

**Faculty of Science Course Syllabus**  
**Department of Oceanography**  
OCEA 4250/5250  
Acoustical Oceanography  
Fall 2025

**Instructors:** David Barclay dbarclay@dal.ca LSC Ocean 5672

**Lectures:** Tues/Thurs 2:30 – 4PM, LSC3652 (Riley Room)

**Office hours:** Once weekly at a time to be determined between students and myself

**Laboratories:** 0

**Tutorials:** 0

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### Course Description

This course covers the basic theory of acoustics in fluids, sound propagation and scattering in the ocean environment, and the applications to acoustic remote sensing of the ocean interior and seabed. Topics include: normal modes; ray theory; ambient noise, scattering from particles, bubbles and biota; sonar theory and operation; and acoustic inversions.

### Course Prerequisites

Intended for first-year graduate students in physical oceanography, but graduate students or senior undergraduates in Mathematics or Physics are invited to take it (subject to instructor approval). Familiarity with vectors, vector calculus, ordinary differential equations, partial differential equations, complex variables and classical mechanics required.

### Course Objectives/Learning Outcomes

The students should expect to gain a theoretical and phenomenological basis of sound propagation and scattering in the ocean, and learn about inversion methods for measuring physical and bio-geo-chemical properties of the ocean.

### Course Materials

Textbook: Clay and Medwin, *Acoustical Oceanography*  
Jensen et al, *Computational Ocean Acoustics*

Complimentary and alternate:

Urlick, *Principles of Underwater Sound* (survey text)  
Frisk, *Ocean and Seabed Acoustics* (propagation, geoacoustics)  
Tolstoy and Clay, *Ocean Acoustics* (propagation, analytic)  
Morse and Ingard, *Theoretical Acoustics* (mainly scattering)  
Morse and Feschbach, *Methods of Theoretical Physics, Part II*  
Pierce, *Acoustics*

Website: [noise.phys.ocean.dal.ca/teaching.html](http://noise.phys.ocean.dal.ca/teaching.html)

## Course Assessment

Component	Weight (% of final grade)	Date
<i>Final exam</i>	30%	[December 9 <sup>th</sup> , December 14 <sup>th</sup> ]
<i>Assignments</i>	50%	assigned weekly, all due December 9 <sup>th</sup>
<i>Term project</i>	20%	December 2 <sup>nd</sup>

## Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

A+ (90-100)	B+ (77-79)	C+ (65-69)	D	(50-54)
A (85-89)	B (73-76)	C (60-64)	F	(<50)
A- (80-84)	B- (70-72)	C- (55-59)		

## Course Policies

### *Assignments*

All assignments will be accepted at any time throughout the term until 11:59 PM ADT, April 8<sup>th</sup>, the day before the final exam. Missed assignments will be graded as a zero. Every student will be allowed to drop their single lowest assignment score in computing their final grade. Note that computer code developed to answer assignment questions may be required to correctly answer questions on the final exams.

### *Term project*

*The term project will be a review paper or presentation on the topic of the student's choice.*

### *Final exam*

The final exam will be a take home exam comprised on analytical and computer-simulation questions. The exam will be designed to be completed in 5 hours under typical closed-book in-class exam writing conditions but is open over 5 days to accommodate student schedules and to reduce cumulative unguided studying. Questions may use code previously developed during the assignments. It will be released at 12:00 AM ADT on December 9<sup>th</sup> and must be submitted by 11:59 PM ADT December 14<sup>th</sup>. Late final submission will not be accepted except under exceptional and verifiable technical circumstances (e.g. power or internet outage). If this time period will not be suitable for pre-existing personal reasons, please inform the instructor as soon as possible to schedule another 5-day period.

In the event that the final exam is not completed after all above-described attempts to accommodate the student have been attempted, a zero grade will be awarded.

## Course Content

### *Lectures & course topics*

Most lectures will be hosted online as private videos on Youtube to maximize accessibility.

*Week 0 – Time series and time-frequency analysis*

*Week 1 – Acoustics and waves.*

*Week 2 – Acoustics in fluids, solids & the ocean*

*Week 3 – Analytical propagation, wave number integration*

*Week 4 – Analytical and computational propagation, normal modes*

*Week 5 – Computational propagation, ray theory*

*Week 6 – Computational propagation, Parabolic Equation*

*Week 7 – Ambient noise*

*Week 8 – Passive acoustic tomography and spectroscopy*

*Week 9 – Seabed acoustics and geoacoustic inversion*

*Week 10 – Interface waves and scattering*

*Week 11 – Final Exam*

### ***Electronic office hours***

By the end of week 0, we will collectively schedule at least one one-hour periods for electronic or in-person office hours, during which a Microsoft Teams meeting will be scheduled. Office hours attendance is voluntary, as the aim of these sessions will be to provide answers to questions with regard to the lectures and assignments.

### ***Required software***

Please install all software in week 0! Students will be required to install the Teams software for office hour meetings. Matlab is suggested, but not required, as the primary development platform for assignments. It is available to Dal students through the software library (<https://software.library.dal.ca/>). Students have successfully used R in past offerings of this course. Fortran would be a sensible choice for those who admire speed, while python would be suitable for those who appreciate modernity. Matlab is the top suggestion only because of some resources such as the Ocean Acoustic Library (<https://oalib-acoustics.org/>) and the Thermodynamic Equation of Seawater (<http://www.teos-10.org/>) provide complementary and useful software in that language.

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## **ACCOMMODATION POLICY FOR STUDENTS**

Students may request accommodation as a result of barriers related to disability, religious obligation, or any characteristic protected under Canadian Human Rights legislation. The full text of Dalhousie's Student Accommodation Policy can be accessed here:

[http://www.dal.ca/dept/university\\_secretariat/policies/academic/student-accommodation-policy-wef-sep--1--2014.html](http://www.dal.ca/dept/university_secretariat/policies/academic/student-accommodation-policy-wef-sep--1--2014.html)

Students who require accommodation for classroom participation or the writing of tests and exams should make their request to the **Advising and Access Services Centre (AASC)** prior to or at the outset of the regular academic year. More information and the ***Request for Accommodation*** form are available at [www.dal.ca/access](http://www.dal.ca/access).

### **ACADEMIC INTEGRITY**

Academic integrity, with its embodied values, is seen as a foundation of Dalhousie University. It is the responsibility of all students to be familiar with behaviours and practices associated with academic integrity. Instructors are required to forward any suspected cases of plagiarism or other forms of academic cheating to the Academic Integrity Officer for their Faculty.

The Academic Integrity website (<http://academicintegrity.dal.ca>) provides students and faculty with information on plagiarism and other forms of academic dishonesty, and has resources to help students succeed honestly. The full text of Dalhousie's ***Policy on Intellectual Honesty*** and ***Faculty Discipline Procedures*** is available here:

[http://www.dal.ca/dept/university\\_secretariat/academic-integrity/academic-policies.html](http://www.dal.ca/dept/university_secretariat/academic-integrity/academic-policies.html)

### **STUDENT CODE OF CONDUCT**

Dalhousie University has a student code of conduct, and it is expected that students will adhere to the code during their participation in lectures and other activities associated with this course. In general:

“The University treats students as adults free to organize their own personal lives, behaviour and associations subject only to the law, and to University regulations that are necessary to protect

- the integrity and proper functioning of the academic and non – academic programs and activities of the University or its faculties, schools or departments;
- the peaceful and safe enjoyment of University facilities by other members of the University and the public;
- the freedom of members of the University to participate reasonably in the programs of the University and in activities on the University's premises;
- the property of the University or its members.”

The full text of the code can be found here:

[http://www.dal.ca/dept/university\\_secretariat/policies/student-life/code-of-student-conduct.html](http://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html)

### **COPYRIGHT**

All members of the Dalhousie community are expected to comply with their obligations under Canadian copyright law. Dalhousie copyright policies and guidelines, including our Fair Dealing Guidelines, are available at <http://www.dal.ca/dept/copyrightoffice.html>. Copyright questions should be directed to the Copyright Office at [copyright.office@dal.ca](mailto:copyright.office@dal.ca).

**SERVICES AVAILABLE TO STUDENTS**

The following campus services are available to help students develop skills in library research, scientific writing, and effective study habits. The services are available to all Dalhousie students and, unless noted otherwise, are free.

<b>Service</b>	<b>Support Provided</b>	<b>Location</b>	<b>Contact</b>
<b>General Academic Advising</b>	Help with - understanding degree requirements and academic regulations - choosing your major - achieving your educational or career goals - dealing with academic or other difficulties	<b>Killam Library Ground floor</b> Rm G28 <b>Bissett Centre for Academic Success</b>	In person: Killam Library Rm G28 By appointment: - e-mail: <a href="mailto:advising@dal.ca">advising@dal.ca</a> - Phone: (902) 494-3077 - Book online through MyDal
<b>Dalhousie Libraries</b>	Help to find books and articles for assignments Help with citing sources in the text of your paper and preparation of bibliography	<b>Killam Library Ground floor</b>  Librarian offices	In person: Service Point (Ground floor)  By appointment: Identify your subject librarian (URL below) and contact by email or phone to arrange a time: <a href="http://dal.beta.libguides.com/sb.php?subject_id=34328">http://dal.beta.libguides.com/sb.php?subject_id=34328</a>
<b>Studying for Success (SFS)</b>	Help to develop essential study skills through small group workshops or one-on-one coaching sessions  Match to a tutor for help in course-specific content (for a reasonable fee)	<b>Killam Library 3<sup>rd</sup> floor</b>  Coordinator Rm 3104  Study Coaches Rm 3103	To make an appointment: - Visit main office (Killam Library main floor, Rm G28) - Call (902) 494-3077 - email Coordinator at: <a href="mailto:sfs@dal.ca">sfs@dal.ca</a> or - Simply drop in to see us during posted office hours <b>All information can be found on our website: <a href="http://www.dal.ca/sfs">www.dal.ca/sfs</a></b>
<b>Writing Centre</b>	Meet with coach/tutor to discuss writing assignments (e.g., lab report, research paper, thesis, poster) - Learn to integrate source material into your own work appropriately - Learn about disciplinary writing from a peer or staff member in your field	<b>Killam Library Ground floor</b> Learning Commons & Rm G25	To make an appointment: - Visit the Centre (Rm G25) and book an appointment - Call (902) 494-1963 - email <a href="mailto:writingcentre@dal.ca">writingcentre@dal.ca</a> - Book online through MyDal  We are open six days a week  <b>See our website: <a href="http://writingcentre.dal.ca">writingcentre.dal.ca</a></b>