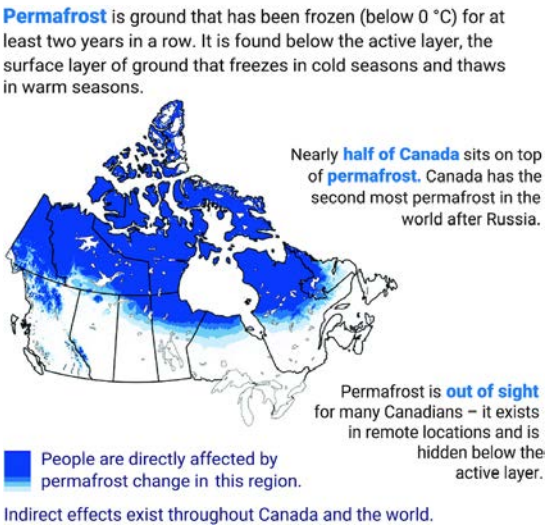
Syllabus for GEOG 4108 Permafrost (0.5 credit), Fall Term 2026 – DRAFT

Why study permafrost at Carleton?

Permafrost underlies almost half of Canada and is one of the fastest-changing components of the Earth system. It affects northern communities and infrastructure, ecosystems, water resources, carbon cycling, land use, and climate adaptation. Understanding permafrost is therefore relevant across environmental research, public policy, planning, engineering, and northern development.





This course is suitable for students from a wide range of backgrounds, including human geography, Earth science, environmental studies, physical geography, geomatics, and engineering. It combines physical processes, landforms, climate-change impacts, infrastructure, and land-use questions without assuming that all students enter with the same disciplinary perspective.

Carleton has a long tradition of permafrost research and education, reinforced by recent national initiatives such as NSERC PermafrostNet (2019–2025), the LEAP training program, and partnerships with governments, northern organizations, engineering firms, and research institutions. Students can continue from this course into a graduate-level permafrost course taught by Dr. S. Gruber in the winter term and then into specialized training in geomechanical aspects of permafrosttaught by Dr. M. Pouragha in Civil and Environmental Engineering. Together, these courses provide a depth of integrated training in permafrost science and engineering that is unique internationally.

The course provides a foundation for careers in geography, environmental science, geomatics, climate science, hydrology, northern policy, civil and geotechnical engineering, environmental consulting, government, infrastructure planning, climate-change adaptation – graduate studies.






Instructor: Stephan Gruber
Office: Room B443A Loeb Building
Hours: Tuesday 11:00–12:00 (September 15 to December 8, 2026)
Email: stephan.gruber@carleton.ca

Lectures: Tuesday and Thursday 08:35–09:55 (September 10 to December 4, 2025)

Location: Loeb A211, in person (some lectures may be delivered as videos in Brightspace)

Brightspace: GEOG4108A Permafrost (LEC) Fall 2026

Description: Understanding permafrost processes and phenomena and how they respond to climate change. Topics include the distribution, development, and degradation of permafrost; interactions between atmosphere, snow, and ground; the thermal and hydrologic regime of permafrost terrain; landforms in permafrost regions; geotechnical consideration in northern construction.

Prerequisites: GEOG 3108 *Soil Properties* or permission of the Department.

Communication: Please ask questions related to course content in class so that everybody can benefit. Written correspondence must be through a Carleton email account.

Learning outcomes

To pass this course, students must demonstrate the ability to:

1. **Explain** important concepts, terms, and models used to describe permafrost processes and phenomena and further clarify them with drawings or simple formulas where appropriate.
2. **Explain** important concepts of atmosphere-ground heat exchange, such as the surface energy balance and seasonal snow, and how they determine the ground thermal regime.
3. **Integrate** knowledge about the processes that determine where permafrost occurs with information about particular areas (e.g., climate data, maps) to estimate or explain permafrost distribution and characteristics.
4. **Explain** the processes governing the aggradation and degradation of permafrost.
5. **Recognize** typical geomorphological features associated with permafrost on photographs and **explain** their mechanism of formation.
6. **Distinguish** questions that can be explained with concepts using equilibrium assumptions from those that require consideration of transient effects.
7. **Develop** narrative scenarios about how particular permafrost landforms and phenomena may respond to climate change or disturbance, and how this may affect land use.
8. **Describe** important geotechnical considerations in accounting for the effects of permafrost.

Preliminary course calendar, subject to revision

#	DATE	Day	Class time	TOPIC	Graded
1	Sep 10, 2026	Thursday	8:35–9:55	Introduction	
2	Sep 15, 2026	Tuesday	8:35–9:55	Permafrost distribution	
3	Sep 17, 2026	Thursday	8:35–9:55	The deep thermal regime	**Exercise 1**
4	Sep 22, 2026	Tuesday	8:35–9:55	Seasonal snow	
5	Sep 24, 2026	Thursday	8:35–9:55	The ground surface	
6	Sep 29, 2026	Tuesday	8:35–9:55	**Midterm 1**	**Midterm 1**
7	Oct 01, 2026	Thursday	8:35–9:55	The active layer and taliks	
8	Oct 06, 2026	Tuesday	8:35–9:55	The seasonal thermal regime	
9	Oct 08, 2026	Thursday	8:35–9:55	The formation of permafrost	**Exercise 2**
10	Oct 13, 2026	Tuesday	8:35–9:55	Frost mounds	
11	Oct 15, 2026	Thursday	8:35–9:55	Unfrozen water	
12	Oct 20, 2026	Tuesday	8:35–9:55	Ice segregation	**Exercise 3**
13	Oct 22, 2026	Thursday	8:35–9:55	Massive ice	
	Oct 27, 2026	Tuesday		No meeting	
	Oct 29, 2026	Thursday		No meeting	
14	Nov 03, 2026	Tuesday	8:35–9:55	Ice wedges	
15	Nov 05, 2026	Thursday	8:35–9:55	**Midterm 2**	**Midterm 2**
16	Nov 10, 2026	Tuesday	8:35–9:55	The ice-rich top of permafrost	
17	Nov 12, 2026	Thursday	8:35–9:55	Frost heave and cryoturbation	
18	Nov 17, 2026	Tuesday	8:35–9:55	Permfrost in mountains	**Exercise 4**
19	Nov 19, 2026	Thursday	8:35–9:55	Permafrost hydrology	
20	Nov 24, 2026	Tuesday	8:35–9:55	Thermokarst	
21	Nov 26, 2026	Thursday	8:35–9:55	Soil carbon	**Exercise 5**
22	Dec 01, 2026	Tuesday	8:35–9:55	Landforms and landsystems	
23	Dec 03, 2026	Thursday	8:35–9:55	Climate change	
24	Dec 08, 2026	Tuesday	8:35–9:55	Land use and infrastructure	**Exercise 6**
25	Dec 10, 2026	Thursday	8:35–9:55	Synthesis	

On the days indicated, midterm exams are written in class and exercises are handed out.

Materials

Online: Basic information and additional reading materials will be provided in Brightspace to supplement each meeting. Individual lectures may be delivered as videos via Brightspace.

Slides: Lecture slides will not be distributed.

Reading: We will use a mixture of book chapters and articles. For each topic, key sources will be outlined on Brightspace. Reading questions or pointers to specific sections will be used to identify what deserves special attention. Students are not required to purchase textbooks or other learning materials for this course.

Key sources:

French, H.M. 2007. The Periglacial Environment. 3rd edition. Wiley. Available online via Carleton library. A fourth edition was published in 2018 but is only available in print.

Williams, P.J. and Smith, M.W. 1989. The Frozen Earth: Fundamentals of Geocryology. Cambridge University Press. Available online via Carleton library.

Lewkowicz, A.G., O'Neill, H.B., Wolfe, S.A., Roy-Léveillée, P., Roujanski V.E., Hoeve, E., Gruber, S., Brooks, H., Rudy, A.C.A., Koenig, C.E.M., Brown, N., Bonnaventure, P.P. (2025). *Glossary of Permafrost Science and Engineering*. Canadian Permafrost Association. http://doi.org/10.3138/cpa-gpse

Lewkowicz, A. G., Wolfe, S. A., Roujanski, V. E., Hoeve, E., O'Neill, H. B., Gruber, S., Roy-Leveillee, P., Brown, N., Koenig, C. E. M., Brooks, H., Rudy, A. C. A., Bonnaventure, P. P. & Paquette, M. (2024). An Illustrated Permafrost Dictionary. 102. Canadian Permafrost Association. https://doi.org/10.52381/CPA.permafrostdictionary.1

The Proceedings of the International Conferences on Permafrost. (www.permafrost.org)

Continuing a long tradition in teaching undergraduate permafrost courses at Carleton University and at the University of Zurich, Switzerland, materials made available by Dr. W. Haeberli and Dr. C. Burn are gratefully acknowledged in contributing to this course.

Evaluation

All evaluated work is graded on a scale of 0–100 points and the final grade is determined as:

Exercises	40%	(counting the four best results of six)
Midterm tests	20%	
Final exam	40%	
Total	**100%**	

The course instructor subject to the approval of the Faculty Dean determines standing in a course. This means that grades submitted by the instructor may be subject to revision. No grades are final until they have been approved by the Dean.

Exercises: Six exercise tasks will be distributed during the term. They will be due before midnight on the fifth day after distribution. The best four submissions will count toward your final grade. The exercises must be submitted in PDF format via Brightspace; see information in section "Generative artificial intelligence (AI)", below.

Mid-term tests will be held in person during the class periods. The tests will have a duration of up to one hour and you must remain in the room for the entire period.

Final exam: The final exam will take place in the final exam period and have a maximum duration of three hours. Students are only allowed to use a **one-sided one-page (letter size) cheat sheet** that they can prepare individually or as a group effort.

The exercises, tests, and exam will use essay or short-answer questions as well as some data interpretation and calculations. They will require knowledge of the lecture materials and of the assigned reading. The work you submit for the exercises, the midterm exams and the final exam must be prepared and presented by you and you alone, without assistance from others. Read the questions carefully. If you answer a different question from that given to you in an exercise, test, or exam, you should not expect to receive any marks for it. Please read section "Generative artificial intelligence (AI)", below.

Missing exercises, tests, or the exam: Late submissions will not be accepted and result in 0 marks. If submission on time is impossible because of a technical problem caused by the instructor or Carleton University, please document that problem and note the date/time. If you miss one or two exer-

cises, no accommodation will be given because only four of six exercises are counted toward your final grade. If you miss more than two exercises or a mid-term test due to illness or other incapacitation, please submit a Self-declaration for Academic Considerations Form to the instructor within three days and a reasonable accommodation will be provided. If you are unable to write the final examination, please follow the instructions for deferral of the Registrar's Office.

Submission of work more than once: Submissions for graded assignments must not have been previously submitted in any course. A repeat submission is recognized by more than 10% of its content being identical to a previous submission. If you intend to re-use work, you must have prior written permission from the instructor.

Generative artificial intelligence (AI)

Process notes: You may use generative AI tools (e.g., ChatGPT, Copilot, Gemini) to support your work in this course. You must include a short process note with each assignment stating whether you used them, and if so, how. Appropriate uses include brainstorming, finding sources and explanations, style feedback, or checking syntax; you remain fully responsible for the accuracy and originality of your submissions. **Assignment without a process note automatically receive 0 marks.**

In-person explanation: To support deep learning and ensure that submitted work reflects your own understanding, students may occasionally be asked to briefly explain their assignments in class or during office hours. For example, you may be asked to *"walk me through how you approached this assignment"* or *"explain what assumptions you made and why they matter."* These short discussions are meant to reinforce learning and accountability. If a student is unable to explain their own submission, this may significantly reduce the grade for that assignment, since demonstrated understanding is a core requirement. AI should enhance—not replace—your own thinking and analysis.

Referencing: Exact referencing and citation is the foundation of scientific research. AI frequently produces errors in citing material and invents references. It is your responsibility to ensure that your citations are exact and that your references are accurate. **A non-existing reference or DOI will automatically result in 0 points for the assignment concerned.**

Language quality: Digitally submitted text must be of very high quality in terms of spelling, grammar, and consistency of conventions (e.g., referencing). Even if this is not your strength, it can be accomplished with available AI tools, provided you use them responsibly and with final proofreading of your own.

Citing generative AI: https://library.carleton.ca/guides/help/generative-ai-chatgpt-and-citations

Academic Integrity, Plagiarism

In this course, you may use generative AI tools within the limits described earlier. Each assignment must include a short process note on AI use. Using AI beyond what is permitted, or failing to disclose it, will be treated as plagiarism under the University's Academic Integrity Policy. Remember that you are responsible for the accuracy, originality, and understanding of all work you submit.

The instructor, following the University Academic Integrity Policy, **will report suspected violations** of the Academic Integrity Policy, along with all relevant evidence to the Office of the Faculty Dean.

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 sources from which the ideas, expressions of ideas or works of others may be drawn from include but are not limited to: books, articles, papers, literary compositions and phrases, performance compositions, chemical compounds, artworks, laboratory reports, research results, calculations and the results of

calculations, diagrams, constructions, computer reports, computer code/software, the output of generative AI systems (e.g., ChatGPT, Copilot, Gemini), and material on the Internet and/or conversations.

Examples of plagiarism include, but are not limited to:

- any submission prepared in whole or in part by someone else, including the unauthorized use of generative AI tools or failure to acknowledge permitted AI use as specified in this syllabus;
- using ideas or direct, verbatim quotations, paraphrased material, algorithms, formulae, scientific or mathematical concepts, or ideas without appropriate acknowledgment in any academic assignment;
- 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 through the use of proper citations when using another's work and/or failing to use quotations marks.

Plagiarism is a serious offence that cannot be resolved directly by the course's instructor. The Associate Dean of the Faculty conducts a rigorous investigation, including an interview with the student, when an instructor suspects a piece of work has been plagiarized. Penalties are not trivial. They can include a final grade of "F" for the course.

Student Mental Health

As a university student you may experience a range of mental health challenges that significantly impact your academic success and overall well-being. If you need help, please speak to someone. There are numerous resources available both on- and off-campus to support you: https://wellness.carleton.ca/mental-health/resource-guide/

Academic Accommodations

Carleton is committed to providing academic accessibility for all individuals. You may need special arrangements to meet your academic obligations during the term. The accommodation request processes, including information about the Academic Consideration Policy for Students in Medical and Other Extenuating Circumstances, are outlined on the Academic Accommodations website (students.carleton.ca/course-outline).

Informal accommodation due to short-term incapacitation: See item *Missing exercises, tests, or the exam* in section *Evaluation*, above.