

PHYS 152: Physics of Sound and Music (Fall 2017)

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Office hours: W 3-4 pm, F 2-4 pm (**see note**), and by appointment (best to email first)

NOTE: W 3-4 changing to 4-5p this week!

Teaching Assistants:

Blake Parris (graduate teaching assistant)

office: 40 WIL (basement)

office hours: M 4-5 pm, W 2-3 pm (F 4-5 pm in drop-in center)

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Brian Cacha (graduate teaching assistant)

office: 220 WIL

office hours: M 11 am-1 pm (T 5-6 pm in drop-in center)

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The physics drop-in center is in the Science Library, room B010.

Course home page: <http://atomoptics-nas.uoregon.edu/~dsteck/teaching/17fall/phys152>



This is the *primary* web site for this course, where news, course notes, etc. will be posted. We will **not** use the Canvas system **at all**.

Schedule: TTh 2:10-3:50, 100 Willamette

Course reference number: 14983

Credits: 4

Prerequisites: no course requirements, but see below

Links: news, course notes, homework sets and keys.

Course overview

What exactly *is* sound? We will study fundamental concepts of harmonic motion, waves, resonance, and adding waves together, and we will apply them to many aspect of sound, including everything from producing, hearing, and recording sound to musical theory, sound effects, and sound quality (timbre).

Required Materials

Calculator: You will need a *scientific* calculator for this course, and you should plan to bring it to all classes and exams. At minimum, it should be able to calculate sin, cos, exp, and log functions, and of course handle basic arithmetic. Anything satisfying these criteria will do, but for example the Sharp EL-501XBWH will work if you want a really cheap one, while the HP 50g will satisfy any cravings your inner nerd might have. There are plenty of choices at the UO bookstore.

i>clicker: You will also need to purchase an i>clicker from the UO bookstore, if you don't already have one for another class. Any edition will work (i.e., with or without an LCD screen), as we will only use the functionality of the older clickers. You do **not** need to register your clicker online; we will register them in class during the first or second weekd. You will use the clicker to respond to class polls and to take in-class quizzes (see the grades section below). You should bring your clicker to **every** class, and I will expect you to obtain one prior to **Thursday, 28 September**.

Text: The (required) textbook for this course is Berg and Stork, *The Physics of Sound*, 3rd ed. (Pearson Prentice Hall, 2005). This book is not cheap, but really is clear and well-written, and at an appropriate level for this course. Feel free to use earlier editions if you can find them for cheap.

For one class we will also use an ebook that I have posted online. You can use any pdf reader to view it, but Adobe Reader will allow you to play the embedded sound files.

Other texts you might find helpful are

- Backus, *The Acoustical Foundations of Music* (ML3805.B245A3 1977)
- Benade, *Fundamentals of Musical Acoustics* (ML3805 .B328)
- Hall, *Musical Acoustics* (ML3805 .H153 2002)
- Rossing, Moore, and Wheeler, *The Science of Sound* (QC225.15 .R67 2002)

These books are available at the Science Library. I **highly** recommend you consult them for practice problems before exams.

I will also post notes for the course (the slides I show in class) on this course web site. Check the news page for updates on when new notes are posted. In general, these notes will be available *after* the corresponding material is covered in class; so you should still plan to take your own notes during class (the simple act of *writing information down* will give you a good head start on learning it).

Mathematical Background

This is a *physics* class. Physics is the discipline of understanding how relatively simple things work. By "simple" I mean things ranging from atoms to lasers to airplanes to the universe (not to mention sound)—things we have *some* hope of understanding precisely and in depth.

One of the main aspects of physics that makes it an especially precise and useful discipline is that you can use *mathematics* to understand how things work. For example, after studying sound, you will know that if you yell at the edge of a canyon, you will hear an echo (duh). But armed with a simple formula and a couple of numbers, you can tell *how long it will take* before you hear the echo, if you know how wide the canyon is. Or, if you want to get fancy, you can *measure* how long it takes the echo to come back, and calculate how wide the canyon is from your measurement.

As such, you will need to employ some *basic* math skills—skills you already needed to master to graduate from high school, like: simple algebra (solve $2x+5=0$), basic trigonometry (how are sin and cos defined), roots, logarithms, exponents, and how to draw and interpret charts and graphs.

So why bother with all this icky math? These are the **same** skills you need to have to balance your checkbook, figure out whether or not it's worth it to refinance your mortgage, figure out how much raw material you need to buy to build a nice wooden cabinet, or to see whether your investments are soaring or crashing. Further, mastering these skills will develop your problem-solving abilities, as well as your ability to think *critically* and *deeply* about just about anything. In other words these are the skills you need to be a *functional, self-sufficient adult*. Not only will you do poorly in this class if you don't master math at this level, but you will do poorly in life—so make sure to *get help* if you need it.

This doesn't mean that you have to be a math whiz. We'll review the more "advanced" math concepts as we need them in the course, and we won't go anywhere near the kind of math you need in an upper-level physics class. However, you're gonna have to get to know your way around a calculator, and if you're math-phobic, you're gonna have to be a bit *less* math-phobic.

Grades

Grades for the course will be based on quizzes, homework, two midterm exams, and a final exam. The relative weights will be as follows:

- Quizzes: 10%
- Homework: 25%
- Midterm exam 1: 20%
- Midterm exam 2: 20%
- Final exam: 25%

Quizzes: each class will begin with a short quiz, where you submit your answers using your clicker. The point of the quizzes is to add incentive to do your assigned reading *before* class. The quiz questions will be announced at the end of each *prior* class, so you can work out the answers while you are reading. Also, 25% of your quiz score is based on whether or not you answer at least **50%** of the clicker questions in class (you get full credit for this part of your score just for *answering*, whether or not your answers are correct; you get none for not answering). The point of this is to give you incentive to **participate** in class. I understand you may need to miss a class or two; therefore I will drop your lowest 4 quiz scores in computing your final grade (missed quizzes are counted as zero scores).

Homework: weekly homework sets will be assigned by paper and on the course web site. Homework is due each Tuesday at the **beginning** of class, and must be completed **before** this deadline. You will have to go online to the course web site to submit your solutions, which will enforce the deadline automatically. Therefore I will *not* accept late homework, so if you're not done by the deadline then go online and enter what you have. Each problem set will be assigned at least one week before it is due. Your lowest homework score will be dropped in computing your final grade, so you can bomb or miss one assignment without affecting your grade (whew).

If you have an issue with how one of your homework problems was graded, please discuss it with the person who graded it **first**. (You can tell who graded it by looking next to your score for that problem.) **Then** contact the instructor if you can't come to an agreement with the grader.

Midterm exams: there are two midterm exams, to be held in class on Thursday, 19 October, and Thursday, 9 November.

Makeup exams: the exams are scheduled **before** the beginning of the term so you can avoid scheduling conflicts. Thus, **there will be no makeup exams for this course**. If you have a **serious** and **documented** reason for missing an exam (death in the family, serious illness), your final-exam score will count in place of the exam score. That is, your final-exam score will account for almost double what it would otherwise. Otherwise, you'll receive a zero score for a missed exam.

Final exam: the final exam will be held from 12:30-2:30 pm on Thursday, December 7, in 100 WIL.

Pass/fail grading option: a passing grade requires the equivalent of a C- grade on all course work (quizzes, homework, exams, and final).

Grading scale: the nominal grading scale for this course is below. If the final class average is excessively low, I may apply a curve for a higher average final grade. However, you are *guaranteed* at least the grade listed below based on your final average; you are *not* competing with others in the class for your grade.

97-100=A+, 93-96.9=A, 90-92.9=A-, 87-89.9=B+, 83-86.9=B, 80-82.9=B-, 77-79.9=C+, 73-76.9=C, 70-72.9=C-, 67-69.9=D+, 63-66.9=D, 60-62.9=D-, <60=F

Your Responsibilities in this Class

Physics is **not** a spectator sport. It is an often challenging discipline that requires **active** engagement on your part—both in and out of the classroom—for you to learn and do well in this class. If you were learning to play the violin, you wouldn't get much out of a lesson where you didn't actually touch your instrument, but just sat and watched your instructor play. Similarly, you aren't going to learn any physics if I just pontificate for the whole class with you staring at me in a half-asleep daze, drool dripping from your chin. Most of your learning will happen *outside* the classroom: this is a 4-credit class, which means you should be averaging *8-16 hours of time per week* on this course between reading, homework, and studying for exams. (The low end of the range applies if you're finding the course to be easy, the high end if you're finding it to be difficult.)

Reading: You need to **read** the assigned material **before** each class. This is **crucial** to your getting any benefit from attending class. Again, we are taking an **active** approach to learning in this class, and this does *not* include me reading the book to you in class. (That would be a waste of time, no?) You wouldn't show up to a literature class without reading the novel to discuss beforehand, and this class is no different. To credit you for reading the material in advance, we will have brief, easy (if you did the reading) quizzes at the start of each class using your clicker. Note that in class, we won't necessarily cover everything that's in the assigned reading—while the exams will concentrate mostly on topics I emphasize in class, *anything* from the assigned reading is fair game for an exam question. In class, I will **review** the more difficult and important concepts in class, answer any **questions** you have, show you **demonstrations** to illustrate the concepts and help you build a mental model for understanding sound, and finally test your understanding and help you confront any misconceptions through class **polls**, which brings me to...

Participation: As an active learner, you will obviously need to **participate** regularly in class. The main way for you to participate will be in the form of "clicker questions," where the whole class will answer a multiple-choice question designed to uncover common misconceptions about the physics of sound, and then we will discuss the question after seeing what the answers are. Remember, you get credit in the form of free quiz points (25% of the total) just for answering at least a couple of poll questions (even incorrectly) in each class. The responses are anonymous, so you don't have to worry about anyone making fun of your wrong answer. In fact, if you **do** get the wrong answer after **thinking** about the question, this is in some sense **good**: this means you have the chance to **learn** something! The point is, I don't expect you to have mastered the material by the time we discuss it in class. But of course, you *should* master it by exam-time!

I will also be **thrilled** if you ask questions in class or during office hours. This tells me you're actually making an effort to learn something. Assuming the in-class questions are actually related to sound and music, just interrupt me anytime. Also, feel free to email me before class if you find something in the reading especially confusing. This helps me know what **you** want to spend class time understanding, and I'd be happy to adjust my lectures, demonstrations, etc. appropriately.

Attendance: You will need to show up **promptly** at the beginning of each class to take (and get credit for) each quiz, and to participate in class. Some of your lowest scores are dropped as I mentioned above in computing your final grade, so this allows you to miss a few classes without penalty if necessary. I won't distinguish between excused and unexcused absences. I have scheduled the exams at the beginning of the term so you can plan around them; there are no make-up exams for this course. You need to make sure you complete homework on time; I will enforce homework deadlines via the web site, and since you have plenty of time (an entire *week*) to work on the homework, I won't accept *any* late homework.

Volunteering: It would be cool to have some demonstrations of the musical instruments that we'll talk about during class, played by someone who knows what they're doing. So if you play an instrument and are willing to show it to the class and play for a bit, please let me know! (Particularly you music majors in the class.) We'll figure out an appropriate day for you to bring it in.

Academic Integrity

A sad reality of academic life is that some students (hopefully not you!) will resort to dishonest means to improve their grade in class (i.e., cheating). Even if you're the honest type (in which case, nice work!), you should be concerned about this: every time someone raises their grade by cheating, it devalues **your** grade. What do I mean by cheating? Some examples:

- Plagiarism, such as:
 - turning in homework solutions identical (or nearly identical) to those of another student
 - turning in homework solutions copied from the internet or anyone else
- Copying answers on exams or quizzes from other students
- Using multiple clickers in class
- Using notes, extra materials, or electronic devices (unless explicitly allowed) on exams or quizzes
- And so on... at this point in your life you **know** what is okay and what isn't.

Doing any of these will send your grade straight to the dustbin (i.e., you will **automatically fail the course**), so **don't do it**.

In case you need more information about acceptable academic conduct, please consult the Student Conduct Code.

Syllabus

This is the schedule of topics we will cover in this course, with reading assignments for you to complete **before** each class.

Tuesday	Thursday
26 September Harmonic Motion and Sine Waves	28 September Waves Reading: Berg/Stork Sections 1.1-1.4 (pp. 1-14), 2.1 (pp. 23-29)
3 October Behavior of Waves Reading: Berg/Stork Sections 2.2-2.3 (pp. 29-46) Homework 1 due	5 October More on Sound Waves Reading: Berg/Stork Sections 2.4-2.9 (pp. 47-64)
10 October Standing Waves and Resonance Reading: Berg/Stork Sections 3.1-3.2 (pp. 68-77) Homework 2 due	12 October More Standing Waves and Resonance Reading: Berg/Stork Sections 3.3-3.5 (pp. 77-88)
17 October Adding Waves and Fourier Analysis Reading: Berg/Stork Sections 4.1-4.2 (pp. 92-104) Homework 3 due	19 October Midterm Exam 1
24 October Synthesizing Waves, Tone Quality, and Resonance Reading: Berg/Stork Sections 4.3-4.4 (pp. 104-114) Homework 4 due	26 October Special Effects Reading: Berg/Stork Sections 5.1-5.3 (pp. 120-136)
31 October The Human Ear Reading: Berg/Stork Sections 6.1-6.3 (pp. 145-153) Homework 5 due	2 November Loudness and Hearing Reading: Berg/Stork Sections 6.4-6.11 (pp. 153-166)
7 November Recording and Microphones Reading: Berg/Stork Sections 7.1-7.3 (pp. 182-191) Homework 6 due	9 November Midterm Exam 2
14 November Reproducing Sound Reading: Berg/Stork Sections 7.4-7.10 (pp. 191-211) Homework 7 due	16 November Room and Auditorium Acoustics Reading: Berg/Stork Sections 8.1-8.5 (pp. 216-233)
21 November Musical Scales and Theory Reading: Steck Chapters 1-3 (read the introduction so you know how to play the sound samples) Homework 8 due	23 November No Class: Thanksgiving
28 November Wind and Brass Instruments Reading: Berg/Stork Sections 10.1-10.2 (pp. 260-272), 11.1-11.2 (pp. 297-308) Homework 9 due	30 November String and Percussion Instruments Reading: Berg/Stork Sections 12.1-12.2 (pp. 318-325), 14.1-14.4 (pp. 351-363)

Other important dates:

Last day to drop classes without a "W": 2 October

Last day to add classes: 4 October

Last day to withdraw from classes or change grading option: 12 November