ENGINEERING 8074: Arctic Ocean Engineering

ENGINEERING 9096: Adv. Design - Ocean & Ice Environments

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Communication: *preferred methods of contact: in person, email, phone*

CALENDAR ENTRY:

ENGI 8074 Arctic Ocean Engineering (same as the former ENGI 8674) examines marine ice as an environmental load factor in the context of ships and engineered structures designed for ice covered waters. Topics include types of naturally occurring ice; sea ice formation and characteristics; mechanical strength of sea ice under common modes of ice failure; modes of ice interaction with ships and marine structures; estimation of ice forces on offshore structures; powering requirements for ice breaking ships; regulations and standards for design of ships and offshore structures in arctic environments.

CR: the former ENGI 8674
PR: ENGI 3934, ENGI 4312
LH: at least four 3-hour sessions per semester

Credit Value: 3 Credits
Accreditation Units: 42 Combined Educational Hours (AUs); Focus: 100% Engineering Sciences

SCHEDULE:

Class: 1:00 – 1:50 M,T,F in EN-4008
Labs: occasional afternoons

RESOURCES:

Textbook:
No textbook required. Course notes in PDF format will be provided. Other papers and readings as assigned.

Reference Books:
1. Michel, Ice Mechanics, Laval University Press 1978
2. Cammaert & Muggeridge, Ice Interaction with Offshore Structures, van Nostrand Reinhold 1988
3. Sanderson, T.J. Ice Mechanics, Risks to Offshore Structures, Graham and Trotman 1988

MAJOR TOPICS:

1. Introduction & Overview, Some Arctic history, Current Arctic Engineering Activities
2. Physical properties of ice and water
3. Ice formation at sea and in fresh water
4. Icebergs – formation, ice type and physical characteristics
5. Mechanical strength of sea ice
6. Ice friction against other materials
7. Ice sheet bearing capacity
8. Ice load processes - crushing, bending, rubble penetration
9. Ship-ice interactions
10. Interactions with pack ice and discrete ice masses
11. Ice model testing
12. Ice regulations and standards
13. Marine installation operations in ice covered waters

ASSESSMENTS:

Method	Credit	Approximate Dates
Assignments*	30% (%'s vary)	
Assignment 1		January 31
Assignment 2		February 7
Assignment 3		March 3
Assignment 4		March 20
Midterm	20%	February 14
Final exam	50%	

* Note: Assignments include both take home and lab reports, and should be submitted in hard copy. Assignments for 9096 will differ from 8074

LEARNING OUTCOMES:

Upon successful completion of this course, the student will be able to:

	LEARNING OUTCOMES	GRADUATE ATTRIBUTES. LEVEL OF COMPETENCE	Methods of Assessment
1	Be able to describe the range of human and industrial activities in the Polar Regions.	7.2, 9.3	Assignments, Midterm
2	Be able to describe the crystal structure of ice and its engineering importance.	1.3	Assignments, Midterm, Exam
3	Be able to discuss the stages of formation of ice in nature from fresh or salt water, including how brash, first year ice, multiyear ice and glacial ice are formed.	1.2	Assignments, Midterm, Exam

4	Understand the natural evolutionary and deformational processes that lead to sea ice features such as rafting and ridging, and hummocks.	1.2, 2.2, 5.3	Assignments, Midterm, Exam
5	Be able to discuss mechanics of ice as a material including the influence of parameters such as strain-rate, temperature, grain size and salinity.	1.3	Assignments, Midterm, Exam
6	Explain why the cantilever beam test is a common measure of effective tensile strength in ice.	5.3	Assignments, Midterm, Exam
7	Explain the approach to determining bearing capacity of an ice sheet based, for static, quasi-static and moving loads.	1.3, 4.2, 5.2	Assignments, Midterm, Exam
8	Discuss the process of ice crushing including the mechanisms of fracture, flaking, pulverization and extrusion.	1.3, 2.3	Assignments, Midterm, Exam
9	Be able to discuss the concept of pressure-area curves, both process and spatial.	1.3, 2.2	Assignments, Midterm, Exam
10	Be able to discuss the concepts of limit strength, limit force, and limit momentum.	1.2, 2.3, 4.3	Assignments, Midterm, Exam
11	Recognize the basic physical mechanisms involved in ship icebreaking and why these mechanisms are treated as components for analysis and model testing.	1.2, 2.3, 4.3, 5.3	Assignments, Midterm, Exam, Labs
12	Calculate ship resistance force using the Lindqvist formulation, and local loads by the Popov method.	1.2, 2.3	Assignments, Midterm, Exam
13	Discuss the basic parameters that influence the global loads from pack ice or iceberg impacts with fixed structures or ships.	1.3, 2.3, 5.3	Assignments, Midterm, Exam
14	Be able to explain the techniques and rational for model testing, showing an understanding types of model ice and scaling concepts.	1.3, 2.3, 3.3, 5.3	Assignments, Midterm, Exam, Labs
15	Recognize what kinds of ships the two types of ice class rules apply to, and contrast ice class and polar class.	1.3, 4.3	Assignments, Midterm, Exam
16	Be able to discuss the concepts of prescriptive rules vs. performance standards with reference to ships and offshore structures.	1.3, 2.3	Assignments, Midterm, Exam
17	Be able to discuss the impact of ice management techniques on marine operations in ice.	2.2, 4.2	Assignments, Midterm, Exam

See www.mun.ca/engineering/undergrad/graduateattributes.pdf for more information on the 12 Graduate Attributes you are expected to be proficient in upon graduation.

Each Graduate Attribute for each learning outcome is rated at a level of proficiency between 1 and 3 (1=introductory, 2=intermediate, 3=sophisticated).

LAB SAFETY:

Students are expected to demonstrate awareness of, and personal accountability for, safe laboratory conduct. Appropriate personal protective equipment (PPE) must be worn (e.g. steel-toed shoes, safety glasses, etc.) and safe work practices must be followed as indicated for individual laboratories, materials and equipment. Students will immediately report any concerns regarding safety to the teaching assistant, staff technologist, and professor.

ACADEMIC INTEGRITY AND PROFESSIONAL CONDUCT:

Students are expected to conduct themselves in all aspects of the course at the highest level of academic integrity. Any student found to commit academic misconduct will be dealt with according to the Faculty and University practices. More information is available at http://www.mun.ca/engineering/undergrad/academicintegrity.php

Students are encouraged to consult the Faculty of Engineering and Applied Science Student Code of Conduct at http://www.mun.ca/engineering/undergrad/academicintegrity.php and Memorial University's Code of Student Conduct at http://www.mun.ca/student/conduct/.

INCLUSION AND EQUITY:

Students who require accommodations are encouraged to contact the Glenn Roy Blundon Centre, http://www.mun.ca/blundon/about/index.php. The mission of the Blundon Centre is to provide and co-ordinate programs and services that enable students with disabilities to maximize their educational potential and to increase awareness of inclusive values among all members of the university community.

The university experience is enriched by the diversity of viewpoints, values, and backgrounds that each class participant possesses. In order for this course to encourage as much insightful and comprehensive discussion among class participants as possible, there is an expectation that dialogue will be collegial and respectful across disciplinary, cultural, and personal boundaries.

STUDENT ASSISTANCE:

Student Affairs and Services offers help and support in a variety of areas, both academic and personal. More information can be found at www.mun.ca/student.