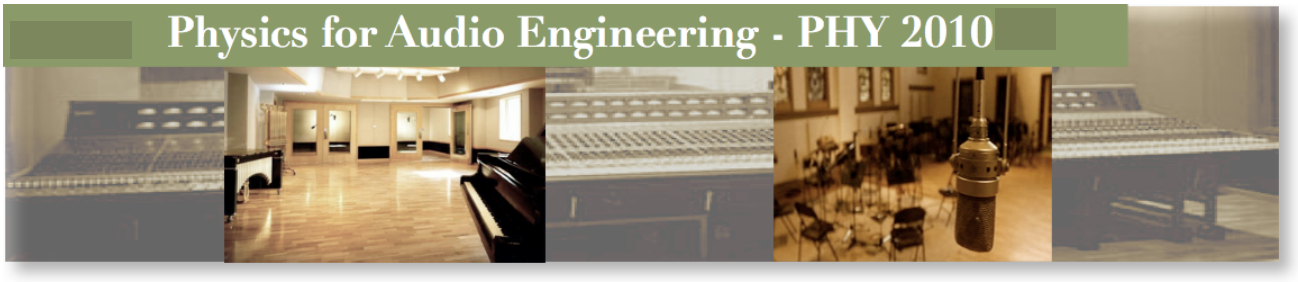
Physics for Audio Engineering - PHY 2010



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 4pm-5pm, T 4:30-5:30pm and by appointments scheduled via tinyurl.com/hawleycal2

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	2:00 pm - 2:50 pm	AYRS 4098
	Lab:	Thurs	1:00 pm - 2:50 pm	AYRS 4078
Section 2010.02:	Class:	MWF	3:00 pm - 3:50 pm	AYRS 4098
	Lab:	Thurs	3:00 pm - 4:50 pm	AYRS 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, 7th Edition (paperback or e-book), by F. Alton Everest

Laboratory Manual
Physics for AET Laboratory Manual by Scott H. Hawley, downloadable via course web page (below).

Resources/Web Page
Course materials will be on Blackboard, and a web page: http://hedges.belmont.edu/~shawley/PHY2010/

Other Requirements
You will need a calculator (*other* than the one in your cell phone) for tests – which will be in-person during lab.

Course Topics & Textbook Chapters

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)

Home Studio Design (slides)

Grading Breakdown

Assignment / Name	Points Each	Points Total	% Total
Homeworks (9 of them)	10	90	12.2%
Labs (8 of them, drop lowest = 7 labs)	15	105	14.3%
Tests (2 of them)	135	270	36.7%
Project (see Rubric, p.5)	135	135	18.4%
Final Exam (Date)	135	135	18.4%
Total Semester		**735**	**100.00%**

Semester Points %	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**

<u>etc.</u> 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. **Attendance will be taken at the beginning of class, and not revised later. Thus, to be late is to be marked absent.** If you should arrive late, enter silently and do not disrupt the class in any way. 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 Late Work: None
All work is due at the time the assignment is due, uploaded to or filled out on Blackboard. *Work uploaded with a late timestamp will retain a grade of zero.*

Policy on Labs, Tests, Exams
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.

Rubric Grading Scale:

10% **Proposal** (sample proposal template available online)

30% **In-Class Presentation** (12 minutes + 2 minutes for questions)

5% **Initial Paper Draft** (Drafts are for *your benefit*, to get instructor feedback. Best if as complete as possible)

10% **Main Paper Draft** (Should be a complete paper. Feedback will help refine/improve before final.)

35% **Final Paper Draft** (this is it!)

10 % **Group Self-Evaluation** (+/- to your individual grade. Via detailed anonymized questionnaire)

***Tentative* Class Schedule:** (compare vs. Official Belmont Academic Calendar)

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	Fri
Jan 6 (Monday)		Course Overview & Syllabus	No Lab	*BS 1.1 - 1.2* "Physics"; Simple Harmonic Motion
Jan 13	*BS 1.3 – 1.4* Waveforms & more.	*Read SHM 'Handout'* Damped, Driven SHM & Resonance	*Read Lab Book pp. 5-9* Lab: Orientation/DAW	*HW 1 Due; BS 2.1* Waves in General
Jan 20	MLK Holiday	*BS 2.2, 2.4* *Class Online Wave Properties	*Read the Lab* Lab: Hooke's Law/ SHM – *Online Sim	*BS 2.3, 2.5* *Class Online Wave Behavior
Jan 27	*HW 2 Due; BS 3.1-3.3* Standing Waves, Overtones	*BS 3.2-3.3* Overtones, SW on Strings	*Read the Lab* Lab: Sound Speed	*BS 3.4, 3.5* Long. SW, Others
Feb 3	*HW 3 Due* Work problems in class	*BS 4.1* Complex Waves	*Read the Lab* Lab: Resonance in Strings	Talk about Projects, assign groups
Feb 10	*Do Practice Test 1* Review for Test	*Bring an Instrument!* - *BS 4.2* Fourier Analysis	***Test 1 (BS Ch 1-3)**	*BS 4.4* Resonance Curves
Feb 17	Meet in project groups, Review Test Results	*HW 4 Due BS 6.4* Logarithms & SIL In-Class SIL "HW5"	*Read the Lab* Lab: SIL & Inverse Square Law	***Project Proposals Due*** *Ev Ch 2*
Feb 24	*BS 8.1* Criteria in Ac. Design	*BS 8.2 & 8.3* Problems in Ac. Design, Modeling Reverb Time	Activity "Lab": Room Design Spreadsheet	*HW 6 Due* Modal Resonances
Mar 3	Reverb in Detail, *Ev pp 151-158*	Measuring Reverb *Ev pp 158-166*	Lab: Measuring Reverb Time	HW7 Due Reverb Issues w/ Real Rooms -*Ev pp 167-175*
Mar 10	Spring Break	Spring Break	Spring Break	Spring Break
Mar 17	*Do Practice Test 2 Before* Review for Test 2, incl. Practice Test answers	Project Status Updates Porous Absorption *Ev 189-200*	***Test 2 (BS Ch 4, §6.4 & Ch 8, Ev Ch 2)**	Traps, Diaphragmatic Abs. - *Ev pp 201-209*
Mar 24	Helmholtz Absorbers *Ev pp 209-220*	*HW 8 Due* Project Status Updates Diffusion in Detail *Ev pp 125-133*	Work on Projects (location: anywhere you want, incl. lab)	Achieving Diffusion *Ev pp 258-266,272-274*
Mar 31	Modes in Detail *Ev pp 241-254*	Work on Projects (wherever, incl. lab)	***Project Presentations (Location TBD)***	Work on Projects/ Papers (wherever / lab)
Apr 7	***1st Paper Draft Due*** Mode Decay / BW *Ev pp 254-260*	*HW 9 Due* Review paper drafts, Work on proj / paper	Work on Project/Paper (wherever / lab)	***2nd Paper Draft Due*** Mode Distribution *Ev pp 264-276*
Apr 14	Review Paper Drafts, Home Studio Design	SPARK Symposium	Easter Break	Easter Break
Apr 21	Easter Break	***Final Papers Due*** Group Evals, Course Evals Review for Final Exam		

"When is our final exam?" see http://www.belmont.edu/registrar/exam-schedules.html