

# **GEOG 474: Glaciers and Glacial Geomorphology**

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Office hours: Wednesday 1-3 pm

## **Course description**

The glaciers and ice sheets of the world are changing as a result of human-induced climate warming. Many physical factors contribute to the flow of ice and mass change of glaciers and ice sheets. We begin by introducing these processes and their interactions through topics including glacial hydrology, controls on glacial sliding and different types of glacial systems such as ice sheets and valley glaciers. In addition to important links between glaciers and climate, ice has a dramatic impact on landscapes of the world. We will look at glacial geomorphology and examine how ice has carved and shaped our environment.

## **Course format**

Course location and time: EV3 3406, Monday and Wednesday, 10:00-11:20

Lab location TBD

## **Course objectives**

By the end of the course, students will be able to:

1. Explain core concepts of glacial dynamics.
2. Critically analyze the current state of glacial science as it relates to a warming climate.
3. Link landscape features with the glacial processes that caused them.
4. Demonstrate critical thinking through oral presentation and preparation of a research project.

## **Pre-requisites**

Students must be at least 3A honors and have GEOG 201 *or* GEOG 209 (or by permission of the instructor).

## **Evaluation**

Lab assignments	20% (5% each)
Midterm	25%
Class participation/Discussion	10%
Research proposal	5%
Oral presentation	10%
Research paper	30%

## **Labs**

There will be four labs for this class, which will take place in one of the computer labs (location TBD). These labs will make use of database, modeling and remote sensing software. Students will also have access to the computer labs outside of class time to complete their assignments. The lab assignment is due in hard copy and is to be handed to the instructor in class one week after the lab takes place. *Late assignments will not be graded and will be awarded 0 marks.* Due dates for lab assignments are noted on the lecture list.

Consultation between students is allowed for the labs but the lab assignment must be the individual's work. Student's are responsible for backing up their own work on the computers.

## **Class discussion**

There will be a class discussion lasting 30 minutes every second week (with the first one occurring on week two of the term). The discussion will take place in the second lecture slot of the week. Readings and a discussion question will be assigned around the topic of that week on LEARN. A participation grade totaling 10% for the term will be assigned for engagement with the class discussion. Students will be graded for each discussion and if the student is not present they will receive a 0% grade for that discussion.

## **Mid-term**

One mid-term is set for this course and will include questions on the content covered until the date of the exam. The mid-term will be completed during class time (the date is included within the lecture list).

## **Research projects**

The research project consists of a research proposal (5% of grade), an oral presentation (10% of grade) and a single-authored term paper (30% of grade). Students will choose a topic within glaciology and/or glacial geomorphology for their individual project. The research proposal is a one-page document outlining the research question and the key areas that will be researched. The research project will involve an extensive and critical examination of the relevant literature. The term paper will be no more than 3000 words, not including title, abstract, figure and table captions and references. Term papers should be double spaced and must be referenced correctly with no plagiarism.

The deadline for the research proposal is listed within the lecture schedule below. Research proposals will be submitted on LEARN. Oral presentations of the research projects will occur in the final week of classes. The research project term paper is due on the last day of term and is to be submitted on LEARN. The research project assignments are expected to be completed on time. *Late assignments will lose 5% in grade per day and will not be taken after 5 days past the deadline, unless a valid doctors note is produced.*

## Textbook

Required textbook: Benn, D. and Evans, D. 2010. *Glaciers and Glaciation 2<sup>nd</sup> Edition*. Copies of this textbook are available at the UW Bookstore.

### Other useful textbooks:

Cuffey K., and Patterson, W. 2010. *Physics of Glaciers, 4<sup>th</sup> Edition*. Elsevier.

van der Veen, C. J. 2013 *Fundamentals of Glacier Dynamics, 2<sup>nd</sup> Edition*. Pearson Canada

Bennett M. R and Glasser, 2009 N. *Glacial Geology: Ice Sheets and Landforms, 2nd Edition*. Wiley.

## Lecture schedule

The instructor reserves the right to change the class schedule and lecture order as appropriate.

Week	Date	Topic	Assessment	Reading
1	Jan 3 <sup>rd</sup>	<b>Introduction to glaciology</b>		Ch. 1
2	Jan 8 <sup>th</sup> Jan 10 <sup>th</sup>	<b>How to make a glacier</b>	<b>Class discussion</b>	Ch. 2
3	Jan 15 <sup>th</sup> Jan 17 <sup>th</sup>	<b>Ice mass balance</b>	<b>Lab 1: mass balance</b>	Ch. 2
4	Jan 22 <sup>nd</sup> Jan 24 <sup>th</sup>	<b>Glacier hydrology</b>	<b>Class discussion/Lab 1 due</b>	Ch. 4
5	Jan 29 <sup>th</sup> Jan 31 <sup>st</sup>	<b>Ice flow processes</b>	<b>Lab 2: ice flow modelling</b>	Ch. 5
6	Feb 5 <sup>th</sup> Feb 7 <sup>th</sup>	<b>Glacier dynamics</b>	<b>Class discussion/Lab 2 due</b>	Ch. 6
7	Feb 12 <sup>th</sup> Feb 14 <sup>th</sup> Feb 19 <sup>th</sup>	<b>Glacier dynamics</b>  <b>READING WEEK</b>	<b>Research proposal due</b> <b>Lab 3: glacier dynamics</b>	Ch. 6
8	Feb 26 <sup>th</sup> Feb 28 <sup>th</sup>	<b>Ice sheets</b>	<b>Class discussion/Lab 3 due</b>	Ch. 7
9	March 5 <sup>th</sup> March 7 <sup>th</sup>	<b>Ice sheets and climate</b>	<b>Midterm</b>	Ch. 9
10	March 12 <sup>th</sup> March 14 <sup>th</sup>	<b>Geomorphology (erosion)</b>	<b>Lab 4: geomorphology</b>	Ch. 10 (pp. 371-386; 436-440)

11	March 19 <sup>th</sup> March 21 <sup>st</sup>	<b>Geomorphology (deposition)</b>	<b>Class discussion/Lab 4 due</b>	Ch. 11 (pp. 442-492; 510-535)
12	March 26 <sup>th</sup> March 28 <sup>th</sup>	<b>Paleo-glaciology</b>	<b>Student presentations</b>	Ch. 12 (pp. 644-671; 707-712)
13	April 2 <sup>nd</sup> April 4 <sup>th</sup>	<i>No class</i>	<b>Student presentations Term paper due</b>	

### **University of Waterloo LEARN Course Environment**

This course uses the LEARN course environment for course material dissemination and information exchange. LEARN is a web-based course management system that enables instructors to manage course materials (posting of lecture notes etc.), interact with their students, and provide feedback. YOU NEED TO ENSURE THAT YOU CAN ACCESS LEARN. Note that lecture slides are posted on LEARN prior to each lecture. Assignment materials are also distributed through LEARN.

#### *Logging Into LEARN*

Since LEARN is a web-based system, you will need a browser.

Once you have started up your browser, you can access LEARN via: <http://learn.uwaterloo.ca>

#### *Checking Your Userid and Password*

Your password can be checked and reset (if needed) by going to:

<https://watiam.uwaterloo.ca/idm/user/login.jsp>

If you still cannot get on LEARN after checking and resetting your password, please confirm with your instructor that you are on the class roster.

#### *Getting Help*

Documentation for LEARN is available at:

[http://av.uwaterloo.ca/uwace/training\\_documentation/index.html](http://av.uwaterloo.ca/uwace/training_documentation/index.html)

### **Intellectual Property**

Students should be aware that this course contains the intellectual property of their instructor, TA, and/or the University of Waterloo. Intellectual property includes items such as:

- Lecture content, spoken and written (and any audio/video recording thereof);
- Lecture handouts, presentations, and other materials prepared for the course (e.g., PowerPoint slides);
- Questions or solution sets from various types of assessments (e.g., assignments, quizzes, tests, final exams); and
- Work protected by copyright (e.g., any work authored by the instructor or TA or used by the instructor or TA with permission of the copyright owner).

Course materials and the intellectual property contained therein, are used to enhance a student's educational experience. However, sharing this intellectual property without the intellectual property owner's permission is a violation of intellectual property rights. For this reason, it is necessary to ask the instructor, TA and/or the University of Waterloo for permission before uploading and sharing the

intellectual property of others online (e.g., to an online repository). Permission from an instructor, TA or the University is also necessary before sharing the intellectual property of others from completed courses with students taking the same/similar courses in subsequent terms/years. In many cases, instructors might be happy to allow distribution of certain materials. However, doing so without expressed permission is considered a violation of intellectual property rights. Please alert the instructor if you become aware of intellectual property belonging to others (past or present) circulating, either through the student body or online. The intellectual property rights owner deserves to know (and may have already given their consent).

### **Academic Integrity**

In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. The University's guiding principles on academic integrity can be found here:

<http://uwaterloo.ca/academicintegrity/>

ENV students are strongly encouraged to review the material provided by the university's Academic Integrity office specifically for students: <http://uwaterloo.ca/academicintegrity/Students/index.html>

Students are also expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for their actions. Students who are unsure whether an action constitutes an offense, or who need help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the Undergraduate Associate Dean. Students may also complete the following tutorial: <https://uwaterloo.ca/library/get-assignment-and-research-help/academic-integrity/academic-integrity-tutorial>

When misconduct has been found to have occurred, disciplinary penalties will be imposed under Policy 71 – Student Discipline. For information on categories of offenses and types of penalties, students should refer to Policy 71 - Student Discipline,

<https://uwaterloo.ca/secretariat-general-counsel/policies-procedures-guidelines/policy-71>

Students who believe that they have been wrongfully or unjustly penalized have the right to grieve; refer to Policy #70, Student Grievance: <https://uwaterloo.ca/secretariat-general-counsel/policies-procedures-guidelines/policy-70>

**Note for students with disabilities:** AccessAbility Services, located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

**Mental Health:** The University of Waterloo, the Faculty of Environment and our Departments consider students' well-being to be extremely important. We recognize that throughout the term students may face health challenges - physical and / or emotional. **Please note that help is available.** Mental health is a serious issue for everyone and can affect your ability to do your best work. Counselling Services <http://www.uwaterloo.ca/counselling-services> is an inclusive, non-judgmental, and confidential space for anyone to seek support. They offer confidential counselling for a variety of

areas including anxiety, stress management, depression, grief, substance use, sexuality, relationship issues, and much more.

**Religious Observances:** Student needs to inform the instructor at the beginning of term if special accommodation needs to be made for religious observances that are not otherwise accounted for in the scheduling of classes and assignments.

**Grievance:** A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. See Policy 70 - Student Petitions and Grievances, Section 4, [www.adm.uwaterloo.ca/infosec/Policies/policy70.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm). When in doubt please contact your Undergraduate Advisor for details.

**Appeals:** decision made or penalty imposed under Policy 70 - Student Petitions and Grievances (other than a petition) or Policy 71 – (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) [www.adm.uwaterloo.ca/infosec/Policies/policy72.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm)

**Unclaimed assignments:** Unclaimed assignments will be retained until one month after term grades become official in Quest. After that time, they will be destroyed in compliance with UW's confidential shredding procedures <http://www.adm.uwaterloo.ca/infostor/Confidential%20Shredding%20procedures%202008.htm>

**Communications with Instructor and Teaching Assistants:** All communication with students must be through either the student's University of Waterloo email account or via Learn. If a student emails the instructor or TA from a personal account they will be requested to resend the email using their personal University of Waterloo email account.

**Recording lectures:**

- Use of recording devices during lectures is only allowed with explicit permission of the instructor of the course.
- If allowed, video recordings may only include images of the instructor and not fellow classmates.
- Posting of videos or links to the video to any website, including but not limited to social media sites such as: Facebook, Twitter, etc., is strictly prohibited.

**Co-op interviews and class attendance:** Co-op students are encouraged to try and choose interview time slots that result in the least amount of disruption to class schedules. When this is challenging, or not possible, a student may miss a portion of a class meeting for an interview. Instructors are asked for leniency in these situations; but, a co-op interview does not relieve the student of any requirements associated with that class meeting.

When a co-op interview conflicts with an in-class evaluation mechanism (e.g., test, quiz, presentation, critique), class attendance takes precedence and the onus is on the student to reschedule the interview. CECA provides an interview conflict procedure to manage these situations. Students will be required to provide copies of their interview schedules (they may be printed from JobMine) should there be a need to verify class absence due to co-op interviews.