

## Physics 108

### Physics of Music (4 Credits)

Course Hrs. M-W-F 9:05 – 11:05

#### Prof. Jamie S. Kern

Office: Science and Mathematics Center 207

(508) 531-2093

[jkern@bridgew.edu](mailto:jkern@bridgew.edu)

Office Hrs. M-W-F by appointment

#### Dr. Donald J. Running

Office: Maxwell Library 312G

(508) 531-2054

[drunning@bridgew.edu](mailto:drunning@bridgew.edu)

Office Hrs. M-W 12:00 – 2:00 (and by appointment)

*Please note: Both of us are committed to being available to meet with you. If our office hours are not convenient, please call us, or speak to us personally before or after class, and we will schedule another time to meet.*

#### Course Description:

Music represents a unique discipline where "art" and "science" meet, and interact on equal footing. This course covers generation and transmission of sound, the ear's response to sound, and sound generated from various musical instruments. There will also be an introduction to room acoustics, sound synthesis, sound analysis, and basic fundamentals of musical construction. Lecture and lab will be combined together, meeting for a total of 6 hours per week.

#### Materials:

Always bring a pencil, paper, and scientific calculator (it should have sin, cos, tan and  $\sqrt{\quad}$ ). The class textbook is *Measured Tones: The Interplay of Physics and Music* (3<sup>rd</sup> edition) by Ian Johnston. Students are invited to share music examples applicable to course topics.

#### Introduction

Welcome to *Physics of Music*. We are glad you are taking this course and hope you will enjoy it. We will make every reasonable effort to support your learning and to create a pleasant and stimulating study environment.

All sound begins with motion: a physical vibration transmitted through a medium to your ear. But what separates music from noise? Is the difference purely a result of mathematical patterns in vibrating air? Alternatively, does the distinction occur in your mind, in your body, in the instrument itself, or in the person who created it?

This course explores the connections between the physics of sound and the nature of what we call music. As we learn more about the nature of sound (its components and rules) we begin to appreciate the possible implications for what music is and how it is created and performed. Music is an important and ubiquitous part of today's environmental soundscape. It is common to see students walking between classes wearing earphones connected to various electronic devices and college students' connections to their personal music can be quite profound. Yet few are truly aware of what happens in the process of creating, performing, hearing, and interpreting sound as music. Therefore, this course provides the opportunity to experience theory building

around a new idea. Professor Kern will bring information on the mathematical and physical nature of sound. Professor Running will provide expertise on music theory and musical genre as they reflect and basic acoustic concepts of physics. Together we will describe the strong and weak linkages that are important to consider between physics and music.

### **Class Description**

The time we have together will be spent in lecture, lab work, review of the scientific evidence related to the topic, and lively discussion. Active learning strategies will be employed to promote movement from knowledge and understanding through application to synthesis and hypothesis.

### **Goals/Objectives**

By the end of this course:

- You will learn several concepts relating to physics and measuring sound. Topics will progress from the simple (note/rhythm reading) to the complex (formal analysis and chordal structures).
- You will have a working knowledge of the mathematics describing waves and wave motion.
- You will understand how sound is generated and transmitted through various media.
- You will have a basic understanding of resonance and acoustics.
- You will be familiar with various terms that describe the qualities of sound waves and music (e.g. amplitude, volume, frequency, pitch, and timbre).
- You will have a basic understanding of how all types of instruments create sound and how the pitch is altered.
- You will have explored the connection between waveforms and what we perceive as music, and considered what differentiates music from sound.

### **Assignments**

**Quizzes:** There are 5 quizzes with the dates shown on your course outline. If you have an emergency that requires you to miss a quiz, please notify us by phone or email within 24 hours of the quiz. If a religious holiday requires you to miss a class or quiz, please notify me within the first week of class. There will be NO makeup quizzes or final exam. Combined scores of all quizzes will constitute **25%** of your final grade.

**Laboratory participation:** Laboratory participation is essential to this class. Observation of physical phenomena as well as application of material learned in class is vital to your learning outcomes. Due to the studio lab format of this course, labs will be spread throughout the course rather than having a specific day and time in which ALL labs will occur. If you have an emergency that requires you to miss a lab, please notify us by phone or email within 24 hours. If a religious holiday requires you to miss a lab, please notify me within the first week of class. There will be NO makeup lab times. Combined scores of all lab assignments will constitute **25%** of your final grade.

**Homework:** Daily and weekly homework assignments will be given throughout the semester. Some assignments may be mathematical in nature while others may be writing based. Unless otherwise stated, all homework assignments will be due on the following class. Late work is unacceptable. All assignments after the due date will be reduced one full letter

grade per day. Combined scores of all homework assignments will constitute **20%** of your final grade.

**Composition project:** Each student will be required to create an original musical work. This work may be in the form of classical composition or in layered soundscape. A paper will accompany this assignment detailing your musical decisions as well as your process. More detail will become available as the semester progresses. This project will constitute **5%** of your final grade.

**Making an instrument:** Each student will be required to create a musical instrument. This instrument will be a member of the woodwind, string, brass, or percussion families. A paper will accompany this assignment detailing your musical decisions as well as your process. More detail will become available as the semester progresses. This project will constitute **15%** of your final grade.

**Final Exam:** Your final exam will be cumulative, covering the materials discussed in class. The exam will include both multiple choice and essay questions. A study guide will be distributed one week before the exam. The final exam will be **10%** of your final grade.

90 – 100% = A

80 – 89% = B

70 – 79% = C

60 – 69% = D

### **Participation/Attendance**

While we expect you to come to class prepared, much of the learning in this course is experiential. Therefore, if you do not attend class, you will miss essential interaction and learning opportunities. Please make every effort to attend class, and inform us in advance if you will not be able to be there. (We want you to commit to being in class, because we will be building on our learning together – as they say, *together we are more!*) Participation in class discussions is strongly encouraged; however, it will not be graded.

### **Late Work/Incompletes/Academic Honesty/Classroom Conduct**

Late work is unacceptable. All assignments after the due date will be reduced one full letter grade per day. Students who are absent on an exam day must contact us prior to the beginning of the following class to arrange for a make-up. Failure to do so will result in a failing grade, **no exceptions**.

Incompletes will not be given except in emergencies, to be determined at the instructor's discretion in accordance with University policies. It is always preferable and nearly always possible to contact your instructors in advance should an emergency occur, via e-mail, voicemail, or a written note.

You must do your own work. Turning in work that is not your own will be penalized in accordance with University policies.

### Detailed Schedule\*

Sept. 4-6	An Introduction to the Course – What are Sound, Music, and Physics? Reading: Chapter 1
Sept. 9-Sept. 13	Consonant Vibrations, Equations and Shapes of Waves Reading: Chapter 2
Sept. 16-Sept. 20	Force and the Laws of Stretched Strings Reading: Chapter 3 pages 57 - 71
Sept. 23-Sept. 27	Quiz 1** Stringed Instruments, Overtones and Timbre Reading: Chapter 3 pages 71 – 74, Chapter 4 pages 87 - 98, Interlude 3
Sept. 30-Oct. 4	Linear Superposition, Fourier Analysis and Frequency Spectra Reading: Chapter 4 pages 98 - 109
Oct. 7-Oct. 11	Quiz 2 Wave Speed and the Speed of Sound Reading: Chapter 5
Oct. 16-Oct. 28 <b>No class 10/14</b>	Ideal and Real Air Pipes, Wind Instruments Reading: Chapter 6, Interlude 5
Oct. 21-Oct. 25	Quiz 3 Brass Instruments, Diffraction, Reflection, Absorption Reading: Interlude 1
Oct. 28-Nov. 1***	Resonance, Percussion Instruments Reading: Interlude 6
Nov. 4-Nov. 8	Quiz 4 Basic Room Acoustics, Speakers Reading: Interlude 4
Nov. 13-Nov. 15 <b>No class 11/11</b>	The Ear, Decibels, Radio Reading: Chapter 7
Nov. 18-Nov. 22	Sound Recording, Digital Sound Processing and Compression Reading: Chapter 8
Nov. 25-Nov. 27 <b>No class 11/29</b>	Quiz 5 Music and Psychology Reading: Chapter 9
Dec. 2-Dec.6	The Human Voice, Review of original compositions and created instruments Reading: Interlude 8

Dec. 9-Dec.11            Review of original compositions and created instruments  
Review for final exam

Dec. 13 – Final exam. 9:00

\*Schedule subject to change if needed.

\*\*Quizzes will always take place during the first class period of the week.

\*\*\*Nov.1 will be “Percussion Petting Zoo” day.