Tu., 1/11 Wed., 1/12 Th., 1/13	**Ch 1** The Nature of Sound **Lab 1** *Oscilloscope & Speed of Sound* (2.1,.2, 8.1) **Ch 1** The Nature of Sound	 HW1: Ch1: 9, 11, A, B

Materials

- Pasco Function Generator
- Oscilloscope & laptop with program (also USB cable)
- Pasco oscillator
- Speaker
- sonometer

Handouts etc:

- Syllabus
- Lab 1
- Office Hour Survey
- Roll sheet
- The text

Set-up:

Projector to my website, powerpoint black-out screen.

Today: Intros, Administrative stuff, begin the class / begin chapter 1

Brief Intro.

- **Physics 107**
  - **The bare stats:** This is Physics 107. It is an algebra-based MS1 (Lab) science course that meets Tuesdays & Thursdays at 9:30 & has lab M or T at 1:00.
  - **Overview:** In this course we'll study the three P's of sound: Production, Propagation, and Perception. Our coverage will have mostly a music bent, but *I* will stay within the realm of physics. The level of our coverage will be algebraic – qualitative. I want you to come out of this course understanding the process on a level that increases your enjoyment of listening to music, that informs your decisions as a performer or composer, or that supports your studies of communicative disorders.
- **Instructor: Eric Hill**
  - **Edu.:** B.A. Carleton College, PhD U. of Minn. – Condensed Matter Physics
  - **Research:** STM studies of surface processes of individual molecules; dabble in Electricity and Magnetism, Optics, and Acoustics.
  - **Experience with this course:** Taught three times before and supported a handful of independent studies in the area for music and Com. Dis. students.
    - While I bring a good deal of physics knowledge and skill to the table, some of you bring far more *musical* experience and knowledge than I do – I welcome your contributions.
  - **Office Hours:** To Be Determined; but most any time I'm in my office, I'm available to you - if I'm not in a class or a meeting, I'm usually in my office M-F

8:40 – 5:00 (or well beyond). You can find my schedule on my faculty web page or tacked outside my office door.

pass around Office Hours Survey – gray is when I can't have office hours because I'm otherwise occupied; in the white cells, mark a *b* if it's a *bad* time for an office hour.

- **Students**
  - How many music majors
  - Musicians
  - Calculus
  - High school physics

Administrative:

Take Role

- Check who's here.
  - Anyone else here who's interested in adding? If the *morning* lab section, I can sign you in after class today.
- **Syllabus - handout**
  - **Walk-through, step-by-step.**
    - **Website**: bring up on projector – Note: address on top page.
      - **Intro page** with the bare info. & links to the Policies & Expectation, Schedule, and a list of related websites.
      - **Policies and Expectations**: Essentially what you've got in your hand.
      - **Schedule**: the back page of what you've got in your hands with any updates, links to the Lab work-sheets, links to exam-review material
      - **List of Related Websites**: Some sites for courses offered at other institutions and some sites with specific resources and cool free programs**;** I also encourage you to check out the library's holdings; mostly the ML 38_ _ shelves on the 3rd floor.
    - **Materials:** You'll want some kind of notebook for class, a mid-level calculator (examples named in the syllabus) and *pencil* –
      - **Pencil:** Some of you may have been taught to do your work, even science work, in pen; that's a *bad* idea in physics. It's very easy to make little mistakes while working a physics problem, and if you're doing your work in pen, you either scrap the page, or strike out the mistake, which generally makes things messier and makes you more prone to making more mistakes – so *do your work in pencil.*
    - **Text:** Musical Acoustics by Donald E. Hall. They look like this (hold it up).
      - **1st Chapter.** I can run off copies of the first chapter for anyone who may be waiting for their book to arrive. Show of hands?
      - I'll put outside my office after I clear out of here this morning.
    - **Reading:** Read before coming to lecture, and lecture will be more meaningful & you'll be prepared to ask questions.
      - **Bonus.** To encourage you to have read and seriously thought about the associated homework – for a correct problem that you submit *before* class, you get bonus (more about that in a moment.)
    - **Theory & Experiment / Homework & Lab:**
      - As there are two natural sides to any science – experiment and theory – together, they test and advance our knowledge of the physical world, so there are two important kinds of work you'll do in class – homework and labs.

- **Homework.**
  - **Math:**
    - **Essential:** Much of the homework will be mathematical physics problems; mathematics is an essential tool of theoretical physics and experimental physics (a class that avoided math would be more *about* than actually *doing* physics.)
    - **Level:** That said, this course is intended for folks who haven't done math in a while, and, at that, have only done high school algebra, trig, geometry.
    - **Assistance:** Particularly here at the beginning of the semester, some of you may want particular help dusting off your math skills – I'm here to help.
  - **Working Together**: For that matter, feel free to consult with your class-mates, but what you turn in needs to be *your* work and represent *your* knowledge.
  - **Due**: In the schedule, I've indicated what days I anticipate you're getting prepared to do what homework problems; the problems are actually *due* Fridays at 4pm @ my office.
  - **WebAssign:** All problems marked in the schedule with a W are mathematical and are to be done in WebAssign by Friday at 4pm and needn't be turned in to me. WebAssign gives you instant feedback and lets you try again without any loss of points. So you can try a problem, if you get it wrong then you know to give it another shot, check with a classmate, or ask me for help. For each problem that you get right *before* the associated class, you get bonus points.
    - **Note:** Each student gets the same problem but different #'s in WebAssign.
- **In-Class Clicker Questions:**
  - I plan on developing in-class clicker questions to give you immediate practice using ideas and equations introduced and me a sense of what folks need help with. You get 1 pt for trying, and 1 bonus point for actually getting it right!
- **Laboratory:**
  - Most weeks there is a laboratory experience that accompanies the material we're going over in lecture & that you're working over in the homework.
  - **Lab hand-outs** (handout Wednesday's) Lab hand-outs are available in lecture a day or two before lab; they're also posted on the course website.
  - **Locations.** Lab is right across the hall – Rm 117.
  - **Preparation.** Prior to coming to lab tomorrow, you should read over the hand-out and any parts of the text recommended therein, and you should address any pre-lab questions in the handout.
  - **During Lab.** During the lab, you will fill out the lab hand-out and at the end of the lab period you will turn it in.

- **Presentation/ Leading Class –** I want to make sure that in this class you get to learn about what you really want to learn about in some depth.
  - During the last few weeks of class, each of you will team with two classmates to lead class. I'll work with you to select appropriate readings for yourself and for your classmates and appropriate homework assignments.
  - Each of you will be responsible for reviewing a number of your classmate's presentations.

- Presentation proposals will be collected ~ the week of the 1st Exam.

- **Exams** There will be two in-class exams and a comprehensive final. The exams will be closed book, closed notes. Necessary equations will be provided.
- **Schedule**
  - Look through the topics of the weeks

Now we begin a whirl-wind intro to the course material. Chapte3r 1 just gives an overview of what we'll see in more depth on the subsequent chapters.

Ch 1. **The Nature of Sound**

- **What is sound?**
  - From everyday experience, if I asked you what you used to detect sound, you'd say your ears; if I asked you where a particular sound was coming from, you could point it out. But how do your ears perceive it, how does the source produce it, and how does it propagate from the source to you? And what *is* sound anyway?
  - These are the questions we'll address in this course, the topics are the 3 P's of acoustics
    - **Production**
    - **Propagation**
    - **Perception**

Introduction

Defining "Sound" is tricky, it means different things to people in different fields. The best compromise, for the sake of this course is to say that "sound" is the three step process. A sound is a production, a propagation, and a perception.

We'll start our study with the middle step, for it turns out to be the simplest of the three. But to give us a sense of baring, and focus our attention on the salient features that define sound, and thus must be propagated, we'll superficially touch on production and perception first.

So let's get started with the beginning: production.

- **Production**
  - Let's examine a few sound sources and see what's in common.
    - **Voice:**
      - With your hand on your throat and noticing what you feel, go ahead and introduce yourself to your neighbor.
      - **Q:** what did you feel?
      - **A:** Something was moving, back-and-forth, quickly, almost buzzing.
    - **String:**
      - **Demo:** pluck the guitar string.
      - **Q:** what do you see?
      - **A:** the string moving, back-and-forth, quickly, almost blurring.
  - **Conclusion**: Sound is produced when something moves, back-and-forth, quickly – something **vibrates**.

- Through the semester, we'll look in more depth at some of the ways different instruments produce sounds and how they color the sound to produce unique timbres.

Let's jump to the end: **perception**.

- Listen to these vibrations.
- **Pitch**
- **Demo:** Pasco Function generator driving the Pasco oscillator with a square wave, hold a board or sheet of paper over it for it to hit into, also displayed on an oscilloscope. Start very slow and dial up.
  - **Explain equipment:**
    - **Function Generator**, produces an electrical signal that repeats itself at the frequency displayed. "20" in the screen means "20 times a second."
    - **Oscilloscope** plots an electrical signal's magnitude vs. time.
    - **Oscillator** this moves in synch with the electrical signal of the function generator.
  - Start as just a periodic tap, as the frequency of tapping increases, slowly blurs together into a continuous tone, the tone rises with the increased frequency of tapping, until finally the tone disappears.
  - Repeated discrete motion, within a range of frequencies, is perceived as a steady tone.
  - **Pitch =** our perception of the sound being "treble" or "base." It reflects how frequently the motion repeats.
- **Demo:** Drive a regular speaker, start well below 20 Hz and end over 20000Hz.
  - Raise your hand when you *start* hearing the sound and lower it when you stop hearing.
  - Our ears are designed to perceive as a tone only motion in a certain range of pitches, or frequencies.
- **Loudness**
  - **Demo:** Dial up the amplitude of the function generator, they can see on oscilloscope.
  - As the electrical signal's amplitude increases, i.e., it varies over a wider range, the speaker cone moves further with each of its vibrations, making the vibrations more violent.
  - **Loudness** = our perception of the sound's "strength" or "weakness." It reflects the violence of the repeated motion.
- **Motion in the Ear**
  - Much later in the semester we'll get into how the ear works, but for now, I'll just say that the doorway to the ear, so to speak, is diaphragm, or drum head, called the ear drum. When sound arrives at the ear, the drum moves to mimic the motion of the sound source. If the source vibrates quickly, the drum vibrates quickly. If the source vibrates violently, the drum vibrates violently.

End for day. *I think we'll leave off here for today so you can read chapter 1. Do so before lab tomorrow; also read* (2.1,.2, 8.1). *I'll continue with Ch 1's whirl-wind intro to sound Thursday.*