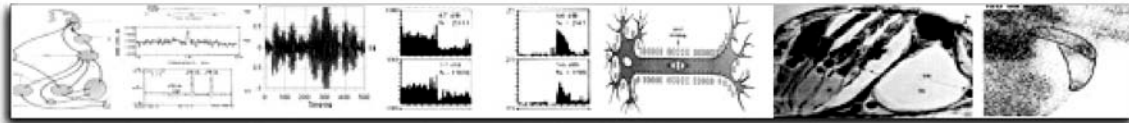


**Introduction to Psychoacoustics and Sound Perception**  
Columbia College, Chicago  
Fall 2011 – 43-2310 Section 01 – Pantelis N. Vassilakis Ph.D.  
<http://www.acousticslab.org/psychoacoustics>



<b>Course # / Section</b>	43-2310 / 01
<b>Credits</b>	3 hours
<b>Class time / place</b>	Thursday, 3:30-6:20 p.m. / 33 E. Congress Ave., Room 609
<b>Course Site</b>	<a href="http://www.acousticslab.org/psychoacoustics">http://www.acousticslab.org/psychoacoustics</a>
<b>Instructor</b>	Pantelis N. Vassilakis, Ph.D.
<b>Phone</b>	Cell: 773-750-4874 – Department: 312-369-8820
<b>e-mail / web</b>	<a href="mailto:pvassilakis@colum.edu">pvassilakis@colum.edu</a> / <a href="http://www.acousticslab.org">http://www.acousticslab.org</a>
<b>Office hours</b>	By appointment
<b>Pre-requisites</b>	Basic Audio Systems – <i>Pre/Co-requisite</i> : Studies in Hearing

## COURSE INTRODUCTION

Psychoacoustics is a multidisciplinary field that examines the relationship between the physical world of acoustics (physical aspects of acoustics, acoustic waves) and the perceptual world of hearing (physiological, behavioral, and cognitive processes). More specifically, it examines ways in which physics and physiology interact to give rise to sound sensations/perceptions. An understanding of psychoacoustics is essential to those wishing to pursue a career in any discipline that involves sound.

## COURSE DESCRIPTION

Class provides the necessary basis for understanding how we hear the world around us. The course is multidisciplinary, with contributions from the academic disciplines of auditory physiology, physics, and psychology. It examines how the human auditory system processes the information it receives, that is, how physical attributes of sound translate into perceptual attributes such as loudness, pitch, and timbre. Topics extend to the perception of music, sound localization, speech, and beyond. Numerous audio-visual demonstrations are used to reinforce the theoretical material presented.

## COURSE RATIONALE AND PREREQUISITES

This course is intended for students who plan to pursue a career in acoustics, recording, audio arts, sound contracting, sound reinforcement, loudspeaker design, multimedia authoring, music, and other related fields.

It fulfills a requirement for the AA+A major at *Columbia College Chicago*. Registration requires satisfactory completion of “Basic Audio Systems” and also has as a pre/co-requisite “Studies in Hearing.”

## GOALS AND OBJECTIVES

Our auditory perception, i.e., hearing, is subjective, while most measurements in acoustics are objective. It is necessary to discriminate between subjective and objective sonic quantities. For instance, although a sound level meter might display the same reading for two acoustical signals, listeners might hear one of them is much louder than the other. Moreover, listeners usually demonstrate individual differences for a subjective quantity. A good example is sound localization in the sagittal (e.g. median) plane: when presenting identical acoustical signal to two listeners through in-ear phones, one listener might localize it in the front, while the other might localize it in the back. The relationship between objective measurement and subjective perception is addressed by psychophysics, through observation and experiments, with psychoacoustics focusing specifically on auditory perception.

### OBJECTIVES

Upon successful completion of the course, students will have demonstrated:

- command of the basic principles of human perception of sound and the ways physics of sound and hearing physiology interact to give rise to sonic perceptions,
- ability to successfully link subjective concepts on sound perception to objective quantities in acoustics and hearing physiology,
- understanding of advanced psychoacoustic phenomena illustrated through relevant audio demonstrations, and
- ability to report on research related to a specific topic in psychoacoustics.

More specifically, successful students will demonstrate basic understanding of the following topics addressed in class, through take-home quizzes, in-class tests, and a written report:

- *Physical aspects of acoustic waves*  
(physical variables of sound generation, transmission, and measurement: frequency, amplitude, phase, time, and spectrum; wave propagation, speed, reflection, absorption, refraction, and diffraction; interference; resonance; overview of sound signal synthesis/analysis, digital signals, and signal processing)
- *Biology of hearing*  
(physiological variables of sound reception: peripheral auditory system; critical bands and masking; neural processing; non-linearity of the hearing mechanism)
- *Perceptual aspects of acoustic waves*  
(perceptual attributes of auditory sensation and their physical/physiological correlates: pitch; loudness; duration; timbre; sensory consonance/dissonance; sound-source localization; subjective evaluation of room acoustics)
- *Speech and music perception; Musical instruments*  
(overview, in the context of sound perception)
- *Cognitive aspects of sound*  
(introduction to cognitive variables of sound organization/interpretation, in the context of sound perception)
- *Audio applications of Psychoacoustics and Cognitive Psychology*  
(examples presented throughout the semester, in the context of the rest of the course materials)

### TEXT AND MATERIALS

REQUIRED TEXT (AVAILABLE AT THE COLLEGE BOOKSTORE)

**Plack, C.J. (2005).** *The Sense of Hearing*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

**Vassilakis, P. (2010).** Introduction to Psychoacoustics and Sound Perception. Online lecture notes.

<http://www.acousticlab.org/psychoacoustics>

#### ADDITIONAL REFERENCE RESOURCES

- Békésy, G. von (1960).** *Experiments in Hearing*. New York: McGraw-Hill.
- Campbell, M. and Greated, C. (1987).** *The Musician's Guide to Acoustics*. Oxford: Oxford University Press.
- Deutsch, D. (1995).** "Musical Illusions and Paradoxes." Compact Disc. La Jolla, CA: Philomel Records, Inc. [http://philomel.com/musical\\_illusions/oncd2.html](http://philomel.com/musical_illusions/oncd2.html)
- Deutsch, D. (ed.) (1999)** (2nd edition). *The Psychology of Music*. San Diego: Academic Press.
- Fastl, H. Zwicker, E. (2007)** (3<sup>rd</sup> edition). *Psychoacoustics, Facts and Models*. Berlin, Germany: Springer Series in Information Sciences (includes psychoacoustic demonstrations CD).
- Helmholtz, H.L.F. (1862/1877/1885)** (2<sup>nd</sup> edition). *On the Sensations of Tone as a Physiological Basis for the Theory of Music*. Trans. A. J. Ellis. New York: Dover Publications, Inc. (1954).
- Moore, B.C.J. (2004)** (4<sup>th</sup> edition). *An Introduction to the Psychology of Hearing*. London, UK: Elsevier.
- Yost, W. A. (2007)** (5<sup>th</sup> edition). *Fundamentals of hearing: An introduction*. New York: Academic Press.

## EVALUATION PROCEDURES & GRADING SCALE

### READINGS AND HOMEWORK: 20%

In each class session a set of topics will be addressed and readings will be assigned (from your textbook and other supplied resources). Homework will be distributed after some of the classes and is designed to assess your understanding of the materials presented in class and the readings. It is your responsibility to read all assigned readings and come to the each class session having completed any homework distributed during the previous class session. In the case of an absence, you are responsible for making arrangements to a) turn-in completed homework and b) obtain and complete any homework distributed during the class meeting you missed.

The lowest homework grade will be dropped from your final grade calculation.

### IN-CLASS TESTS: 40% (2 TESTS, 20% EACH)

### FINAL EXAM: 25%

Two in-class tests and one final cumulative exam are scheduled, covering materials discussed in class, not all of which are included in the textbook.

### RESEARCH PROJECT - 15% (25% ORAL PRESENTATION, 75% WRITTEN REPORT)]

Students will work in groups of 3-4 on a specific topic of their choice, within the area of sound perception. Group formation and topic selection are due between Week 8 and Week 10 of classes. Project presentation and submission are due the week before the final exam. Detailed project instructions are provided in a separate document.

### GRADING SCALE

<b>A:</b> 100 - 90	<b>B+:</b> 86.9 - 84	<b>C+:</b> 76.9 - 74	<b>D:</b> 66.9 - 60
<b>A-:</b> 89.9 - 87	<b>B:</b> 83.9 - 80	<b>C:</b> 73.9 - 70	<b>F:</b> < 60
	<b>B-:</b> 79.9 - 77	<b>C-:</b> 69.9 - 67	

**I:** (incomplete – assigned in accordance with the College's academic guidelines)

## CLASSROOM POLICIES

- You are expected to abide by the College's policies on **academic honesty and integrity**, as outlined in the student handbook <http://students.colum.edu/handbook/entries/academic-integrity>  
Violations include but are not limited to: cheating, plagiarism, fabrication, falsification or sabotage of research data, destruction or misuse of the College's academic resources, and alteration or falsification of academic records.
- **Be respectful of all class members. Be prepared to accept and offer criticism, to question and be questioned.** Intellectual disagreements and conflicts that do not involve personal attacks are strongly encouraged. They are necessary in order to formulate strong intellectual argumentation skills and improve understanding.
- Cell-phones and other mobile devices must be silent during class. **Be ready to begin by the scheduled class start time.**
- **Attendance** is necessary in order to do well in this course. **If you cannot make it to a class meeting you must notify me in advance via email or phone.** Unapproved, unexplained, and extensive (beyond 2) absences will be penalized. Exceptional circumstances will be handled on an individual basis.

## STUDENTS WITH DISABILITIES STATEMENT

Columbia College Chicago seeks to maintain a supportive academic environment for students with disabilities. Students who self-identify as having a disability should present their documentation to the Services for Students with Disabilities (SSD) office. After the documentation has been reviewed by the SSD office, a Columbia College accommodation letter will be provided to the student. Students are encouraged to present their Columbia accommodation letters to each instructor at the beginning of the semester so that accommodations can be arranged in a timely manner by the College, the department, or the faculty member, as appropriate. Accommodations will begin at the time the letter is presented. Students with disabilities who do not have accommodation letters should visit the office of Services for Students with Disabilities, Room 304 of the 623 S. Wabash building (312-369-8296). For more see

[http://www.colum.edu/students/Academics/Services\\_for\\_Students\\_with\\_Disabilities/index.php](http://www.colum.edu/students/Academics/Services_for_Students_with_Disabilities/index.php)

## SATISFACTORY ACADEMIC PROGRESS

In the fifth week of the semester, your teacher will be asked to provide some early feedback on your academic performance to help the College identify students who may be falling behind and are at risk of not satisfactorily completing a course. This online Academic Progress Report (APR) will notify students in time to seek academic coaching or other assistance to improve their grade. The APR is necessary because new federal regulations require that students who achieve less than a 2.0 GPA and/or don't complete two-thirds of their classes for two semesters in a row must be dismissed from the College. Below is a sample list of indicators that will be considered by your teacher to trigger an early alert message regarding your progress:

- Student has missed at least half of the scheduled class sessions or individual conferences (3 out of 5 for classes that meet once a week; 5 out of 10 for classes that meet twice a week).
- Student arrives more than 15 minutes late or leaves more than 15 minutes early 3 out of 5 class sessions.
- Student has earned a grade lower than C on the majority of graded assignments so far (including quizzes, homework, in-class activities, etc.).
- Student has turned in the majority of assignments more than 1 day late.
- If the semester ended at week 5, the student would have a grade lower than C for the class.
- Student has failed to provide detailed documentation of their independent work (if applicable) for the past three weeks. Explanations that have been provided have not been supported by evidence such as audited notebook entries or time-stamped files.

## TENTATIVE WEEKLY SCHEDULE

*Specific weekly readings from the textbook and other resources will be assigned and lecture notes will be posted on the course's website by the weekend prior to each class session.*

Week 01	Class introductions/expectations; Syllabus analysis  <i>_Introduction to Psychophysics and Psychoacoustics: definitions and scope of study _Sound, Music, Noise: Essential &amp; operational definitions _Basic physical variables and units</i>
Weeks 02-03	<i>_Physical aspects of acoustic waves - Part I: _Basic acoustic concepts and measures _Physical aspects of acoustic waves - Part II: _Logarithmic scales - Root mean square Pressure _Sound Waves - Inverse square law _Fourier analysis - Spectra - Amplitude and Frequency modulation _Resonance - Reflection/Reverberation - Diffraction – Refraction - Absorption - The Doppler effect _Linear Superposition &amp; Interference _Musical instruments as sound-wave generators and transmitters _Signal Processing &amp; Digital Signals</i>
Week 04	<i>_Biology of hearing: _The auditory system</i>
Week 05	<i>_Nonlinearity of the hearing mechanism _Masking and Psychophysical Tuning Curves</i>
Week 06	<i>Review for Test 1 <b>Test 1</b></i>
Week 07	<i>_Perceptual attributes of acoustic waves – Part I: Loudness _Intensity discrimination &amp; Just Noticeable Difference (JND) _Effects of frequency, spectrum, and duration; Loudness scales _Adaptation, Fatigue, &amp; Temporary Threshold Shift (TTS)</i>
Week 08	<i>_Perceptual attributes of acoustic waves – Part II: Pitch _Definitions; Frequency/Pitch ranges; JND for pitch; Pitch of pure &amp; complex tones; Pitch theories _Pitch relations/units; The Octave; Multidimensionality of pitch: Pitch height &amp; pitch chroma</i>
Week 09	<i>_Perceptual attributes of acoustic waves – Part III: Timbre _Cognitive aspects of timbre _Beating &amp; roughness - consonance / dissonance _Time and pitch, loudness, &amp; timbre</i>
Week 10	<i>Review for Test 2 - <b>Test 2 (Group formation / topic selection for the research project are due)</b></i>

Week 11	<ul style="list-style-type: none"> <li>_ <i>Auditory localization – Part I</i></li> <li>_ Introduction</li> <li>_ Auditory localization cues: Interaural time (phase) and interaural level differences</li> </ul>
Week 12	<ul style="list-style-type: none"> <li>_ <i>Auditory localization – Part II</i></li> <li>_ Binaural cues and release from masking</li> <li>_ Sound source localization neural mechanisms</li> <li>_ Auditory localization cues: Interaural spectral differences &amp; HRTFs</li> <li>_ Cone of confusion - Localization cues from head movements</li> <li>_ Judging sound source distance</li> <li>_ The <i>precedence</i> effect</li> </ul>
Week 13	<ul style="list-style-type: none"> <li>_ <i>Sound Environment</i></li> <li>_ Introduction</li> <li>_ Perceptual criteria for room acoustics &amp; related acoustic &amp; room construction/layout features</li> </ul>
Week 14	<p><i>Research Project presentations</i>  <b>Research Project is due</b></p>
Week 15	<p><b>Final Exam</b></p>

*This schedule serves as an outline for the layout of the course. The instructor reserves the right to revise it depending on circumstances. Students will be informed of any changes in writing.*