Course Description
This course explores hearing at levels that include stimulus parameters and their psychophysical correlates, middle ear function, cochlear biophysics, central auditory neurophysiology, and principles of speech perception. We emphasize mechanisms of normal hearing and speech, but address pathology wherever it helps us understand the relation between neurophysiology and perception.

Course Prerequisites
PSYO 2000.03 or NESC 2007.03, and PSYO/NESC 2470.03

Course Objectives/Learning Outcomes
1. Students should acquire a basic knowledge of physical acoustics, including the wave equation, diffraction, and Fourier analysis.
2. Students will acquire a knowledge of peripheral and middle ear function, and the consequences of middle ear disease.
3. Students will acquire a knowledge of cochlear anatomy and biophysics, with special emphasis on auditory transduction processes.
4. Students will acquire a basic knowledge of the central auditory pathways and their tonotopic organization.
5. Students will acquire a detailed knowledge of sound localization processes, including the physical cues for sound location, the neural encoding of that cue information, the “architecture” of sound localization neurophysiology, and the effects of brain lesions on sound localization.
6. Students will acquire a knowledge of the physical acoustics of speech sounds, and the levels of processing involved in speech perception.
7. Students will acquire a knowledge of the physical processes involved in the generation of speech sounds.
8. Students will acquire a detailed understanding of the processes involved in speech perception, including the links between speech production and perception, and the resolution of the “speech is special” debate.

Course Materials
- There is no prescribed textbook for this course. There are, however, assigned readings for most of the course topics, and additional handouts are provided during the course.
- There is no course website.

Course Assessment
Tests/quizzes

There are four tests in this course, at approximately 3-week intervals. Each test is worth 25% of the final grade for the course. The dates of the first 3 tests will be announced in class, with no less than one week’s notice. The final test is during the last class of the course. The first two tests are in the form of short-answer, often problem-solving questions. The last two tests are essays. The first of the essays is a take-home one, with a due date of a few days. The second of the essays will be written in-class, and there will be no prior warning as to the exact topic of the question. The tests in this course are not cumulative. However, knowledge from the earliest sections of the course are directly relevant to successful completion of the subsequent tests, including the final. A student’s final grade for the course is the numerical sum of the grades for the four tests.

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

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<thead>
<tr>
<th>Grade</th>
<th>Numerical Range</th>
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<tbody>
<tr>
<td>A+</td>
<td>90 - 100</td>
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<tr>
<td>A</td>
<td>85 - 89</td>
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<td>A-</td>
<td>80 - 84</td>
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<td>B+</td>
<td>77 - 79</td>
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<td>B</td>
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<td>B-</td>
<td>70 - 72</td>
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<tr>
<td>C+</td>
<td>65 - 69</td>
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<td>C</td>
<td>60 - 64</td>
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<td>C-</td>
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<td>D</td>
<td>50 - 54</td>
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<tr>
<td>F</td>
<td>&lt;50</td>
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Course Policies

A single make-up exam will be arranged for students unable to complete a test on the scheduled date, providing that a doctor’s note is provided. These make-up tests are usually scheduled for about 7 days after the regular test date, contingent on room availability. In the absence of a doctor’s note, failure to take a test results in a grade of zero for that test. Failure to attend the make-up test results in a grade of zero for that test. Late submissions of test #3 (take-home essay) are penalized at a rate of 1 mark (out of 25) per day, failing the provision of an appropriate doctor’s note.

We have not historically missed lectures or tests due to weather, but bad weather can happen. In the case of missed lectures, the Instructor will modify the course content, and the relevant tests, accordingly and those modifications will be reported in class and ideally also by e-mail. The same is true for weather-related missed tests. NB: “weather-related” means that the University is closed on those dates.

Course Content

How to Study for this Course

Here are some guidelines that you might find helpful in studying for this course. The first rule is “Don’t miss class”. The content of the lecture stream has been very carefully “sculpted” so that nothing
(examinable) is missed, and so that there is a continuous and logical thread or “unfolding” of the material. This natural unfolding of the material does not occur in the articles on the reading list, so you cannot use the readings as a substitute for the lectures. The readings will give you access to the original reports of various topics, but will not place the findings in the context provided by our lecture stream. The readings also will provide lots of information that is not relevant to our course; that’s because the motivation for publishing the articles had nothing to do with this course. The lectures have also been designed so that concepts or issues developed very early in the course re-appear later on. This point is important, so let’s make it the second rule. Don’t treat the lecture material as simply a serial learning exercise so that you learn some subject matter, get tested on it, and then forget it: concepts that arise very early in the course are critical to understanding topics that occur later in the course. So, rule #2 is remember everything!

There are some websites that you might wish to explore to supplement the material we cover in lectures. The danger with websites is that they are not peer-reviewed, and so, unless you are an expert in the field, you have little way of knowing whether the material they present is factually correct. Here are some good sites, though they are by no means the only ones.

http://www.physics.smu.edu/~olness/www/05fall1320/applet/pipe-waves.html
http://www.cochlea.org/
http://www.augie.edu/perry/ear/hearmech.htm

Especially towards the beginning of the course (because there’s so much new language and so many unfamiliar concepts there), I give so-called “homework assignments”. These are completely voluntary, and are not graded. I will simply pose a question (or two) at the end of a class, and your task is to try to derive an answer to the question by the start of the next class. The questions themselves exploit factual material from recent lectures, and typically require some problem-solving ability, i.e., the application of the factual information in some context or setting that might be unexpected. The questions are designed to “stretch your thinking.” It is less important that you get the answer right than that you try to. I will always provide the “correct” answer (if there is one) at the beginning of the class that follows giving you the homework question. So, rule three is: “Always do the homework assignments”.

Letters of Reference

Each year, some students need letters of reference in support of their applications for admission to graduate programs. These letters can sometimes be important, and they should be prepared by a professor (or other person) who knows you well, and who has grounds to believe that s/he should support your application. If time permits it, I am prepared to write letters for students who (a) have completed at least one of my classes, (b) have done so with a grade of A- or better, (c), provide me with a complete transcript of their grades at Dalhousie (photocopy will do), and (d), give me at least three weeks to prepare and send the letter. In general, when seeking a letter of reference, you should consider not whether some person can write you a letter per se, but whether they can write you a good letter. These are two quite different things.

Course Outline

1. PHYSICAL ACOUSTICS
   • nature and properties of sound waves
   • key terms: frequency, amplitude, phase, period, wavelength, diffraction, interference, standing waves, filtering, impedance
Fourier analysis, fundamental frequency, harmonics
measurement of sound: dB scales, short-term and long-term spectra

2. OUTER AND MIDDLE EARS
- structure and sound collecting function of the external ear
- anatomy of the middle ear
- the impedance mismatch problem
- nature of conductive hearing loss

3. COCHLEA
- gross structure of the cochlea
- basilar membrane mechanics
  - passive and active components
- fine structure of the Organ of Corti
- transduction processes: hair cell receptor potentials
- two types of hair cells: innervation patterns
- genesis of auditory nerve fiber tuning, and the roles of the two hair cell populations
- cochlear hearing loss ('nerve deafness')
- cochlear potentials (if time permits)

4. AUDITORY NERVE
- two types of auditory nerve fibers (if time permits)
- phase-locking
- two neural codes for sound spectrum: spatial and temporal
- rationale for the cochlear implant programs

5. CENTRAL AUDITORY NERVOUS SYSTEM
- structural and functional organization of the central auditory system
- brainstem evoked potentials in audiological and neurological diagnosis

6. SOUND LOCALIZATION MECHANISMS
- nature of binaural sound localization cues: effects of sound frequency and azimuth
- neural coding of binaural sound localization cues, interaural phase and intensity differences
- behavior-lesion studies of sound localization
- evolutionary factors in sound localization acuity

7. SPEECH PRODUCTION AND SPEECH PERCEPTION
- distinguishing speech and language
- nature of speech sounds
- generation of speech sounds: the source-filter theory
- the problem of invariance in speech perception
- Liberman's solution of the problem: the motor theory
- testing the motor theory: linguistic feature detectors
- testing linguistic feature detectors: the problem of invariance again
- the acoustic account of speech recognition
- the auditory cortex and 'pure word deafness' (if time permits)
Reading List

Following is a list of readings for the course. The list is sorted by lecture-stream topic. Remember that these articles were not particularly intended for students, let alone for students in this course. Treat each one as another author’s perspective on the general topic we covered in the relevant lecture(s). For the purposes of our exams, the important sections of the readings are those that directly address (or repeat) the lecture material.

Physical Acoustics, External And Middle Ears


Cochlea, Auditory Nerve


Sound Localization


Speech Perception


**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](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:
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.

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<tr>
<th>Service</th>
<th>Support Provided</th>
<th>Location</th>
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<tr>
<td>General Academic Advising</td>
<td>Help with understanding degree requirements and academic regulations, choosing your major, achieving your educational or career goals, dealing with academic or other difficulties</td>
<td>Killam Library Ground floor Rm G28</td>
<td>In person: Killam Library Rm G28 By appointment:</td>
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<td>Bissett Centre for Academic Success</td>
<td>- e-mail: <a href="mailto:advising@dal.ca">advising@dal.ca</a> - Phone: (902) 494-3077 - Book online through MyDal</td>
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<tr>
<td>Dalhousie Libraries</td>
<td>Help to find books and articles for assignments, Help with citing sources in the text of your paper and preparation of bibliography</td>
<td>Killam Library Ground floor Librarian offices</td>
<td>In person: Service Point (Ground floor) By appointment:</td>
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<td>- 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></td>
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<tr>
<td>Studying for Success (SFS)</td>
<td>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)</td>
<td>Killam Library 3rd floor Coordinator Rm 3104 Study Coaches Rm 3103</td>
<td>To make an appointment:</td>
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<td>- 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</td>
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<td>All information can be found on our website: <a href="http://www.dal.ca/sfs">www.dal.ca/sfs</a></td>
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<td>Writing Centre</td>
<td>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</td>
<td>Killam Library Ground floor Learning Commons &amp; Rm G25</td>
<td>To make an appointment:</td>
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<td>- 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</td>
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<td>We are open six days a week See our website: writingcentre.dal.ca</td>
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