

**Physics 115 – Physics of Sound and Music (4)**  
**Course Outline                      GE B3**

**Prerequisites for Phys 115:** Passing score on ELM examination, or an ELM exemption or credit in MATH 104. MATH 116, completion of G.E. area B1 requirements and high school trigonometry or consent of the instructor.

Recommended: High school physics. Not open to students who have credit in a college physics course. Students will need basic algebra skills to be able to understand some of the more important mathematical concepts in simple harmonic motion, standing waves and the overtone series.

**Learning Objectives and Criteria:**

Students will:

1. Identify physical principals such as simple harmonic motion, energy and resonance as applied to sound production, amplification and sustain.
2. Recognize the fundamental properties of waves and how sound travels in different media.
3. Be familiar with standing wave resonances of both longitudinal and transverse types.
4. Gauge how tones are perceived by the human ear and analyze the overtone series.
5. Be able to explain how sound is recorded and reproduced.
6. Be able to understand the basics of room acoustics.
7. Be able to distinguish between the different families of instruments, appreciate how each family produces tones in their own particular way and differentiate between the advantages and disadvantages of particular instruments.
8. Recognize the historical development of particular instrument families and some of the technologies needed for their development.

**Text and References:**

**The Physics of Sound** by R.B. Berg & D.G. Stork, 3<sup>rd</sup> Ed, Pearson Prentice Hall, 2005

**Content and Method:**

**Method: Physics 115** will consist of 4 lectures per week. In-class demonstrations will be relied upon to better exemplify the production of sound and how it is analyzed.

**Assessment:**

Students will be evaluated through weekly homework assignments, examinations (2) and research papers (2). Examinations (45% of Grade): Two midterm examinations (total of 25% of final grade, during weeks #4 and #7) and a final examination (20% of grade) will assess the student's understanding of the course content. All assessments will consist of approximately 50% short answer and/or multiple-choice problems, 30% numerical and/or problem solving and 20% essay questions. The research paper will account for 20% of the final grade.

**Content: Physics 115 will adhere to the following topics:**

- Definitions and examples of fundamental physical quantities
- Simple harmonic motion (SHM) and its application to sound-inertia
- Simple harmonic oscillators and resonance
- Introduction to traveling waves, wave propagation and behavior
- Addition of waves-interference, beats and the doppler effect
- Transverse standing waves and resonance- boundary conditions
- The overtone series
- Properties of waves on strings
- Longitudinal standing waves
- Production of complex waves through wave addition
- Fourier analysis and spectra
- Tone quality and harmonic structure - overtones
- Resonance curves of sound resonators
- The human auditory system and response of the ear-mechanical levers/membranes
- Sound intensity scales and logarithms- power and energy
- Ohm's law of hearing
- Anatomy of the human vocal tract- vibrations/damping and resonant cavities
- Analysis of vocal sounds
- Electrical circuits, recording and amplification-Ohm's Law
- Microphones, loudspeakers and amplifiers-Faraday's Law
- Radio tuners- resonant electronic circuits
- Analog and digital sound reproduction- Faraday's Law
- Criteria and problems in acoustic design- wave reflection, interference
- Control of reverberation times- materials and absorption
- Auditorium designs
- Introduction to temperament and pitch (Ch. 9)
- Piano strings, sound production and recent innovations
- Bar instruments, chimes and triangles- vibrations in bars and rods
- Traditional drums- vibrations and resonance in thin sheets and membranes
- Gongs, cymbals and bells- vibrations and resonance in plates and 3-D surfaces