Request for New General Education Course
Background Information

This request is for a permanent course number for Physics of Music, which has been taught under the PHYS 210 number. It was introduced in 2002 and has been taught four times including one summer session.

As PHYS 210, the course was approved for the new General Education category 3: Study of the Natural World. (See the current catalog.)

A survey of existing courses within the OUS revealed two similar courses, one given at PSU the other at OSU. Both used a PHYS 331 number. Both courses required one year of a physical science as a prerequisite. However, the proposed course will be a lower division course and the only prerequisite will be high-school algebra skills. Therefore I propose to assign the course number PHYS 231, which keeps the last two digits of the similar courses in the OUS.

Resource implications: We propose to continue teaching this course in alternate years. Dr. Herrmann teaches the Experimental Techniques sequence in years beginning with an even number, so PHYS 231 would be taught in the years that Experimental Techniques is not offered. This can be done in-load, as we have experienced since PHYS 210 was first offered. Therefore no additional resources are requested.

(One may note, however, that there is a load problem during the years that Experimental Techniques is offered. The proposed Physics of Music course has no effect on this.)

Statement regarding how the course meets expectations for General Education

(1) A brief statement regarding how the course meets the mission of general education.

The General Education Program at Eastern Oregon University challenges students to become critical, creative thinkers and engaged, knowledgeable citizens, open to new ways of looking at the world.

The multidisciplinary nature of this course challenges students to look at familiar topics in new ways. For example, we initially study resonances in one dimension while looking at how woodwinds, brass, and the organ produce sound. Later, in a lab activity we examine resonances in a three-dimensional box. This turns out to be a great introduction to the techniques of spectroscopy which are used not only in acoustics but in many branches of engineering, physics, chemistry, geology, and biology. Moreover, the students find that the simple one-dimensional relations they learned are not adequate for this new system; they must be creative to explain the new observations. The knowledge gained here is used later in explaining the physiology of hearing. Our aim is that students learn that the methods of science may be applied across disciplines. This is clearly in keeping with the mission statement that students "become critical, creative thinkers" who are "open to new ways of looking at the world." A fine arts major who learns to look at his discipline from an analytic, scientific viewpoint is certainly fulfilling the latter part of the mission statement. There is a "history of science" component to this course, as well, since until the eighteenth century music was part of "natural philosophy". Indeed, the Quadrivium of the classical *artes liberales* concerned itself with numbers and comprised Arithmetic, Geometer, Music, and Astronomy. Students in this course become knowledgeable of the co-development of Music and Science, including the contributions of historical figures such as Pythagoras, Bach, and the Galilei's (Vincenzio and Galileo). This approach emphasizes science as a human endeavor and certainly encourages "new ways of looking at the world."

(2) Identify which components of the general education requirements will be met by completion of this course.

This course will fulfil the new general education Category 3: Study of the Natural World.

(3) Identify the specific general education outcomes that the course will address and describe how the course will assess these outcomes in relation to student achievement.

From the New General Education requirements:
"A liberally educated person should be familiar with the methodology, practice, and controversies regarding the academic study of the natural world. Students will choose from specifically designed course work in variety of disciplines. Upon completion of course work in this category, students should be able to employ scientific methods in the laboratory or in fieldwork as defined by the specific discipline(s) or sub-discipline(s) the student has studied, analyze and evaluate data based on discipline-defined criteria, observe accurately, integrate knowledge and data with the fundamental concepts of the specific discipline(s) or sub-discipline(s) the student has studied, and report results effectively both orally and in writing."

Students in PHYS 210 will gain knowledge and appreciation of the natural world; obtain an understanding of the basic principles of wave motion and propagation; obtain an

understanding of how sound is produced by various physical systems and how it behaves in enclosures; obtain a facility in working with units of measurement; learn some of the methodology of laboratory work and to write a well-organized and clearly presented description of laboratory activities; obtain an understanding of how basic music theory evolves from the physical and mathematical principles governing sound.

Specifically, the students will

- employ the basic units of measurement as used in the study of waves and sound;
- mathematically describe traveling and standing waves, using the concepts of amplitude, frequency, angular frequency, wavelength, and velocity;
- explain the phenomenon of beats and how this leads to the concept of musical harmony;
- demonstrate sufficient understanding of sound production that the student can design a musical instrument from physical principles;
- perform measurements in the laboratory using a microphone, an oscilloscope, appropriate computer software, and other instrumentation;
- clearly describe, in a notebook, measurements they have done and the subsequent analysis of the measurements, relating these to theory;
- describe the parts of the ear and their functions in the physiology of hearing;
- describe the acoustical properties of a room in terms of basic acoustical measurements such as uniformity and reverberation time.
- describe some of the scientific developments in the history of music, including the contributions of Pythagoras, Bach, and others.

Outcomes and objectives are assessed as follows. One midterm exam and a final exam are given. Homework is assigned once a week, graded, and returned. Students keep a laboratory notebook which is evaluated after each hands-on laboratory activity. Finally, students write a term paper and give an oral presentation to the class based on the paper.

General Education Syllabus
Eastern Oregon University
School of Arts and Sciences
Courses Syllabus

PHYS 231

Physics of Music

Catalog Description: An exploration of the physical principles of musical instruments, acoustics, and the biophysics of hearing. In-class laboratory activities provide a significant hands-on aspect to the course. This course is designed with music and fine arts majors in mind, but is accessible to anyone.

Math skills needed: high school algebra.

General Education Course Information

A. **Response to the mission statement:** The multidisciplinary nature of this course challenges students to look at familiar topics in new ways. For example, we initially study resonances in one dimension while looking at how woodwinds, brass, and the organ produce sound. Later, in a lab activity we examine resonances in a three-dimensional box. This turns out to be a great introduction to the techniques of spectroscopy which are used not only in acoustics but in many branches of engineering, physics, chemistry, geology, and biology. Moreover, the students find that the simple one-dimensional relations they learned are not adequate for this new system; they must be creative to explain the new observations. The knowledge gained here is used later in explaining the physiology of hearing. Our aim is that students learn that the methods of science may be applied across disciplines. This is clearly in keeping with the mission statement that students "become critical, creative thinkers" who are "open to new ways of looking at the world." A fine arts major who learns to look at his discipline from an analytic, scientific viewpoint is certainly fulfilling the latter part of the mission statement. There is a "history of science" component to this course, as well, since until the eighteenth century music was part of "natural philosophy". Indeed, the Quadrivium of the classical *artes liberales* concerned itself with numbers and comprised Arithmetic, Geometer, Music, and Astronomy. Students in this course become knowledgeable of the co-development of Music and Science, including the contributions of historical figures such as Pythagoras, Bach, and the Galilei's (Vincenzio and Galileo). This approach emphasizes science as a human endeavor and certainly encourages "new ways of looking at the world."

B. **General Education Requirements met:** Category Three - Study of the Natural World.

"A liberally educated person should be familiar with the methodology, practice, and controversies regarding the academic study of the natural world. Students

will choose from specifically designed course work in variety of disciplines. Upon completion of course work in this category, students should be able to employ scientific methods in the laboratory or in fieldwork as defined by the specific discipline(s) or sub-discipline(s) the student has studied, analyze and evaluate data based on discipline-defined criteria, observe accurately, integrate knowledge and data with the fundamental concepts of the specific discipline(s) or sub-discipline(s) the student has studied, and report results effectively both orally and in writing."

C. **Outcomes:**
Students in PHYS 210 will gain knowledge and appreciation of the natural world; obtain an understanding of the basic principles of wave motion and propagation; obtain an understanding of how sound is produced by various physical systems and how it behaves in enclosures; obtain a facility in working with units of measurement; learn some of the methodology of laboratory work and to write a well-organized and clearly presented description of laboratory activities; obtain an understanding of how basic music theory evolves from the physical and mathematical principles governing sound.

Prerequisites: a good facility with algebra; two year of high-school algebra required.

Format 3 fifty-minute lecture/labs per week. For summer delivery, this will be modified to accommodate the shortened schedule.

Credit hours: 3.

Grading: Based on a 100-point scale. Grade ranges are: A = 85-100, B = 72-84, C = 62-71, D = 55-62, F = less than 55.

Objectives:
Upon completion of this courses, students should be able to:

- employ the basic units of measurement as used in the study of waves and sound;
- mathematically describe traveling and standing waves, using the concepts of amplitude, frequency, angular frequency, wavelength, and velocity;
- explain the phenomenon of beats and how this leads to the concept of musical harmony;
- demonstrate sufficient understanding of sound production that the student can design a musical instrument from physical principles;
- perform measurements in the laboratory using a microphone, an oscilloscope, appropriate computer software, and other instrumentation;
- clearly describe, in a notebook, measurements they have done and the subsequent analysis of the measurements, relating these to theory;
- describe the parts of the ear and their functions in the physiology of hearing;
- describe the acoustical properties of a room in terms of basic acoustical measurements such as uniformity and reverberation time.

- describe some of the scientific developments in the history of music, including the contributions of Pythagoras, Bach, and others.

Materials

- *The Physics of Sound, Third Edition* by Berg and Stork, Prentice-Hall 2005, ISBN 0-13-145789-6.
- A calculator with scientific functions, a ruler, a protractor, and a stapler.

Course Requirements:

- Attendance, especially for laboratory-related sessions, is mandatory.
- Students will keep a laboratory notebook.
- Homework problems will be assigned at regular intervals.
- Students will write term paper relating an in-depth study of a topic approved by the instructor, and present an oral presentation to the class, based on this paper.

Method of evaluation.

Activity	**Weight**
Homework	20%
Midterm exam	15%
Laboratory notebook	15%
Oral presentation	30%
Final examination	20%

The grading scale is given in a previous section.

Syllabus revised by Tom Herrmann
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