

## Syllabus for GEOG 4108 Permafrost (0.5 credit), Fall Term 2023

**Instructor:** Stephan Gruber  
Hours: Thursday 14:00–15:00  
Email: [stephan.gruber@carleton.ca](mailto:stephan.gruber@carleton.ca)

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

**Lectures:** Tuesday and Thursday 16:05–17:25 (September 7 to December 7, 2023)

**Location:** in person (some lectures may be delivered as videos in Brightspace)

**Brightspace:** *GEOG4108A Permafrost (LEC) Fall 2023*

**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.

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

**Communication:** Correspondence must be through a Carleton email account; requests from other addresses will not be answered. Please ask questions related to course content in class if possible.

### 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.

### Materials

**Online:** Only basic information 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.

**Key sources:**

- French, H.M. 2007. *The Periglacial Environment*. 3<sup>rd</sup> 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.
- The Proceedings of the International Conferences on Permafrost. ([www.permafrost.org](http://www.permafrost.org))
- Van Everdingen, R. O., & International Permafrost Association. (1998). *Multi-language glossary of permafrost and related ground-ice terms in Chinese, English, French, German...* Arctic Institute of North America, University of Calgary. ([Link](#))

**Course calendar, may be subject to minor revision**

DOW	Date	TOPIC	Graded
Thu	Sep 07, 2023	Introduction	
Tue	Sep 12, 2023	Permafrost distribution	
Thu	Sep 14, 2023	Ground temperature at depth	EX1
Tue	Sep 19, 2023	Seasonal snow	
Thu	Sep 21, 2023	The ground surface	
Tue	Sep 26, 2023	<b>Midterm test one</b>	<b>MT1</b>
Thu	Sep 28, 2023	The active layer	
Tue	Oct 03, 2023	The thermal regime (video lecture and reading)	
Thu	Oct 05, 2023	The formation of permafrost (video lecture and reading)	EX2
Tue	Oct 10, 2023	Frost mounds	
Thu	Oct 12, 2023	Unfrozen water below 0°C	
Tue	Oct 17, 2023	Ice segregation	EX3
Thu	Oct 19, 2023	Massive ice	
Tue	Oct 24, 2023	Reading Week, no class meeting	
Thu	Oct 26, 2023	Reading Week, no class meeting	
Tue	Oct 31, 2023	Ice wedges	
Thu	Nov 02, 2023	<b>Midterm test two</b>	<b>MT2</b>
Tue	Nov 07, 2023	The ice-rich zone at the top of permafrost	
Thu	Nov 09, 2023	Frost heave and cryoturbation	
Tue	Nov 14, 2023	Permafrost in mountains	EX4
Thu	Nov 16, 2023	Thermokarst	
Tue	Nov 21, 2023	Catch up on reading, no class meeting	
Thu	Nov 23, 2023	Soil carbon	
Tue	Nov 28, 2023	Permafrost hydrology	EX5
Thu	Nov 30, 2023	Land use and infrastructure in permafrost areas	
Tue	Dec 05, 2023	Anthropogenic climate change and permafrost	EX6
Thu	Dec 07, 2023	Synthesis	

**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%	
<b>Total</b>	<b>100%</b>	

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.

**Mid-term tests** will be held in person during the class periods. The tests will have a duration of 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 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.

**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 exercises, 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 on the [Deferral Form](#) of the Registrar's Office.

### Academic Integrity, Plagiarism

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, 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 (e.g., ChatGPT);
- 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 acknowledgment;
- 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://carleton.ca/health/emergencies-and-crisis/emergency-numbers/>

## Requests for Academic Accommodations

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

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

**Pregnancy obligation:** Write to the 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 accommodation regarding a formally-scheduled final exam, you must complete the Pregnancy Accommodation Form ([click here](#)).

**Religious obligation:** Write to the 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 [click here](#).

**Academic 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](mailto:pmc@carleton.ca) for a formal evaluation. If you are already registered with the PMC, please request your accommodations for this course through the [Ventus Student Portal](#) at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (*if applicable*). Requests made within two weeks will be reviewed on a case-by-case basis. For final exams, the deadlines to request accommodations are published in the [University Academic Calendars](#). After requesting accommodation from PMC, meet with the instructor to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable).

**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: <https://carleton.ca/equity/sexual-assault-support-services>

**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 will be provided to students who compete or perform at the national or international level. Write to the 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. <https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf>