PHYS 152: Physics of Sound and Music (Fall 2010)

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Office hours: TF 4:00-6:00, and by appointment (best to email first)
Teaching Assistants: (TBA)
Course home page: http://atomoptics.uoregon.edu/~dsteck/teaching/10fall/phys152
This is the primary web site for this course, where news, course notes, etc. will be posted. We will also use the Blackboard system, but only for announcements.

Schedule: MW 4:00-5:20, 100 Willamette
Course reference number: 15059
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 EL531WBBK 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. You will also need to register your clicker via Blackboard. Go to the Blackboard page for this course, and under “Course Documents” you should find a “Register your clicker ID” section. Use your UO Duck ID and the ID number on the back of the clicker when you register. Contact me immediately if you have problems registering your clicker. You will use this 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 and register one prior to Monday, 5 October.

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 especially 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.

Other texts you might find helpful are


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).

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**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 especially precise and useful 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 annoying 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.

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**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:** every 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, and the questions are designed to be easy if you've done the reading (i.e., they won't test understanding or mastery of the material). Also, 25% of your quiz score is based on whether or not you answer at least two clicker questions in class (you get full credit 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 an occasional class; therefore I will drop your lowest 2 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 Monday at the beginning of class, and must be completed before the 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, with the exception of the first one due to the funny schedule this term. 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). Note also that not every problem will be graded; whenever this is the case, you won't know which ones will or won't be graded, so it's very much to your advantage to finish all the problems.

**Midterm exams:** there are two midterm exams, to be held in class on Wednesday, 20 October, and Wednesday, 10 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 3:15-5:15 pm on Tuesday, December 7.

**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, 90-93.9=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+, 63-66.7=D, 60-62.9=D-, <60=F

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**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.

**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 to 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 Blackboard, 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.

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**Syllabus**

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

<table>
<thead>
<tr>
<th>Monday</th>
<th>Wednesday</th>
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<tbody>
<tr>
<td>27 September</td>
<td>29 September</td>
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<tr>
<td>Harmonic Motion and Sine Waves</td>
<td>Waves</td>
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<tr>
<td><strong>Reading:</strong> Sections 1.1-1.4 (pp. 1-14), 2.1 (pp. 23-29)</td>
<td>6 October</td>
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<tr>
<td>4 October</td>
<td>More on Sound Waves</td>
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<tr>
<td><strong>Reading:</strong> Sections 2.2-2.3 (pp. 29-46)</td>
<td><strong>Reading:</strong> Sections 2.4-2.9 (pp. 47-64)</td>
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<tr>
<td><strong>Homework 1 due</strong></td>
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<tr>
<td>11 October</td>
<td>13 October</td>
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<tr>
<td>Standing Waves and Resonance</td>
<td>More Standing Waves and Resonance</td>
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<tr>
<td><strong>Reading:</strong> Sections 3.1-3.2 (pp. 68-77)</td>
<td><strong>Reading:</strong> Sections 3.3-3.5 (pp. 77-88)</td>
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<tr>
<td><strong>Homework 2 due</strong></td>
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<td>18 October</td>
<td>20 October</td>
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<td>Date</td>
<td>Topic</td>
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<td>25 October</td>
<td>Synthesizing Waves, Tone Quality, and Resonance</td>
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<td>1 November</td>
<td>The Human Ear</td>
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<td>8 November</td>
<td>Recording and Microphones</td>
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<td>15 November</td>
<td>Reproducing Sound</td>
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<td>22 November</td>
<td>Musical Scales and Theory</td>
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<tr>
<td>29 November</td>
<td>String and Percussion Instruments</td>
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**Other important dates:**
- Last day to drop classes without a “W”: 4 October
- Last day to add classes: 6 October
- Last day to withdraw from classes: 14 November