Point Loma Nazarene University
Department of Physics and Engineering
PHY 1034/L The Physics of Sound and Music and Lab (3 + 1 units)

Spring, 2025
Class meetings: RS 295 MWF 12:15 PM - 1:10 PM
Lab meeting: RS 294 R 3:00 PM - 4:55 PM
Final Exam: Wednesday, May 7, 10:30 a.m.-1:00 p.m.

Instructor: Dr. Paul D. Schmelzenbach
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Office hours (RS 258): MWF 8:30-9:45, T 9:15-1:00, other times available by appointment.

PLNU Mission: To Teach ~ To Shape ~ To Send
Point Loma Nazarene University exists to provide higher education in a vital Christian community where minds are engaged and challenged, character is modeled and formed, and service is an expression of faith. Being of Wesleyan heritage, we strive to be a learning community where grace is foundational, truth is pursued, and holiness is a way of life.

Department Mission
The Physics and Engineering Department at PLNU provides strong programs of study in the fields of Physics and Engineering. Our students are well prepared for graduate studies and careers in scientific and engineering fields. We emphasize a collaborative learning environment which allows students to thrive academically, build personal confidence, and develop interpersonal skills. We provide a Christian environment for students to learn values and judgment, and pursue integration of modern scientific knowledge and Christian faith.

General Education Mission
PLNU provides a foundational course of study in the liberal arts informed by the life, death, and resurrection of Jesus Christ. In keeping with the Wesleyan tradition, the curriculum equips students with a broad range of knowledge and skills within and across disciplines to enrich major study, lifelong learning, and vocational service as Christ-like participants in the world's diverse societies and culture.

Course Description
An introduction to the science of sound, hearing and music. The course will focus on concepts of sound production, propagation, and perception including topics such as musical scales, instruments, and acoustics. PHY1034L is the co-requisite lab course designed for a hands-on exploration of the physics of sound.

Program and Course Learning Outcomes
After completing this course, students can

1. Translate the description of physics problems into the mathematical equations required to solve them using relevant physical principles.
2. Calculate solutions to physics problems once appropriate equations or techniques are identified.
3. Predict reasonable answers to appropriate problems and assess the reasonableness of calculated answers.
4. Explain relevant physical concepts and apply them to the analysis of sound and the functioning of musical instruments.
5. Create and interpret graphical and visual representations of physical quantities, such as interpreting waveforms and understanding how they relate to perceived sounds.
6. Recognize different instrument groups and understand how they function.
7. Understand how the ideas and techniques of physics are used to analyze sound, the operation of instruments, and the propagation of musical sound.
8. Gather and interpret data in a lab setting.

General Education Learning Outcomes
This course is one of the components of the Foundational Experience program at Point Loma Nazarene University, through which students will acquire knowledge of human cultures and the physical and natural world while developing skills and habits that foster life-long learning. Specifically, this course supports this broader context in developing FELO 1e. Quantitative Reasoning: Students will be able to solve problems that are quantitative in nature. Assessment of this learning outcome will be demonstrated on the final exam embedded in questions typical of introductory physics.

Required Texts and Materials:

"Physics and Music: The Science of Musical Sound" (Dover Books on Physics) by White and White, and a calculator.

Course Credit Hour Information
In the interest of providing sufficient time to accomplish the stated course learning outcomes, this class meets the PLNU credit hour policy for a 4-unit class delivered over 15 weeks. Specific details about how the class meets the credit hour requirements can be provided upon request.

Assessment and Grading: The grade you earn in this course is based on the scale below. The points you receive during the course are weighted accordingly:

A	B	C	D	F
92–100 (A)	**87–89** (B+)	**77–79** (C+)	**67–69** (D+)	< 59
90–91 (A–)	**83–86** (B)	**73–76** (C)	**63–66** (D)	
	80–82 (B–)	**70–72** (C–)	**60–62** (D–)	

(2%) Preclass: In preparation for each class meeting, there is a reading assignment or activity. Class meetings are not in a standard lecture format, making these assignments especially important. To complete the reading assignment, answer three questions and submit them electronically by 11:59 pm the evening before a class meeting. Late submissions will not earn points.

(20%) Lab: Hands-on experience with topics from class meetings. The final class and lab sessions will allow for the development and completion of a final project applying various concepts learned throughout the course.

(18%) Homework/Activities: Weekly problem sets will allow you to apply and explore various aspects of the science of sound. Engaging in practicing your knowledge is extremely important to your success in the class.

(30%) Exams (3): Three exams will be given during the semester. Exams will include both multiple-choice and short answer conceptual questions, as well as problems to solve. Exams will be closed book, but a sheet of formulas will be provided. Partial credit will be given for correct reasoning at any step of a problem, but only if it is communicated clearly enough for me to understand.

(20%) Final Written Portion: The final examination will be comprehensive, and you will have the use of a handwritten page of notes along with a provided sheet of formulas.

(10%) Final Project: As a capstone to our exploration of the physics of sound, each student (or small team) will design, build, and analyze a musical instrument. This project will synthesize many of the concepts and lab and class techniques we've practiced throughout the semester. Key elements: Instrument Construction, Acoustic Analysis, Project Poster, Presentation and Demonstration.

Exams: Examinations, including the final examination, will cover topics explored in the text, lecture and through homework. The specific learning outcomes distributed for each section will serve as a valuable study guide.

Late Assignments and Exam Policy: Preclass assignments, homework, and labs will not earn points if submitted late. The lowest homework score and the lowest lab score will be dropped in the calculation of your final grade. Labs are typically submitted at the end of the lab period.

No examination may be missed without prior consent or a well-documented emergency beyond your control. A score of zero will be assigned for any examination missed without

prior consent or a documented emergency. If such an event arises, please ensure that you communicate with the professor as soon as possible so other arrangements can be made.

Final Exam
Successful completion of this class requires taking the final examination on its scheduled day. The final examination schedule is posted on the Class Schedules site. If you find yourself scheduled for three (3) or more final examinations on the same day, you are authorized to contact each professor to arrange a different time for one of those exams. However, unless you have three (3) or more exams on the same day, no requests for alternative final examinations will be granted.

Incomplete grade
Incompletes will only be assigned in extremely unusual circumstances. If you believe that your particular circumstances qualify be in clear communication with the professor as soon as you are able.

Course AI policy
Emerging technologies, such as large language models (e.g., ChatGPT), are intriguing and potentially beneficial. However, their pedagogical impact on physics learning outcomes remains somewhat untested. Any work that employs AI-based tools must be clearly identified, including the specific tool(s) used and relevant details. This policy will be further elucidated with examples during lectures. Please be aware that AI policies may differ among classes this semester.

PLNU Academic Accommodations Policy
PLNU is committed to providing equal opportunity for participation in all its programs, services, and activities in accordance with the Americans with Disabilities Act (ADA). Students with disabilities may request course-related accommodations by contacting the Educational Access Center (EAC), located in the Bond Academic Center (EAC@pointloma.edu or 619-849-2486). Once a student's eligibility for an accommodation has been determined, the EAC will work with the student to create an Accommodation Plan (AP) that outlines allowed accommodations. The EAC makes accommodations available to professors at the student's request.

PLNU highly recommends that students speak with their professors during the first two weeks of each semester/term about the implementation of their AP in that particular course. Accommodations are not retroactive so clarifying with the professor at the outset is one of the best ways to promote positive academic outcomes.

Students who need accommodations for a disability should contact the EAC as early as possible (i.e., ideally before the beginning of the semester) to assure appropriate accommodations can be provided. It is the student's responsibility to make the first contact with the EAC. Students cannot assume that because they had accommodations in the past, their eligibility at PLNU is automatic. All determinations at PLNU must go through the EAC process. This is to protect the privacy of students with disabilities who may not want to disclose this information and are not asking for any special accommodations.

Additional Course Information:

Additional PLNU policies and practices that apply to this course can be found at this link

Topics and Assignments at a glance:

Date	Topic	Reading	Hmk
M 1/13	Introductions		
W 1/15	Building our Toolkits of Understanding	1.1-1.5	
R 1/16	Lab: Periodic Motion		
F 1/17	Periodic Motion & Frequency	2.1-2.3	Hmk 1
W 1/22	Simple Harmonic Motion; Damped Oscillations	2.4-2.6	
R 1/23	Lab: Sound and Oscillations		
F 1/24	Transverse & Longitudinal Waves	3.1-3.4; 4.1	
M 1/27	Standing Waves on Strings	3.5; 11.1-11.4	Hmk 2
W 1/29	Standing Waves in Air	12.1-12.3	
R 1/30	Lab: Standing Waves		
F 1/31	Sound as Waves	5.1-5.2	
M 2/03	Advanced Sound Waves; Review	5.3-5.6	Hmk 3
W 2/05	Test 1		
R 2/06	Lab: Tubes of Air		
F 2/07	Resonance; Helmholtz Resonators	6.1-6.4	
M 2/10	Beats, Interference, Doppler Effect	6.5-6.6	Hmk 4
W 2/12	Wave Synthesis & Analysis I	Notes	
R 2/13	Lab: Helmholtz Resonator		
F 2/14	(No class meeting: PLNU President)		
M 2/17	Wave Synthesis & Analysis II	Notes	Hmk 5
W 2/19	Sound and Hearing	9.1-9.5	
R 2/20	Lab: dB		
F 2/21	Sound and Hearing (Cont.)	9.5; 10.1-10.3	

Date	Topic	Reading	Hmk
M 2/24	Sound and Hearing (Wrap-Up)		Hmk 6
W 2/26	Acoustics I	26.6-26.7; 27.1-27.5	
R 2/27	Lab: Acoustics		
F 2/28	Acoustics II	26.5	
M 3/03	Wrap up and Review		Hmk 7
W 3/05	Test 2		
R 3/06	Lab: Musical Straws		
F 3/07	Musical Temperament I	14.1-14.4	
M 3/17	Musical Temperament II	14.5-14.8	Hmk 8
W 3/19	Musical Temperament III	14.9-14.12	
R 3/20	Lab: Musical Temperament		
F 3/21	Analog & Digital	Notes	
M 3/24	Analog & Digital (Cont.)	Notes	Hmk 9
W 3/26	Instruments: Woodwinds I	18.1-18.3	
R 3/27	Lab: Woodwinds		
F 3/28	Instruments: Woodwinds II	18.4-18.6	
M 3/31	Instruments: Brass	19.1-19.4	Hmk 10
W 4/02	Instruments: Percussion I	13.1-13.3; 20.3-20.4	
R 4/03	Lab: Metal Bars		
F 4/04	Instruments: Percussion II	13.4, 13.6; 20.8-20.11	
M 4/07	Instruments: Speech & Voice I	19.11-19.14	Hmk 11
W 4/09	Instruments: Speech & Voice II		
R 4/10	Lab: Speech and Voice		
F 4/11	Test 3		

Date	Topic	Reading	Hmk
M 4/14	Project Intro and Parameters	Handouts	
W 4/16	Project Brianstorm and Develop		Hmk 12
W 4/23	Build & Analyze Instrument I		
R 4/24	Lab: Build & Analyze an Instrument II		checkpoint
F 4/25	Build & Analyze Instrument III		
M 4/28	Build & Analyze Instrument IV		Peer Reviews
W 4/30	Build & Analyze Instrument V		
R 5/01	Final Projects		Poster
F 5/02	Review Key Ideas		
5/07	Wednesday 7:30-10:00 a.m.		