

(toll free) to make an appointment with a counsellor in the community. More information is available https://students.carleton.ca/services/empower-me-counselling-services/

5. **The Walk-In Counselling Clinic** (off-campus community resource): The walk-in Counselling Clinic have offices in various locations across Ottawa and the greater Champlain region that are open 7 days a week. Individuals will be assisted, with no appointment, on a first-come, first-serve basis during the Walk-in Counselling Clinic hours. The Walk-in Counselling Clinic offers services in many languages and is free and confidential. More information can be found at: https://walkincounselling.com/
6. **Distress Centre of Ottawa and Region**: Available 10am – 11pm, 7 days/week, 365 days/year. Distress Line: 613-238-3311, Crisis Line: 613-722-6914 or 1-866-996-0991, Text: 343-306-5550. https://www.dcottawa.on.ca/
7. **Distress and Crisis Ontario**, Available for chat 2 pm – 2 am EST. For more information, see https://www.dcontario.org/
8. **BounceBack Ontario** (Toll-Free: 1-866-345-0224) is a free skill-building program managed by the Canadian Mental Health Association (CMHA). It is designed to help adults and youth 15+ manage low mood, mild to moderate depression and anxiety, stress or worry. Delivered over the phone with a coach and through online videos, you will get access to tools that will support you on your path to mental wellness. For more information, see https://bouncebackontario.ca/