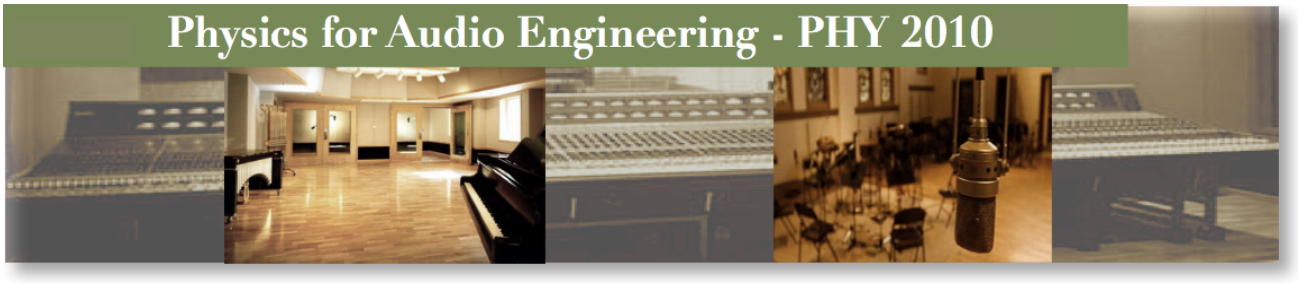
Physics for Audio Engineering - PHY 2010



General Course Description - *PHY 2010, Physics for Audio Engineering, 4 semester hours credit*
Prerequisite: PHY 1140 or PHY 1120 or PHY 2120.
This course is designed to introduce the use of principles of physics to applications in acoustics, recording media, and equipment used in the production of sound. The course will consist of three (3) hours of lecture and two (2) hours of lab.

Instructor: Dr. Hawley
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Office Hours: MWF 1pm-3pm, and by appointment.
This is your time. Do not hesitate to come see me if you have questions or want to talk.

Class Meeting Times and Location
Turn off all cell phones, pagers, recorders etc before coming to class. If you do not you will be asked to leave class and it will count as an unexcused absence.

Section 2010.01:	Class:	MWF	11:00 am - 11:50 pm	JAAC 2096
	Lab:	Thurs	3:30 pm - 5:20 pm	JAAC 4078
Section 2010.02:	Class:	MWF	3:00 pm - 3:50 pm	JAAC 2092
	Lab:	Thurs	1:30 pm - 3:20 pm	JAAC 4078

Course Objectives
To acquaint the students the physics necessary to understand the generation of sound, generation of music by instruments and how sound/music interacts in structures.
To provide students with laboratory experience that will enhance their ability to make physical measurements and analyze data.
To utilize cooperative learning in laboratory exercises, problem solving experiences and in group projects.

Textbooks
We want a text which geared toward physical principles, which is more technical than "Physics for Musicians," but not as technical as a full acoustics class (which would have differential equations). Such a text has not yet been found. As such, we will use a combination of two books:
Required: The Physics of Sound, 3rd Edition, by Richard Berg and David C. Stork
Required: Master Handbook of Acoustics, 5th Edition (paperback), by F. Alton Everest

Laboratory Manual
Physics for AET Laboratory Manual by Scott H. Hawley, downloadable via course web page. **Print it out.**

Resources/Web Page
See course web page (will transition to BlackBoard): http://hedges.belmont.edu/~shawley/PHY2010/

Other Requirements
You will need a calculator (*other* than the one in your cell phone) for homework and tests.

Course Topics
Fundamentals of Sound (Chapters 1-4 Berg & Stork, Chapter 1 Everest)
- Simple Harmonic Motion and Applications (Chapter 1 Berg & Stork, Supplemental Notes)
- Waves and Sound (Chapter 2 Berg & Stork)
- Standing Waves and the Overtone Series (Chapter 3 Berg & Stork)
- Analysis and Synthesis of Complex Waves (Chapter 4 Berg & Stork)

Sound Intensity Scales (Section 6.4 Berg & Stork, Chapter 2 Everest)
Room and Auditorium Acoustics (Chapter 8 Berg & Stork)
- Reverberation (Chapter 7 Everest)
- Absorption (Chapter 9 Everest)
- Diffusion (Chapter 13 Everest)
- Modal Resonances (Chapter 15 Everest)

Grading Procedure

25% Final exam
30% Tests (3)
20% (Group) Project
15% Lab work
5% Preparation/Compliance: Reading Quizzes/HW
5% Class Contribution/Participation

Homework
Homework will be completed at the student's initiative, via written assignments and online (Blackboard) and at http://hedges.belmont.edu/~shawley/PHY2010/

Course Average	Letter Grade
90 -100	A
87 - 89	B+
83 - 86	B
80 - 82	B-
77 - 79	C+
73 - 76	C
70 - 72	C-
67 - 69	D+
63 - 66	D
60 - 62	D-
Below 60	F

Meaning of Letter Grades
A - Truly exceptional, remarkably excellent work, going well beyond what is typically 'expected'.
B - Above average work. Extra effort and/or attention was paid to producing quality work.
C - *Average*, satisfactory work. Meets the requirements and nothing more.
D - Unsatisfactory work. e.g., inadequate, incorrect, incomplete presentation of material.
F - Completely inadequate. Unacceptably poor or incomplete work.

Policy on Attendance

Do not schedule appointments, interviews, practice time, music sessions, advising, taking family and friends

to places, work-related activities, travel plans, vacation time, doctor appointments, dental appointments, court dates, lawyer appointments, trips or other types of activities during class time, **These will not constitute valid excuses. Please do not schedule** airline reservations to leave campus or return to campus on days class meets**. These will *not* constitute valid excuses if a class is missed because of flight delays due to weather etc. Plan your life in every way possible to avoid exceeding the absence policy. The recommendation is that your guiding principle is to attend every single class, saving your absences for instances, should they occur, when you truly need one.**

Class and labs will start promptly **at its designated times**. It is your responsibility to be on time. If you should arrive late, enter silently and do not disrupt the class in any way. You will be marked as tardy and any assignments you turn in will be regarded as late. Note the assignment policy below implies an attendance requirement. Also note that Belmont University policy requires that 12 or more absences must result in a failing grade being granted for the entire course.

Note that days preceding and following Belmont Holidays are not holidays. You will be expected to attend class accordingly. Travel plans will not constitute excused absences. Failure to return because of travel related delays etc. will not constitute excused absences.

Policy on Assignments

All work is due at the beginning of class on the day the assignment is due. You will have a 15-minute "grace period" from the beginning of class, before an assignment will be considered "late," during which time you must not be present in class if you intend to take advantage of this concession. Late work will receive an automatic 50% penalty and will not be accepted more than 24 hours after the due date, unless the due date is a Friday, in which case late work will not be accepted after 5pm on the due date.

Policy on Labs and Examinations

No make-up labs or examinations will be given. If you have a **valid reason** (as determined by the instructor) for missing a midterm exam, the grade you receive on the final exam will be applied (i.e., copied) to stand in for your grade for the missed examination. Note that lab time will be used either for lab assignments or to administer examinations, so it is never a good idea to miss lab. **Lab will begin promptly at the designated time, beginning with a quiz about your reading of the lab book beforehand.** If you arrive late, you will miss 10% of your lab grade in the form of this quiz.

Group project

Groups will be assigned for this project. A presentation and paper will be submitted as part of the project. See the attached rubric for this project (page 5, below).

University policies:

Honor Code - The Belmont community values personal integrity and academic honesty as the foundation of university life and the cornerstone of a premiere educational experience. Our community believes trust among its members is essential for both scholarship and effective interactions and operations of the University. As members of the Belmont community, students, faculty, staff, and administrators are all responsible for ensuring that their experiences will be free of behaviors, which compromise this value. In order to uphold academic integrity, the University has adopted an Honor System. Students and faculty will work together to establish the optimal conditions for honorable academic work. Following is the Student Honor Pledge that guides academic behavior:

"I will not give or receive aid during examinations; I will not give or receive false or impermissible aid in course work, in the preparation of reports, or in any other type of work that is to be used by the instructor as the basis of my grade; I will not engage in any form of academic fraud. Furthermore, I will uphold my responsibility to see to it that others abide by the spirit and letter of this Honor Pledge."

Disabilities Compliance:

In compliance with Section 504 of the Rehabilitation Act and the Americans with Disabilities Act, Belmont University will provide reasonable accommodation of all medically documented disabilities. If you have a disability and would like the university to provide reasonable accommodations of the disability during this course, please notify the Office of the Dean of Students located in Beaman Student Life Center (460-6407) as soon as possible.

Disclaimer:

The policies, topics and course organization described in this syllabus are subject to change. Adequate prior notice will be provided to all students in the event of a change.

Quotes from Previous Students:

- "I was applying for an internship a few weeks back and the interviewer was talking about how the low frequencies next to their practice room weren't very loud but in their offices a little farther away, were very loud. I was able to explain...several things we could do to fix the problem. I'm sure it helped them to hire me."
- "Many concepts, such as the inverse square law,...became increasingly... important as I learned about live sound reinforcement. It already helped on my final for that class."
- "I can now sound proof and manipulate the acoustic qualities of a room. People pay high-end dollars for what I learned in this class. Also, with my Audio Engineering, I will better be equipped with the tools to manipulate my environment to achieve a desired sound when recording."
- "Since I am in the process of designing a couple studios for friends, I can use what I have learned about the way waves behave and how to absorb & diffuse them to create a recording environment that could produce the next big hit."

How to Succeed in this Course:

- *Prepare*. Studies in education research show that learning occurs best when students' *first exposure* to course material occurs in private, *prior* to class. (Note: This does *not* include sitting in the hallway immediately before class trying to cram.) Thus this instructor recommends reading the relevant section of the text the evening before class.
- *Work problems, answer questions, work problems*. Physics can be regarded as a *reasoning skill* which can be acquired through *practice*. By doing so, you *train your brain* through the *actions* of applying the concepts you're learning. Reading the text is helpful for first exposure and clarification, but for "studying" (e.g., before a test) there is little substitute for experience. In particular, "memorization" is rarely a useful avenue for success in a physics course.
- Become skilled in using ***both*** the *concepts* as well as the *mathematical tools* used in the course. Being able to "do the math" without understanding the concepts behind it is a frequent pitfall of engineering students. Likewise, lack of mathematical proficiency will severely limit your performance in the course.
- Complete all assignments on time and in compliance to Academic Standards (below).
- *Begin* assignments at least two days prior to due date, so you can ask the instructor one class period prior to their due date
- *Make use of the instructor's office hours*. Do not be afraid to come ask questions, share concerns, make suggestions, etc.
- *Stay current*. This course will move quickly. Do not fall behind!
- *Put in the time*. You are (very) unlikely to attain proficiency without investing substantial, *focused* time *daily* toward studying and working problems. Unfortunately, there are no shortcuts.

Academic Standards:

- Clarity: Written work (e.g., homework) will be clearly *readable, intelligible* and *explain* the *reasoning* behind each solution, exercise, etc. A simple list of formulas --- or worse, an "answer" with no supporting work --- will not do. Imagine that you are writing to explain to fellow students, such that if they picked up your paper, they could follow your reasoning and arrive at your conclusion.
- Presentation: In addition to clarity of *content* described above, assignments will be neatly written (recopy your original calculations as needed, vast amounts of scribbling should be omitted, etc.), any "ratty spiral binder detritus" will be removed, and multiple pages will be *stapled* or secured with a paperclip.
- Accuracy: Answers will be numerically and conceptually correct, and not claim undue degrees of numerical precision (i.e. pay attention to "significant digits")
- *Units*: Rarely in physics is a dimensionless number the requested quantity. All (applicable) answers will contain the appropriate units (meters, volts, etc.).

Rubric for Physics 2010 Project

You will work in groups of ~4, investigating some aspect of the physics of sound which interests you. This may include audio measurements of a physical system, building or modifying an existing apparatus, and/or library research on some advanced topic. Previous topics chosen by students include room tuning, loudspeaker cabinet modification, Faraday waves. Feel free to ask a professor to suggest ideas!

Proposal: Your group's first graded work on this project will be a one-page proposal for your project, describing the **concept** of your project, its **purpose** (why you are doing it), a list of **equipment** you will obtain and use for the project, and a **timeline** consisting of various "milestones" to meet along the way and with which to track your progress.

Presentation: Your group will make an oral presentation to the class, 15 minutes in length, including visuals (e.g. PowerPoint) and/or a demo. Double-spaced. You may put figures at the end.

Paper: Your group will also turn in a paper approximately 6-8 pages in length, graded for the following:

10pts **Abstract**
Four to six sentence, complete overview of project, noting investigation, methods used, and results.

12pts **Introduction**
Describe background (principles & priors), purpose, what you hoped or expected to achieve.
Include references to and remarks about other (prior) work/research in this area.

20pts **Methodology**
Describe equipment, methods used.
Perhaps characterize "Before" state of system under investigation, or do so in Results, below.

25pts **Results** (*SHOW* us what you found)
What you found… Explained in text. But you'll also need to *present your data*, either via graphs or tables. Any figures are captioned and numbered e.g. "Figure 1: Frequency spectrum of my dog's bark." Axes labeled & with units.
Note anything that didn't "work" and perhaps why.

12pts **Conclusion**
Restate what you found, possibly any ideas for future work

6pts **References**
Note literature or other works you referred to in preparing this paper (journal articles, books, class notes, web pages, tech. specs. Use citation format of the *Journal of the AES*.
You will earn one point for each reference cited, up to 6.

15pts **Text Quality**
Spelling & Grammar are correct. Paragraph breaks for different subjects. Verb tense is consistent throughout paragraphs; number (singular vs. plural) is consistent.

In general, the guideline "Make it like a *J. AES* publication" will get you a long way.

Total grade for the project will be assigned as follows:

10% Proposal
30% In-Class Presentation
50% Paper
10% Group self-evaluation(s)

Important Milestones (see calendar, below):

Proposals Due ; Status Updates; In-class Presentations; Papers Due

***Tentative* Class Schedule:**

Italics indicate the reading or other preparation you are expected to have performed for that day
"BS" = Berg & Stork, "Ev" = Everest

Week of	Mon	Wed	Thurs - Lab	Fri
Aug 21 (Monday)	*"BS" = Berg & Stork* *"Ev" = Everest*	Syllabus / Questionnaire	Orientation & Lab: DAW	*BS 1.1 – 1.2* Physics Units, Simple Harmonic Motion
Aug 28	*BS 1.3, & 1st page of SHM Handout* More SHM, Waveforms	*BS 1.4, & rest of SHM handout* Driven SHM, Resonance	Lab: Hooke's Law & SHM	Work problems in SHM
Sep 4	Labor Day	*HW 1* Waves in General *BS 2.1*	Lab: Damped, Driven SHM & Resonance	Wave Properties *BS 2.2, 2.4*
Sep 11	Wave Behavior *BS 2.3, 2.5*	*HW 2* Standing Waves, Overtones,*BS 3.1-3.2*	Lab: Sound Speed / Wave Properties	Overtones, SW on Strings - *BS 3.2-3.3*
Sep 18	Long. SW, Others *BS 3.4, 3.5*	*HW 3* Complex Waves *BS 4.1*	Lab: Resonance in Strings	Review for Test
Sep 25	**Test 1 (BS Ch 1-3)**	*Bring an Instrument!* Fourier Analysis - *BS 4.2*	Lecture: Resonance Curves *BS 4.4*	*HW 4* Logarithms & SIL *BS 6.4*
Oct 2	SIL, *Ev Ch 2* Activity: SIL (HW5)	Criteria in Ac. Design, *BS 8.1*	Lab: SIL Meter & Inverse Square Law	Modal Resonance *BS 8.2, Ev pp 350-351*
Oct 9	***Project Proposals Due*** Problems in Ac. Design *BS 8.2*	Reverb Time *BS 8.3*	Activity: Room Design	Review for Test
Oct 16	Fall Break	***---------- AES Convention in New York ----------*** Meet with your project groups and work on projects (No Class)		
Oct 23	*HW 6* Reverberation in Detail - *Ev pp 151-158*	Measuring Reverb *Ev pp 158-166*	**Test 2 (BS Ch 4, §6.4 & Ch 8, Ev Ch 2)**	Reverb Issues w/ "Real" Rooms *Ev pp 167-175*
Oct 30	*HW 7* Absorption in Detail *Ev pp 179-186*	Porous Absorption *Ev pp 187-200*	Lab: Measuring Reverb Time	Traps, Diaphragmatic Abs. - *Ev pp 201-209*
Nov 6	Helmholtz Absorbers *Ev pp 209-220*	*HW 8 Due* Diffusion in Detail *Ev pp 125-133*	?Schermerhorn Visit? 1:30 / 3:30. Meet in West Atrium, Park on your own	Achieving Diffusion *Ev pp 258-266,272-274*
Nov 13	*HW 9* Modes in Detail *Ev pp 223-230*	*Project Status Update* Mode Decay / BW *Ev pp 230-240*	**Test 3** **(Ev Ch 11, 12, 9 & 14)**	Mode Distribution *Ev pp 241-250,254-256*
Nov 20	*Project "Draft" Presentations*	Thanksgiving	Thanksgiving	Thanksgiving
Nov 29	*Project Presentations*	*Project Presentations*	Work on Projects	*HW 10 Due* Review for Final
Dec 4	*Papers Due* Group Evals, Course Evals	Dead Day	(finals start)	

For final exams, see http://www.belmont.edu/registrar/exam-schedules.html