ACKNOWLEDGEMENT

UBC's Point Grey Campus is located on the traditional, ancestral, and unceded territory of the xwməθkwəy̓əm (Musqueam) people. The land it is situated on has always been a place of learning for the Musqueam people, who for millennia have passed on their culture, history, and traditions from one generation to the next on this site.

COURSE INFORMATION

Course Title	Course Code Number	Credit Value
Carbon Capture, Conversion and Sequestration Technologies	CHBE 488 / 588	3
Course Calendar Description		
Examination of carbon capture technologies, and CO_2 conversion and sequestration options. Technical foundations on carbon cycle, thermodynamics, transport, absorption, adsorption, sequestration, process control, mineralization and conversion. Analysis of cases in the context of technology, policy and regulatory framework.		

PREREQUISITES

CHBE 346 or MTRL 350 (or equivalent)
CHBE 351 or MTRL 263 (or equivalent)

CONTACTS

Course Instructor(s)	Contact Details	Office Location	Office Hours
Naoko Ellis	naoko.ellis@ubc.ca	CHBE 227	Tuesdays 13:00 - 14:00 (online) Others by appointment

COURSE NARRATIVE

This is a technical elective for senior undergraduate and graduate students. Problems related to climate change can be framed as "wicked problems" for they are often poorly defined and poorly understood. We are often asked to solve these problems in spite of having incomplete and sometimes contradictory information. For instance, even though we have many technologies to capture CO_2 from power plants, why are so few of them in operation around the world? Would installing technical solutions alleviate climate change? Since wicked problems may not have definitive solutions, framing the problem, and asking the right questions leading to better understanding the problem become of paramount importance.

In this course, we will use Carbon Capture, Conversion and Sequestration as the technical field to understand the mindset and skills required to deal with these types of challenges. We will learn in collaboration with others (potentially from different discipline, and vertical integration, i.e., undergrad and grad), examine our assumptions, and practice reflection to cultivate ways in becoming a practicing engineer.

This is the first time this course is offered. As such, students with a design mindset - who may be open to co-designing this course - would be welcome. At the same time, some aspects are based on previously offered graduate course, RES 500W "toward a low carbon future" with rich connections with faculty members across campus. Depending on the diversity of students, this course has the

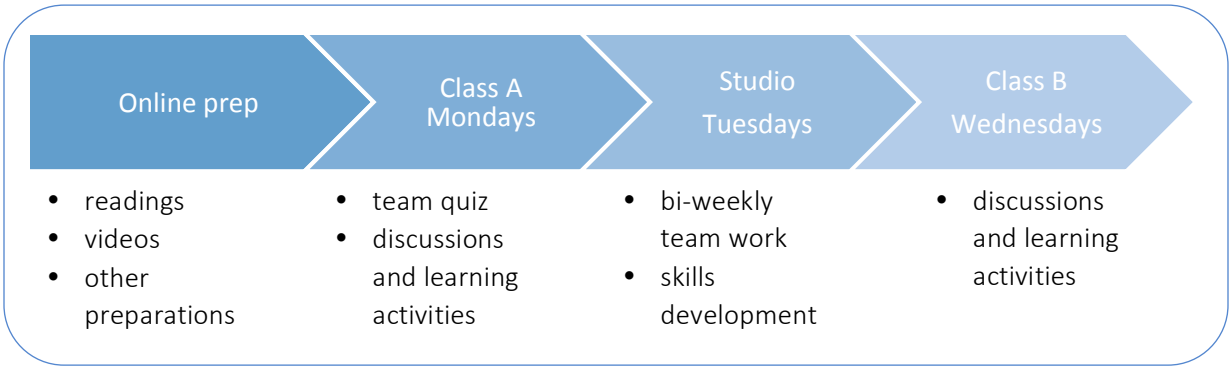
potential to foster transdisciplinary learning.

COURSE STRUCTURE

The course is divided into seven interwoven modules:

- Module 1: Introduction to carbon cycle
- Module 2: Systems approach
- Module 3: Carbon capture and conversion technologies
- Module 4: Assessing emerging technologies
- Module 5: Market analysis and regulatory framework
- Module 6: Carbon transport and containment
- Module 7: Wrap-up

Each week in a module follows a regular pattern of online preparation - large class A - studio - large class B.



SCHEDULE OF TOPICS

Here is a tentative schedule for the course. If there are any changes to the schedule, you will be notified.

Modules	Week	Topics
1: Introduction to Carbon Management	1	Introduction; carbon cycle; wedges game
2: Systems Approach to Evaluating Technologies	2	Systems thinking; causal loop diagram; circular economy
	3	Intro to TEA/LCA
	4	LCA
3: Carbon Capture and Conversion Technologies	5	Carbon capture technologies I
	6	Carbon capture technologies II
	7	Carbon conversion technologies
4: Assessing Emerging Technologies	8	Emerging technologies assessment
	9	Building a narrative around a technology; technology development and de-

		risking
5: Market Analysis and Regulatory Framework	10	CCUS regulatory framework
	11	Communication Strategies
6: Carbon Transport and Containment	12	CO_2 transport and sequestration
7: Wrap up	13	Team project presentation and summary

LEARNING OUTCOMES

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

- Evaluate carbon capture and conversion technologies through conducting process flowsheet and life cycle framework analyses
- Assess technical, economic and environmental issues involved in designing and operation of CO_2 capture plants
- Analyze CCCS cases using technical, policy and regulatory frameworks
- Integrate systems thinking in analyzing the impact of CCCS technology in climate change scenarios
- Develop one's tolerance towards ambiguity and uncertainty
- Cultivate one's strength and abilities towards working in teams and with the learning community
- Develop one's skills as a reflective practitioner

LEARNING MATERIALS

No single textbook is assigned to this course.

For each module, there are mandatory preparatory materials to review (readings and/or web links). These will be posted on Canvas. Further suggested reading material is available on course website (Canvas) through the UBC library online reserve system (LORC). Some of the suggested references are as follow:

- Smit, B., Reimer, J.A., Oldenburg, C.M., Bourg, I.C. (2014) Introduction to Carbon Capture and Sequestration. Imperial College Press.
- Wilcox, J., (2012) Carbon Capture. Springer.

ASSESSMENTS OF LEARNING

Your course grade will be determined according to the following components:

Items	CHBE 488	CHBE 588	Notes
Technology knowledge	quiz and content production 15%	content production 15%	Demonstrate an in-depth understanding of the CCCS technologies and their potential impacts
Case analysis	in teams 20%	in teams 20%	Conduct technical and life-cycle based analyses of emerging technology
Reflections and course expectation entry	15%	15%	Document one's learning journey
Climate model analysis and narrative	10%	10%	Apply systems thinking in analyzing impacts of CCCS technology in scenarios
Final exam	25%		Demonstrate knowledge of CCUS and their contextual issues
Final paper		25%	Produce a report on a chosen CCUS technology/process/instrument
Participation/facilitation and contribution to the learning community	15%	15%	Contribute to class discussions, facilitations, online blog entries and peer learning support

UNIVERSITY POLICIES

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions.

Details of the policies and how to access support are available on **the UBC Senate website.**

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