**General Education Course Inclusion Proposal**

**Quantitative Reasoning and Analysis**

*This proposal form is intended for departments proposing a course for inclusion in the Northern Michigan University General Education Program. Courses in a component satisfy both the Critical Thinking and the component learning outcomes. Departments should complete this form and submit it electronically through the General Education SHARE site.*

**Course Name and Number: PH 102 Physics of Sound and Music**

**Home Department: Physics**

**Department Chair Name and Contact Information** (phone, email): Dr. David Lucas, 227-2191, dlucas@nmu.edu

**Expected frequency of Offering of the course** (e.g. every semester, every fall): Every winter

**Official Course Status**: Has this course been approved by CUP and Senate? YES

**Overview of course** (please attach a current syllabus as well): *Please limit the overview to two pages (not including the syllabus)*

A. Overview of the course content

Ph102 introduces the students to the fundamentals of the description of waves (both sound and electromagnetic), terminology (wavelength, frequency, etc.) analysis (e.g. Fourier series) and the physical aspects of wave interactions (diffraction, interference, etc.). The creation of sound waves through musical instruments (e.g. striking of a drumhead, plucking or bowing a string, etc) is studied and analyzed (e.g. Fourier transforms). In addition to acoustical (sound) waves, some aspects of wave interaction are demonstrated with experiments involving electromagnetic waves. The creation of sound via the transformation of electromagnetic waves (i.e., electronic sound generation) is also introduced.

B. Explain why this course satisfies the Component specified and significantly addresses both learning outcomes

**Critical Thinking Outcome:**

**Evidence:**

Through experimentation, students gather data in order to evaluate physical properties such as the speed of sound or the period of a pendulum. In the first example, students must be aware of the location of harmonics within a tube and understand that misinterpretation of what they hear (for example, amplified sound not related to the harmonic of interest) will lead to wrong values for the speed of sound. The second example requires students to obtain data by varying several parameters in simple and spring-mass pendulums to determine which of the variables are important in determining the pendulum’s period.

Another example of obtaining evidence is through the use of an oscilloscope in understanding how to make appropriate adjustments and interpretation of the scales for amplitude and frequency to determine parameters for incoming signals, primarily the period as derived from the frequency scale.

**Integrate:**

On exams and quizzes, students are asked to take a variety of information in order to solve multiple concept problems. For example, the mass and length of a string might be provided along with the hanging mass providing string tension. Students need to determine the linear density of the string as well as the tension itself in order to then determine the speed of a wave on the string.

Another example would be creating a program on their spreadsheet which combines various sine and cosine functions to produce a particular waveform.

**Evaluate:**

Laboratory experiments and the taking of data ultimately require students to evaluate and determine whether or not their results are reasonable. A good example of this in PH102 involves the construction of a flute using PVC pipe. Upon completion, students acquire a frequency spectrum for each of the notes the flute can produce. Based on the determined frequencies, they must compare to standard notes on a piano to determine the scale and key for which the flute was constructed. Due to variability in obtaining data, students evaluate which note is reasonably represented and compare to which note it should be based on the designed key.

In evaluating simple pendulum performance, the mass and displacement variables have little effect on the period. However, when students plot the data, they may see slight trends in the plots due to difficulty in accurately accumulating data in a consistent way. They need to evaluate these graphs in order to assess whether or not that variable really does make a difference in the period based on the average and range of values for a given data point.

**Quantitative Reasoning and Analysis Outcome:**

**Calculation:**

Quizzes, exams, and laboratory exercises typically require a host of calculations (and subsequent evaluation of results) to be performed. A more difficult calculation for the students at this level involves intensity ratios based on decibel readings, requiring the use of logarithms. Many more straightforward calculations are done to help students understand the fundamental ideas of, for example, the relationships between wavelength, frequency, and velocity of a w

A**nalysis/application:**

The flute example mentioned above is one very good example of analysis and application; building the flute, analyzing the frequencies, and determining the scale.

Another example would be to determine the time delay associated with direct vs reflected sound from a source on a stage to a location in the audience of a performance hall. This has been done using calculations utilizing the speed of sound and the law of reflection.

Simple decibel measurements using dB meters have been used to analyze the uniformity of sound transmission from the stage to the audience in one of NMU’s performance halls.

**Interpretation:**

Students are asked to interpret where a string is plucked based upon looking at the frequency spectrum of the string.

Interpretation of oscilloscope measurements allow students to determine frequencies of source inputs.

Based upon measurements of interference patterns produced by laser light shining through thin slits, students will interpret the relative size of the slits (and also be able to calculate them).

Exam and quiz questions ask similar types of questions over a range of topics.

**C. Describe the target audience (level, student groups, etc.)**

This course was originally designed to help the speech/language/hearing sciences majors fulfill the physics requirement for their major. Only 24 students are allowed in the course due to its combined lecture/lab format. Any student can enroll but approximately half the spots are reserved for the SLH majors. The mathematical requirement is at the high school algebra level and the course cannot be taken for credit towards a physics major. The course does fulfill the laboratory graduation requirement.

**D. Give information on other roles this course may serve (e.g. University Requirement, required for a major(s), etc.)**

 Provided in part C. above.

E. Provide any other information that may be relevant to the review of the course by GEC

Syllabus Winter 2014 (Lucas) – attached
Syllabus Winter 2015 (Russell) – attached

**PLAN FOR LEARNING OUTCOMES
CRITICAL THINKING**

*Attainment of the CRITICAL THINKING Learning Outcome is required for courses in this component. There are several dimensions to this learning outcome. Please complete the following Plan for Assessment with information regarding course assignments (type, frequency, importance) that will be used by the department to assess the attainment of students in each of the dimensions of the learning outcome. Type refers to the types of assignments used for assessment such as written work, presentations, etc. Frequency refers to the number of assignments included such as a single paper or multiple papers. Importance refers to the relative emphasis or weight of the assignment to the entire course. For each dimension, please specify the expected success rate for students completing the course that meet the proficiency level and explain your reasoning. Please refer to the Critical Thinking Rubric for more information on student performance/proficiency in this area. Note that courses are expected to meaningfully address all dimensions of the learning outcome.*

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| **DIMENSION** | **WHAT IS BEING ASSESSED** | **PLAN FOR ASSESSMENT** |
| **Evidence** | Assesses quality of information that may be integrated into an argument | **Type**: Comprehensive midterm and final examination including both objective and interpretive elements. Quizzes.**Relation to Dimension:** Students must assess information that is provided in order to apply it to solving numerical or conceptual problems.**Frequency**: Exams: Midterm and at end of semester. Quizzes: approximately weekly.**Importance**: Exams and quizzes are 65% of the total grade**Success rate**: Approximately 70% of the students are expected to earn a grade of C- or better.**Type**: Homework is given in each chapter, approximately 10 to 12 assignments.**Relation to Dimension:** Based upon the information provided in the problems, students use learned concepts to apply the information to find numerical solutions or through written description explain the results of their solution.**Frequency**: Throughout the semester, approximately weekly.**Importance**: Homework constitutes 20% of the course grade.**Success rate**: Approximately 70% of the students are expected to earn a grade of C- or better.**Type:** Laboratory Exercises **Relation to Dimension:** Students will set up experiments, decide how to make measurements, collect data, and utilize the data in explaining the physical phenomenon being investigated, which could include the appropriate use of calculations, graphical analysis, and written explanation.**Frequency:** At least weekly if not more.**Importance:** Laboratory exercises constitute approximately 30% of the activities in the course. Student performance is evaluated by direct grading of laboratory work sheets or testing on quizzes and exams, or both, depending on the instructor.**Success Rate:** Approximately 70% of the students are expected to earn a grade of C- or better. |
| **Integrate** | Integrates insight and or reasoning with existing understanding to reach informed conclusions and/or understanding | **Type**: Midterm and comprehensive final exam, quizzes. **Relation to Dimension:**  Students must utilize information from previously learned concepts to expand on and apply in conjunction with new concepts. This is done both numerically in solving problems and through written explanation**Frequency**: Middle and end of semester for the exams and approximately weekly for the quizzes**Importance**: Approximately 65% of the course grade is based on these tools.**Success rate**: Approximately 70% of the students are expected to earn a grade of C- or better.**Type:** Laboratory exercises.**Relation to dimension:** Students utilize concepts from previous labs and apply them to subsequent lab exercises.**Frequency**: Approximately weekly.**Importance**: Laboratory exercises constitute approximately 30% of the activities in the course. Student performance is evaluated by direct grading of laboratory work sheets or testing on quizzes and exams, or both, depending on the instructor.S**uccess rate** Approximately 70% of the students are expected to earn a grade of C- or better. |
| **Evaluate** | Evaluates information, ideas, and activities according to established principles and guidelines | **Type**: Exams and quizzes.**Relation to Dimension:** Students assess their results as being reasonable, or not, within the context of the physical phenomenon.**Frequency**: Midterm and final exams, approximately weekly quizzes.**Importance**: Exams and quizzes comprise 65% of the course grade.**Success rate**: Approximately 70% of the students are expected to earn a grade of C- or better.**Type:**  Laboratory exercises;**Relation to Dimension:** Students compare experimental results to accepted values.**Frequency:** Approximately weekly.**Importance :** Laboratory exercises constitute approximately 30% of the activities in the course. Student performance is evaluated by direct grading of laboratory work sheets or testing on quizzes and exams, or both, depending on the instructor.**Success rate:**  Approximately 70% of the students are expected to earn a grade of C- or better. |

**PLAN FOR LEARNING OUTCOMES
QUANTITATIVE REASONING AND ANALYSIS**

*Attainment of the QUANTITATIVE REASONING AND ANALYSIS Learning Outcome is required for courses in this component. There are several dimensions to this learning outcome. Please complete the following Plan for Assessment with information regarding course assignments (type, frequency, importance) that will be used by the department to assess the attainment of students in each of the dimensions of the learning outcome. Type refers to the types of assignments used for assessment such as written work, presentations, etc. Frequency refers to the number of assignments included such as a single paper or multiple papers. Importance refers to the relative emphasis or weight of the assignment to the entire course. For each dimension, please specify the expected success rate for students completing the course that meet the proficiency level and explain your reasoning. Please refer to the Rubric for more information on student performance/proficiency in this learning outcome. Note that courses are expected to meaningfully address all dimensions of the learning outcome.*

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| **DIMENSION** | **WHAT IS BEING ASSESSED** | **PLAN FOR ASSESSMENT** |
| **Calculation** | Ability to perform mathematical/numerical operations. | **Type**: Quiz and exam questions.**Relation to Dimension:** Students perform calculations in order to solve problems**Frequency**: Midterm and final exam, weekly quizzes.**Importance**: Quizzes and exams are 65% of the course grade.**Success rate**: Approximately 70% of the students are expected to earn a grade of C- or better.**Type**: Homework.**Relation to Dimension:** While some homework questions are purely conceptual, many require numerical calculations.**Frequency**: Approximately weekly, one assignment per chapter.**Importance**: Homework is 20% of the course grade.**Success rate**: Approximately 70% of the students are expected to earn a grade of C- or better.**Type:** Laboratory exercises.**Relation to Dimension:** Students collect data from which calculations are performed which are applicable to the physical system being studied.**Frequency:** Approximately weekly.**Importance:** Laboratory exercises constitute approximately 30% of the activities in the course. Student performance is evaluated by direct grading of laboratory work sheets or testing on quizzes and exams, or both, depending on the instructor.**Success Rate:** Approximately 70% of the students are expected to earn a grade of C- or better. |
| **Analysis/Application** | Ability to manipulate quantitative data to produce new data.Ability to use data to make judgments and draw conclusions. | **Type**: Quiz and exam questions.**Relation to Dimension:** Calculations learned previously are used in different ways and with new calculations to develop newly learned concepts**Frequency**: Midterm and final exams, weekly quizzes.**Importance**: Exams and quizzes comprise 65% of the course grade.**Success rate**: Approximately 70% of the students are expected to earn a grade of C- or better.**Type**: Laboratory exercises.**Relation to Dimension:** Students take and analyze data to draw conclusions about the physical system being studied.**Frequency**: Approximately weekly.**Importance**: Laboratory exercises constitute approximately 30% of the activities in the course. Student performance is evaluated by direct grading of laboratory work sheets or testing on quizzes and exams, or both, depending on the instructor.**Success rate**: Approximately 70% of the students are expected to earn a grade of C- or better. |
| **Interpretation** | Ability to explain information presented in mathematical forms (e.g. equations, graphs, diagrams, tables, and words) | **Type**: Exam and quiz questions.**Relation to Dimension:** Information pertinent to the concept being studied is extracted through interpreting results from calculations or through written description.**Frequency**: Midterm and final exam, approximately weekly quizzes.**Importance**: Quizzes and exams are worth 65% of the course grade.**Success rate**: Approximately 70% of the students are expected to earn a grade of C- or better.**Type**: Laboratory exercises.**Relation to Dimension:** Utilizing graphs they create or calculations they perform, students derive information about the physical system they are studying.**Frequency**: Approximately weekly.**Importance**: Laboratory exercises constitute approximately 30% of the activities in the course. Student performance is evaluated by direct grading of laboratory work sheets or testing on quizzes and exams, or both, depending on the instructor.**Expected success rate**: Approximately 70% of the students are expected to earn a grade of C- or better. |