**General Education Course Inclusion Proposal**

**SCIENTIFIC INQUIRY**

*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:** Introductory Physics / PH 221

**Home Department:** Physics Department

**Department Chair Name and Contact Information** (phone, email): Dr. David Lucas, 2517 West Science 227-2191

**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

*Courses that have not yet been approved by CUP must be submitted to CUP prior to review by GEC. Note that GEC is able to review courses that are in the process of approval; however, inclusion in the General Education Program is dependent upon Senate and Academic Affairs approval of the course into the overall curriculum.*

**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

PH 221 is a calculus-based introductory physics course designed for students majoring in physics, physical science related majors, or engineering. The course has a lecture portion which meets four times a week and a laboratory portion which meets once a week. The course covers a wide range of topics in the field of electricity and magnetism and serves as a foundation for future physics courses which deal with more advanced topics in electricity and magnetism. Topics covered in PH 221 include electric fields, electric potential, magnetism, basic electric circuits, electromagnetic induction, electromagnetic waves, optics, and wave interference. Particular emphasis in PH 221 is placed on the ability to solve problems using the concepts covered in class. The laboratory portion is focused on introducing the students to methods of data collection, analysis, and reporting using a variety of classic physics experiments.

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

**Critical Thinking Outcome**

**Evidence:**

Students in PH 221 assess the quality of information in two primary ways. In the laboratory, one of the tasks for the students is to assess the quality of the data they are collection for each experiment. This is done at two points during the experiment. First, during data collection students are to assess the data they are collecting for obvious errors such as misalignment of equipment, failures of an electronic device to properly trigger, and poor data collection techniques. The second time is during the analysis. The students are required to compare their results with those from an acceptable resource. An example of this would be an experiment designed to measure the resistivity of a common wire and compare the result to a standard source.

The second way students assess the quality of information is in the lecture portion. On homework, quizzes, and exams students are asked to use the concepts they have learned in the class to solve problems of varying levels of complexity. During the process of solving the problem, students will be faced with choices which could include which concepts to apply, which pieces of given information are useful, and finally they will evaluate the result to see if it makes sense. An example could be the analysis of the electric field around a given charge distribution. The student has to decide how to best analyze the distribution, setup the mathematics to solve for the electric field, and then compare the result in the limiting cases.

**Integrate:**

Exam and quiz questions require students to take basic information and use it to answer problems and questions that they have not been exposed to previously. An example of this would be the analysis of electric circuits. In lecture the students learn how the basic principles are applied to solving electric circuits. On exams and quizzes students are challenged to solve problems they haven’t necessarily seen using these same techniques. This requires that the students integrate the methods they have learned into analysis of another system.

In the laboratory, students are challenged to combine several ideas in the analysis of a data set. An example would be the Wheatstone Bridge experiment. In this experiment the students must use a Wheatstone bridge circuit determine the values of resistors. This is done using a balancing technique and calls on their knowledge of resistivity, resistance, Ohm’s Law, and basic circuit analysis principles. They have to take the basic data they collect and derive the accelerations from that data and the net force acting on the system. From that data, they generate the necessary plots and extract out the constant values. Lastly, they compared their results with the expectations of theory and generate a conclusion.

**Evaluate:**

In lecture we challenge students to evaluate the results of their calculations. For example, when calculating the electric field around a charge distribution the students are expected to check their results against the known limits. In the case of long distances from the charge distribution the electric field should go to zero just like a point charge. On quizzes and exams, the students are expected to compare their results with expectations or limits.

In the laboratory, the students are asked to compare their results with those from a standard source or a theoretical calculation. They are expected to make a data driven statement about their results from their experiment. An example of this is in the Wheatstone Bridge experiment in which the students are measuring the value of a known resistor. In this case there is a well-established value to which the students can compare their results.

**Scientific Inquiry Outcome:**

**Research Question:**

In one or two of the laboratory experiments, students will be tasked to analyze a system with knowledge and skills discussed in pervious lectures and laboratories and from that develop one or more hypothesis to be tested. An example of this would be the resistivity experiment. In this laboratory, students would analyze the basic physics of the system, identify the basic variables in the system, and develop one or more hypothesis to be tested via experimentation.

**Methodology/Data Collection:**

The students will develop the necessary methodologies for data collection and carry out the data collection within the confines of the resources available to them. In the case of the resistivity experiment, the students will decided on the number of trials to run, analysis methods to be used, range over which to test the variables, and the specifics of the test methods so as to limit other contributing factors. Along the way they will identify the limits to which the experiment is valid, limitations in data collection, and conditions under which the data is take.

The students would be expected to collect the data in a systematic way and display the data in an appropriate data table or similar structure.

**Analysis, Result, and Presentation:**

The students will be expected to analyze the data using techniques learned in earlier experiments and decided on the appropriate results to extract from the data. The analysis and results will be summarized in a document consistent with the course structure.

**Discussion/Conclusions:**

The document containing the data tables and analysis will also answer the question posed by the one or more hypothesis stated by the students. It will be expected that their conclusion will answer the question and use the results of the data analysis to support their conclusion.

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

The primary audience of PH 221 is physics majors, pre-engineering students, and students from other science disciplines, however, there are a few students from other majors requiring a science course whom take PH 221 due to their interest in physics.

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

This course is a requirement for physics and pre-engineering students. It also serves as a course to fulfill the University lab graduation requirement.

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

N/A

**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:** Quiz and/or exam questions**Relation to Dimension:** Students decide what information to use to solve problems and answer questions.**Frequency:** Quizzes are usually weekly, Exams 2-3 per semester, 1 Final Exam**Importance:** Quiz and Exams are 50 – 60% of overall grade**Success Rate:** Approximately 65% of students get a C- or better in PH 220 so the anticipated success rate is 65%**Type:** Laboratory exercises**Relation to Dimension:** Students develop hypothesis, develop methodologies, collect and analysis data, and report the results with data driven conclusions. **Frequency:** One or two per semester as agreed upon by the Physics Faculty**Importance:** Labs are 20% of the overall course grade**Success Rate:** Approximately 80% of the students achieve a grade of greater than 70% or better in laboratory so the anticipated success rate is 70%. |
| **Integrate** | Integrates insight and or reasoning with existing understanding to reach informed conclusions and/or understanding | **Type:** Quiz and/or Exam questions**Relation to Dimension:** Students must combine skills and knowledge learned from solving problems in class to solving new problems using the same basic physics principles.**Frequency:** Quizzes are typically weekly, Exams are 2-3 times per semester, 1 Final Exam**Importance:** Quizzes and exams are 50 – 60% of the overall grade**Success Rate:** Approximately 65% of students get a C- or better in PH 220 so the anticipated success rate is 65%.**Type:** Laboratory exercises**Relation to Dimension:**  Students will apply previously learned methods and skills to analyze data and draw conclusions**Frequency:** One or two per semester as agreed upon by the Physics Faculty**Importance:** Labs are 20% of the overall grade**Success Rate:** The anticipated success rate is 70% for students in the class. This is based on previous experience. |
| **Evaluate** | Evaluates information, ideas, and activities according to established principles and guidelines | **Type:** Quiz and/or Exam questions**Relation to Dimension:** Students will apply knowledge and skills learned in class to evaluate the results from problems they solve and conclude if the result is reasonable. The students will have to evaluate a problem and determine which physics principles and problem solving methods should be applied. **Frequency:** Quizzes are typically weekly, Exams are 2-3 times per semester, 1 Final Exam**Importance:** Quizzes and exams are 50 – 60% of the overall grade**Success Rate:** Approximately 65% of students get a C- or better in PH 220 so the anticipated success rate is 65%.**Type:** Laboratory exercises**Relation to Dimension:**  Students will make comparisons with accepted results from reasonable sources and draw conclusions about the quality of their results. They will also use their results to evaluate the effectiveness of the underlying theory for the system that was tested.**Frequency:** One or two per semester as agreed upon by the Physics Faculty**Importance:** Labs are 20% of the overall grade**Success Rate:** The anticipated success rate is 70% for students in the class. This is based on previous experience.  |

**PLAN FOR LEARNING OUTCOMES
SCIENTIFIC INQUIRY**

*Attainment of the SCIENTIFIC INQUIRY 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** |
| **Research Question** | Develop a manageable and appropriate research question that is tied to testable hypotheses. | **Type:** Laboratory exercises**Relation to Dimension:** In these exercises, students will be given a system which they must evaluate using previously learned physics concepts, identify the variables in the system using the proper theory, and develop one or more hypothesis in order to test the system through systematic experimentation. **Frequency:** One or two per semester as agreed upon by the Physics Faculty**Importance:** Laboratory is 20% of the overall course grade**Success Rate:** The anticipated success rate is 70% for students in the class. This is based on previous experience. |
| **Methodology/Data Collection** | Select and/or develop appropriate scientific methodologies  | **Type:** Laboratory exercises**Relation to Dimension:** In these exercises, students will develop a methodology to systematically test the hypothesis they stated within the limitations of the available resources. They will identify the difficulties, limitations, and take appropriated precautions to collect good data.**Frequency:** One or two per semester as agreed upon by the Physics Faculty**Importance:** Laboratory is 20% of the overall course grade**Success Rate:** The anticipated success rate is 70% for students in the class. This is based on previous experience. |
| **Analysis, Results and Presentation** | Collected data is appropriately analyzed and presented | **Type:** Laboratory exercises**Relation to Dimension:** In these exercises, students will use the appropriate methods to analyze the data collected and present the results in tables and graphs as appropriate. Details about the analysis should be considered and the students need to identify when approximations and simplifications have been used. **Frequency:** One or two per semester as agreed upon by the Physics Faculty**Importance:** Laboratory is 20% of the overall course grade**Success Rate:** The anticipated success rate is 70% for students in the class. This is based on previous experience. |
| **Discussion/Conclusions** | Conclusions are linked to evidence and are in the context of scientific limitations and implications. | **Type:** Laboratory exercises**Relation to Dimension:** In these exercises, the students will use the results from their analysis to draw data driven conclusions and perform comparisons with reasonable and theoretical predictions. It is expected that the students analyze their results in the context of the limitations they encountered during their experiment. **Frequency:** One or two per semester as agreed upon by the Physics Faculty**Importance:** Laboratory is 20% of the overall course grade**Success Rate:** The anticipated success rate is 70% for students in the class. This is based on previous experience. |