

# Acoustics

PHYS - 3330  
Fall Semester, 2018

**Dr. Steven Gollmer**

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**Office:** ENS 357

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**Office Hours:** M, W: 1:00 –1:50

T: 12:00 – 12:50 Th: 11:00 – 11:50 F: 9:00 – 9:50

Open Door Policy (See below)

**Text:** *The Science and Applications of Acoustics 2<sup>nd</sup> Ed.*, by Raichel. We will cover the first twelve chapters of the textbook as well as parts of chapter eighteen and nineteen.

**Prerequisite:** PHYS 2110 General Physics I  
MATH 2710 Differential Equations

**Class Room:** MIL 132

**Class Time:** 2:00 – 2:50 M W F

**Class Web Page:** <http://people.cedarville.edu/employee/gollmers/phys3330/phys3330.htm>

## Course Description:

### PHYS 3330 – Acoustics - FA

**3 hours**

This course will study the generation, transmission and reception of sound. Topics include wave propagation through air, resonance conditions for strings, bars, membranes and air cavities, acoustic filters, measurement and human perception of sound. Applications will be made to musical instruments, room acoustics, microphones, and speakers.

**Prerequisites:** MATH-2710 Differential Equations; PHYS-2110 General Physics I. (even years)

## Objectives:

**Theory/Concepts:** The student will be able to recall basic principles of physics (velocity, acceleration, force, and energy) and use them to develop appropriate models to understand wave propagation, vibrating systems, sound level, sound production, sound reception and architectural acoustic design. In addition he/she will apply these principles by solving a wide range of acoustics problems using the appropriate mathematical techniques.

Assessment Mapping	Theory / Concepts	Analysis	Communication	Community
<b>Exams</b>	X	X		
<b>Final Exam</b>	X	X		
<b>Homework</b>	X	X	X	X

**Analysis:** The student will be able to analyze the validity of acoustical models by comparing them to physical observations and measurements.

**Communication:** The student will express acoustical concepts with clarity and precision and express how musical instruments and room design are based on these concepts.

**Community:** The student will be able to express how acoustics interfaces with decisions affecting society and value the importance of thinking through problems using appropriate problem solving techniques.

## Grading:

300	3 Unit Exams (100 pts each)
150	Final Exam (Cumulative)
150	Homework (Announced during course of quarter)
600	Total

### Grading Scale

90% and up:	A
80% and up:	B
70% and up:	C
60% and up:	D
Below 60%:	F

(-) Lowest 3 percentage points in a grade range.  
(+) Highest 3 percentage points in a grade range except for an A.

## Exams:

3 unit exams will be given during the course of the quarter. Though each unit exam only covers material from the previous unit exam, there is some building of concepts that will show up in later exams. Problems on the exam will be similar to problems that exist in the textbook and on collected homework. As may be appropriate, some or all exams may be take home in format. A cumulative final will also be given during finals week.

## Homework:

Homework is the key to being successful in physics. If you become proficient at solving the homework problems, you will do well in the course. Graded and non-graded homework will be assigned in class.

All of the graded homework problems will be collected and need to be on standard sized white paper using blue or black ink or a dark pencil. Do not use spiral bound notebook paper since it makes such a mess. Your name needs to appear on the front upper right corner and if you have multiple pages, they must be stapled together. When doing graded homework only use one side of the page. If a graded homework assignment appears to be messy, difficult to read or does not conform to the above guidelines, it may be returned for recopying and be considered late. All graded homework is due at the beginning of the period when the bell rings and should be placed on the front desk. Each graded homework assignment will be worth 10 points. Any graded homework assignments over 5 will be used to replace poorer homework grades.

You are encouraged to work together when doing homework. There should not be a sharing of answers (one person doing the work and others copying), but there is a definite benefit in helping each other to understand the problem and comparing results at various stages of the problem to see where the difficulties lie.

## Topics:

The following topics will be covered during the course of the semester. Timing of these topics is reflected in the schedule.

### Fundamentals

- Wave Equation
- Wave Propagation
- Frequency Ranges
- Sound Level
- Sound Intensity and Energy

### Vibrating Strings

- Standing Waves
- Fourier Analysis
- Forced Vibrations

### Vibrating Bars

- Stress/Strain
- Boundary Conditions
- Longitudinal Vibrations
- Transverse Vibrations
- Transcendental Equations

### Membranes and Plates

- Rectangular Vibration Modes
- Bessel Functions
- Circular Vibration Modes
- Thin Plates

### Pipes and Resonators

- Propagation in a Pipe
- Rectangular Cavity
- Transmission Modes
- Helmholtz Resonator

### Acoustic Filtering

- Lumped Impedance
- Junctions and Branches
- Acoustic Filters

### Measuring Instruments

- Microphones
- Sound Level Meter
- Frequency Sampling
- Sound Power

### Hearing

- Mechanism of Hearing
- Characteristics of Hearing
- Speech Intelligibility

### Architectural Acoustics

- Sound Fields
- Absorption Coefficients
- Reverberation Time
- Room Constant
- Auditorium Design
- Noise Attenuation

### Musical Instruments

- Percussion
- Strings
- Wind

### Sound Reproduction

- Recording Equipment
- Storage Formats
- Loudspeakers
- Digital Modification

## Late Work:

Late work will be accepted with a penalty. Late homework and labs will be docked 10% if turned in within the first week and 20% thereafter. If late work is turned in during finals week 50% of the value of the homework will be docked unless it falls under the category of being within the first week. Homework that is late due to an excused absence (prior arrangement with me or medical excuse) will not be docked if turned in the following class period.

## Extra Credit:

No extra credit is available for this class. It is felt that spending time working on extra credit distracts from staying current on the material and preparing for the next graded activity.

## Academic Integrity:

*"The Academic Integrity Pledge is a commitment to live with integrity in all areas of life including the classroom. All forms of academic dishonesty violate this pledge and could result in dismissal from this community."*

Although I encourage group efforts in studying and lab work, I still expect you to turn in your *own* work. If your work appears to be copied from another person's lab or homework, your assignment will be returned with either a zero or returned with the intent of a redo with a loss of credit. Which of these two options is chosen is at the discretion of the instructor.

During quizzes and exams you are required to do your own work. If during the quiz or examination time you receive help from an unauthorized source (ie. class mates, wireless access to the network, etc.), your quiz or exam will receive a zero and the Office of the Academic Vice-President will be notified.

### **Appeal Process:**

Our commitment as faculty is to provide you with the best possible educational experience this semester. If a concern arises during the semester, I encourage you to discuss the issue with me or, if you wish to remain anonymous, you may share your concern Dr. Mark McClain, Chair of the Department of Science and Mathematics. He will work to resolve the issue. If the concern is about grading assignments or exams, your first responsibility is to speak with me. If you believe that the outcome of that meeting did not resolve the issue, you may appeal to Dr. McClain. The formal grade appeal process can be found at [www.cedarville.edu/gradeappealprocess](http://www.cedarville.edu/gradeappealprocess)." Dr. McClain can be contacted by email ([mcclain@cedarville.edu](mailto:mcclain@cedarville.edu)), by phone (extension 7940) or in his office (ENS 380A).

### **Academic Accommodations:**

**Disability Services** coordinates reasonable accommodations for students with documented disabilities. Students in need of academic accommodations because of the impact of a disability are invited to e-mail the Disabilities Compliance Coordinator at [disabilityservices@cedarville.edu](mailto:disabilityservices@cedarville.edu) or visit [www.cedarville.edu/disabilities](http://www.cedarville.edu/disabilities) for information and an application. **Disability Services** is located in **The Cove (Academic Enrichment Center)** on the second floor of the BTS.

### **Attendance:**

Attendance will be taken each day of class. Though it does not get recorded as a grade, it will be to your benefit to be present for class. One example is that a missed quiz will be recorded as a zero unless the absence is excused. Also material will be presented differently than in the book since I will endeavor to illustrate some of the physical principles, generate discussion about issues related to physics and include Biblical perspectives on these physical principles. Faithful attendance also demonstrates a good stewardship of the time and money with which God has entrusted you.

### **Open Door Policy:**

I have one hour each day scheduled for office hours. You may also drop by my office at any other time whether it is class related or not. As long as I am present in my office and I do not have any pressing work that needs to be done, I will meet with you. I am privileged to have this ministry at Cedarville College. Whether you recognize it or not, God has put me in your life this quarter to minister to you.

### **Assessment Criteria:**

This course is used by the following programs to satisfy assessment criteria.

*Teacher Education Program*

*Teacher Education Program Unit and Program Assessments Assigned to Course*

Unit Outcome	Program Outcome	Assessment
Competence	NSTA Std 1a, 1b.	#1 OAE Exam
Competence	NSTA Std 1a, 1b.	#2 Content Knowledge

### **Conclusion:**

Use this quarter in physics well. Physics is not purely knowledge, facts or information, but a skill. You need to practice this skill correctly in order to become proficient with it. 2 hours of study outside of class for each hour in class is recommended to be successful in this class. If you are weak in your calculus and problem solving skills you may need to invest even more time.

I hope your appreciation for physics will grow during this quarter even though it will require a sustained amount of effort. Physics is a foundation for all other sciences since it attempts to quantify how this universe works from the largest to the smallest scales. The basic laws and structure present in the universe were created and are maintained by God (Col. 1:17) and provide illustrations of God's majesty and power.

### **Addendum to the Syllabus:**

Due to dynamics present during the course of the semester, the instructor may make adjustments to the printed schedule. However, if any changes are made to content coverage or dates of exams, students will be notified either in class or by email.

	Date	Ch.	Topic	Activities		Date	Ch.	Topic	Activities
			<b>PHYS3330 - Acoustics</b>						
W	8/22	1	Introduction & History		M	10/15		<b>Exam #2 Ch. 4 - 6</b>	
F	8/24	2	Basic Equations		W	10/17	7	Resonance in Pipes	
M	8/27	2	Acoustic Equations	HW1	F	10/19		<i>Fall Break (No Class)</i>	
W	8/29	3	Wave Propagation		M	10/22		Musical Instruments	
F	8/31	3	Wave Behavior / Frequency Ranges		W	10/24	7	Rectangular Cavity	HW6
M	9/3		<i>Labor Day (No Class)</i>		F	10/26	7	Helmholtz Resonator	
W	9/5	3	Sound Pressure and Decibels	HW2	M	10/29	8	Acoustic Impedance	
F	9/7	3	Displacement and Intensity		W	10/31	8	Acoustic Filters	
M	9/10		Frequency Analysis	HW3	F	11/2	8	Acoustic Filters	HW7
W	9/12	10	Hearing Mechanism		M	11/5	9	Microphones & Dosimeters	
F	9/14	10	Characteristics of Hearing		W	11/7	9	Sound Measurement	
M	9/17		Human Voice		F	11/9	9	Sound Measurement	
W	9/19		<b>Exam #1 Ch. 1 - 3, 10</b>		M	11/12	11	Sound Fields	HW8
F	9/21	4	Vibrating String & Standing Waves		W	11/14	11	Sound Absorption	
M	9/24	4	Fourier Analysis		F	11/16	11	Auditoriums	
W	9/26	4	Forced Vibrations	HW4	M	11/19		Room Assessments	HW9
F	9/28	5	Vibrating Bar		W	11/21		<i>Thanksgiving Break (No Class)</i>	
M	10/1	5	Vibrating Bar		F	11/23		<i>Thanksgiving Break (No Class)</i>	
W	10/3	5	Transverse Vibrations on Bar		M	11/26		<i>Thanksgiving Break (No Class)</i>	
F	10/5	6	Stretched Membrane	HW5	W	11/28		Room Assessments	
M	10/8	6	Boundary Conditions		F	11/30		<b>Exam #3 Ch. 7 - 9, 11</b>	
W	10/10	6	Vibrating Plates		M	12/3		Room Assessments	
F	10/12		Review		W	12/5	12	Transmission Loss	HW10
					F	12/7	12	Walls & Barriers	
					M	12/10	19	Digital Sampling and Storage	
					F	12/14		<b>Final Exam (1:00 - 3:00)</b>	