

## Course Outline: ENSC 454/654-3 *Snow and Ice*

### Course Instructors:

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**Office hours:** F 13:00 - 14:00 (BB) OBA

**Lecture:** M 10:30-11:50 (BB)

**Tutorial and Drop-in Session:** F 10:30-11:50 (BB)

## Objectives

This course focuses on the physical processes involving snow and ice that greatly influence the hydrometeorology of northern B.C. and the remainder of Canada. Some of the goals of this course are: 1) to gain a better understanding of snowpack, permafrost, lake ice, and glacier formation and ablation processes, 2) to learn about the characteristics of snow and ice and how they will evolve with climate change, 3) to conduct an extensive snow survey in the field that will form the basis of a research project and in-class presentation.

The Access Resource Centre (ARC) provides service to students with documented disabilities or health conditions, ranging from permanent to temporary, including but not limited to mental health disabilities, learning disabilities and attention deficit disorders, chronic health issues, brain injury, hearing and visual impairments, mobility and other physical disabilities. ARC staff are available by appointment to assess specific needs, provide referrals, and arrange appropriate accommodations to assist you in achieving your academic goals. Students who may have a need for special accommodation are encouraged to contact ARC by email at [arc@unbc.ca](mailto:arc@unbc.ca), by phone 250-960-5682, or in person in Room 10-1048 of the Teaching and Learning Building (Building 10). For more information, please visit <https://www.unbc.ca/access-resource-centre>.

Check your Blackboard course list on <https://learn.unbc.ca> or in the student portal at <https://my.unbc.ca> for a link to the Learning Commons. The UNBC virtual learning commons is a 'one stop shop' for student supports and collaborative online spaces, including Academic Success Centre tutoring, Student Technology Troubleshooters, the online forms of MACE and Nucleus, other drop-in services like Resume and Career help, as well as links

to services such as the Library Research Desk and the Academic Advisors. Also keep an eye on the Learning Commons for links to events and workshops!

Students are responsible for informing themselves of the risks associated with field data collection in an outdoor setting. By participating in such studies they shall be deemed to have accepted personal responsibility for all such risks, to have agreed to abide by the safety rules and procedures established by the instructors, and to have waived the liability of UNBC and its instructors in respect of such activities.

ENSC 454/654 lectures will be taught in an online format due to COVID-19 restrictions using BlackBoard (BB) Collaborate for synchronous sessions, and BB to distribute recorded content. There will be both synchronous and asynchronous components to the course. We plan to use the first scheduled lecture session each week (M 10:30-11:50 PT) as a synchronous lecture delivered using BlackBoard Collaborate (BBC). The remaining lecture content in a given week will generally be delivered in asynchronous format. The second scheduled lecture session each week (F 10:30-11:50 PT) will generally be used to review solutions to example problems, assignments and quizzes, to discuss materials covered in the synchronous and asynchronous lectures that week, and prepare for, and review, the field data collection effort including the snow tracking game.

## **Resources**

The required course textbook is:

Marshall, S. J., 2012: **The Cryosphere**, Princeton University Press, 288 pp.

Other related books that are not necessarily available at the library are:

Armstrong, R. L. and E. Brun, 2008: **Snow and Climate**, Cambridge, 222 pp.

DeWalle, R. and A. Rango, 2008: **Principles of Snow Hydrology**, Cambridge, 410 pp.

French, H. M., and O. Slaymaker, 1993: **Canada's Cold Environments**, McGill-Queen's University Press, 340 pp.

Gray, D. M., and D. H. Male, 1981: **Handbook of Snow**, Blackburn Press, 776 pp.

Paterson, W. S. B., 1994: **The Physics of Glaciers**, Butterworth Heine-  
mann, 3rd ed., 481 pp.

Slaymaker, O., and R. E. J. Kelly, 2007: **The Cryosphere and Global  
Environmental Change**, Blackwell Publishing, 261 pp.

Resources related to ENSC 454/654 (especially video recordings and lecture-  
related materials) can be found on the BlackBoard (BB) page for ENSC  
454/654 at <https://learn.unbc.ca>. Other ENSC 454/654 resources (especially  
field data collection materials) can also be found in the course homepage  
located at <https://cyclone.unbc.ca/454>.

## **Evaluation**

There will be two marked assignments, a snow survey report and presenta-  
tion, a take home final exam. Additionally, associated with lectures there will  
be participation marks and weekly quizzes for a total of 25% of the course  
mark. Participation marks accounting for 5% will be based on attendance  
and participation during the weekly synchronous lectures, with the “best”  
10 participation marks counting. Weekly quizzes will account for 20% of  
the course mark and are based on the synchronous and asynchronous lecture  
material of a given week for weeks 1 through 12. They will be done on BB,  
and due before the next week’s synchronous lecture. The best 10 of 12 quizzes  
will be count toward the total quiz mark.

Due to COVID-19 restrictions, an individual snow data collection effort  
will be undertaken by each student instead of the usual class field trip. Details  
on these measurements and snow survey report will be presented during  
Friday classes. One component of the data collection effort will involve a snow  
tracking game whereby each student will collect at least one measurement  
of snow depth at their current place of residence each week up to the end of  
March. The snow survey report based on these and other snow measurements  
will be a formal one and each student will present their findings to the class.  
The take-home final exam will occur sometime during the April exam period,  
so no travel or employment plans should be made during this time.

Assignments and reports handed in late will have marks deducted at a rate of 20% per day, except for medical or other extraordinary circumstances. In any case, the instructor must be notified of late assignments prior to the due date. Missed exams cannot be made up except on documented grounds **and** notification prior to exam date. Plagiarism and other forms of cheating will not be tolerated and will be strictly dealt with according to university policy (see the “Academic Offenses” section of the UNBC Calendar).

Participation	5%
Assignments*	10%
Snow Tracking Game	10%
Snow Survey Report*	25%
Presentation	10%
Lecture Quizzes	20%
Take home Final Exam*	20%
<b>Total</b>	<b>100%</b>

**\*Note:** Graduate students taking this course will be required to perform additional analyses for the snow survey report and respond to supplemental questions on the assignments and take home final exam.

## **Acknowledgement of Territory**

We acknowledge the land on which we teach is the traditional and unceded territory of the Lheidli T’enneh.

## **Topics:**

The following topics will be covered in the course, as time permits. The dates listed are the Mondays of each week for the winter 2021 semester.

Week	Date	Topic
1	Jan. 11	Introduction to the cryosphere, properties and characteristics of snow and ice (density, thermal conductivity, albedo, etc.). Surface radiation, energy and water budgets.
2	Jan. 18	Snowfall formation and distribution (atmospheric processes, formation and properties of snow crystals and snow flakes).
3	Jan. 25	Snowcover formation and distribution (factors controlling snowpack evolution: precipitation, wind, terrain, vegetation). Global distribution and climatology of snowcover.
4	Feb. 1	Description of research project and preparation for snow data collection in the field.
5	Feb. 8	Snowpack ablation processes (sublimation, melt, liquid water infiltration and runoff).
	Feb. 15	<b>Family Day and mid-semester break, no lectures</b>
6	Feb. 22	Introduction to glaciers: Glacier distribution in Canada, glacier formation and ablation processes, mass balance of glaciers, sea level rise. (guest lectures)
7	Mar. 1	Greenland and Antarctic ice sheets, sea level rise.
8	Mar. 8	Arctic and Antarctic sea ice.
9	Mar. 15	Lake ice and river ice.
10	Mar. 22	Arctic and alpine permafrost.
11	Mar. 29	In class presentations of the snow survey reports.
	Apr. 5	<b>Easter Monday, no lectures</b>
12	Apr. 12	Climate change impacts on the cryosphere.
13	Apr. 19	Final review