Mission / Purpose
The Department of Physics and Astronomy offers a bachelor of science in physics. In addition to
the standard program in physics, concentrations in Applied Physics, Astronomy, Pre-Medicine,
Biophysics, Geology, and Computer Science are available. All bachelor degrees are constructed
around a core of upper division physics and math courses which cover the core subject matter for
a degree in physics. All physics majors also complete upper division lab and research
requirements. In addition to the physics content, instruction in scientific reasoning, scientific
writing, and technology are emphasized. The mission of the program is quite broad since
students go on to many different career paths. Half of physics majors nationally go to graduate
school in some field including physics, math, chemistry, engineering, medicine and law. The other
half pursue careers which include research & development, business, technical sales or support,
K-12 education, and many others. Due to the rigor of a physics degree program, the
overwhelming feature of a student with a physics degree should be the ability to think clearly and
apply scientific reasoning. The mission of the B.S. in physics program is to prepare students for a
wide variety of fields and activities which require analysis, critical thinking, and the application of
physical principles and scientific critical thinking to new situations.

Goals
G 1: Physics Content Knowledge and Application Skills
Students receiving a B.S. in physics should understand the core principles of physics, usually
divided into the areas of classical mechanics, electricity & magnetism, statistical & thermal
physics, and quantum physics. In addition students should be able to apply appropriate
mathematical tools to set-up and solve quantitative problems using those core principles.

G 2: Skills of a scientist
Students receiving a B.S. in physics should demonstrate the skills and abilities needed to use
their scientific knowledge and problem-solving skills in a collaborative, technological environment.

Student Learning Outcomes/Objectives
SLO 1: Classical Mechanics (G: 1) (M: 1)
Students demonstrate a knowledge and understanding of core principles in classical mechanics
and effectively apply their knowledge in the above areas to solve problems using advanced
mathematical tools where appropriate.

SLO 2: Electricity & Magnetism (G: 1) (M: 1)
Students demonstrate a knowledge and understanding of core principles in electricity &
magnetism and effectively apply their knowledge in the above areas to solve problems using
advanced mathematical tools where appropriate.

**SLO 3: Statistical & Thermal Physics (G: 1) (M: 1)**
Students demonstrate a knowledge and understanding of core principles in statistical & thermal physics and effectively apply their knowledge in the above areas to solve problems using advanced mathematical tools where appropriate.

**SLO 4: Quantum Physics (G: 1) (M: 1)**
Students demonstrate a knowledge and understanding of core principles in quantum physics and effectively apply their knowledge in the above areas to solve problems using advanced mathematical tools where appropriate.

**SLO 5: Scientific Collaboration (G: 2) (M: 2)**
Students collaborate effectively with other students in a laboratory setting as they perform physics experiments.

**SLO 6: Research Implications (G: 2)**
Students effectively evaluate the implications and applications of research and technology and express them in laboratory reports.

**SLO 7: Scientific Critical Thinking (G: 2) (M: 2)**
Students apply the basic scientific process as they perform and report laboratory experiments. That is, they develop research questions appropriate for research, appropriately collect experimental or theoretical data to address identified research questions, analyze and interpret data to evaluate research questions, and use results of data analysis to formulate new research questions.

**SLO 8: Scientific Communication (G: 2) (M: 2)**
Students communicate effectively orally and in writing in a context relevant to scientific research using appropriate formats and styles.

**SLO 9: Scientific & Research Technology (G: 2) (M: 2)**
Students effectively use specialized scientific equipment for data collection and effectively use computers for data analysis, literature research and scientific writing in laboratory and research settings.

**SLO 10: Critical thinking through writing (G: 2) (M: 4)**
Students in Phys4900 Research Project course write a long research report over the course of the semester. They write the report in sections with feedback from instructor and other students followed by revisions. The final report is evaluated using the physics CTW rubric.

**Measures, Targets, and Findings**

**M 1: Evaluations in Content Courses (O: 1, 2, 3, 4)**
Physics Majors take a number of required courses in their junior and senior years that cover the
content in the Physics and Math Core. The core content courses are Phys3401 (Modern Physics I), Phys3850 (Statistical and Thermal Physics), Phys4600 (Classical Mechanics), and Phys4700 (Electricity and Magnetism). The outcomes are assessed by the instructors for each of the core courses by rating each student on each outcomes with a score scaled from 1 to 5. The criteria for these scores are set by the assessment committee in consultation with the faculty. The criteria for each course are in the Document Repository and are linked below.

Source of Evidence: Academic direct measure of learning - other

**Target for O1: Classical Mechanics**

Target performance is an average score of 4.0 out of 5.0 where 4.0 corresponds to substantial understanding and 5.0 corresponds to mastery. See attached rubric for more detailed information.

**Findings 2012-2013 - Target: Not Met**

Nineteen physics majors completed Phys4600, Classical Mechanics, in the Spring 2013 semester. According to the criteria given above, the average evaluation for their knowledge and understanding of core principles in this area was 3.3 out of 5.0. The average evaluation for their ability to use mathematics to solve problems in this area was 2.7 out of 5.0.

**Target for O2: Electricity & Magnetism**

Target performance is an average score of 4.0 out of 5.0 where 4.0 corresponds to substantial understanding and 5.0 corresponds to mastery. See attached rubric for more detailed information.

**Findings 2012-2013 - Target: Not Met**

Twenty three physics majors completed Phys4700, Electricity Magnetism, in the Fall 2012 semester. According to the criteria given above, the average evaluation for their knowledge and understanding of core principles in this area was 3.5 out of 5.0. The average evaluation for their ability to use mathematics to solve problems in this area was 3.3 out of 5.0.

**Target for O3: Statistical & Thermal Physics**

Target performance is an average score of 4.0 out of 5.0 where 4.0 corresponds to substantial understanding and 5.0 corresponds to mastery. See attached rubric for more detailed information.

**Findings 2012-2013 - Target: Not Reported This Cycle**

**Target for O4: Quantum Physics**

Target performance is an average score of 4.0 out of 5.0 where 4.0 corresponds to substantial understanding and 5.0 corresponds to mastery. See attached rubric for more detailed information.

**Findings 2012-2013 - Target: Met**

Twenty two physics majors completed Phys3401, Modern Physics I, in Fall 2013
semester. According to the criteria given above, the average evaluation for their knowledge and understanding of core principles in this area was 4.2 out of 5.0. The average evaluation for their ability to use mathematics to solve problems in this area was 4.3 out of 5.0.

**M 2: Laboratory Reports in Advanced Physics Lab (O: 5, 7, 8, 9)**

Physics Majors are also required to take a junior-level laboratory course, Phys3300 (Advanced Physics Laboratory). This course is designed to bring the student from the level of the introductory physics labs (where goals and procedures are mostly given to them) up to a level where they are prepared to do a Research Project (more independent and open-ended project, collaborating with graduate students and professors in a research lab). The development of critical thinking skills and appropriate written communication (lab notebooks and lab reports) are emphasized. In this lab course the students work both independently and collaboratively. They also use computers and other specialized laboratory apparatus. The outcomes are assessed by the instructor by rating each student on each outcomes with a score scaled from 1 to 5. The criteria for these scores are set by the assessment committee in consultation with the faculty and have been placed in the Document Repository and linked below.

Source of Evidence: Academic direct measure of learning - other

**Target for O5: Scientific Collaboration**

Target performance is an average score of 4.0 out of 5.0 where 4.0 corresponds to substantial understanding and 5.0 corresponds to mastery. See attached rubric for more detailed information.

**Findings 2012-2013 - Target: Not Met**

Twenty one physics majors completed Phys3300, Advanced Physics Laboratory - CTW, in the Fall 2012 semester. According to the criteria given above, the average evaluations were 3.6 out of 5.0 for scientific collaboration.

**Target for O7: Scientific Critical Thinking**

Target performance is an average score of 4.0 out of 5.0 where 4.0 corresponds to substantial understanding and 5.0 corresponds to mastery. See attached rubric for more detailed information.

**Findings 2012-2013 - Target: Not Met**

Twenty one physics majors completed Phys3300, Advanced Physics Laboratory - CTW, in the Fall 2012 semester. According to the criteria given above, the average evaluations were 3.5 out of 5.0 for scientific critical thinking.

**Target for O8: Scientific Communication**

Target performance is an average score of 4.0 out of 5.0 where 4.0 corresponds to substantial understanding and 5.0 corresponds to mastery. See attached rubric for more detailed information.

**Findings 2012-2013 - Target: Not Met**

Twenty one physics majors completed Phys3300, Advanced Physics Laboratory - CTW, in the Fall 2012 semester. According to the criteria given above, the average evaluations were 3.6 out of 5.0 for scientific communication.
were 3.3 out of 5.0 for scientific communication.

**Target for O9: Scientific & Research Technology**

Target performance is an average score of 4.0 out of 5.0 where 4.0 corresponds to substantial understanding and 5.0 corresponds to mastery. See attached rubric for more detailed information.

**Findings 2012-2013 - Target: Not Met**

Twenty one physics majors completed Phys3300, Advanced Physics Laboratory - CTW, in the Fall 2012 semester. According to the criteria given above, the average evaluations were 3.5 out of 5.0 for scientific and research technology.

**M 4: Research Project (O: 10)**

The capstone of the physics bachelor's degree program is now Phys4900, Research Project - CTW. In this course students work in the research lab of a professor (within Physics and Astronomy or another department) to perform a research project while at the same time attending a class meeting each week to work on writing a research proposal and a report on their semester long research project in the style of a scientific article. The project is one that is integrated with the ongoing research done in that group and may lead to the student being part of a presentation at a scientific conference or an article in a scientific journal. It is meant to prepare students for graduate work or a career in corporate research and development or basic research. The student participates in research group interaction (e.g. group meetings) over the course of the project. The outcomes are assessed by according to a rubric.

Source of Evidence: Project, either individual or group

**Target for O10: Critical thinking through writing**

At least 80% of students will achieve 3 out of 4 (competency) on each criterion of the rubric after all revisions are completed. At least 50% of the final evaluations will be 4 out 4 (mastery) for each criterion.

**Findings 2012-2013 - Target: Partially Met**

In Spring 2013 a total of twelve students registered for Phys4900, Research Project. One student stopped attending and failed the course while two other students received grades of incomplete. Nine students completed and passed the course with high marks. Each of these students performed a research project with an existing research group in the department of physics & astronomy. Each student wrote a research proposal in the first two weeks of the term and received comments from the course coordinator and two fellow students. This research proposal then served as the starting point for a long research report in the appropriate style for scientific journals. The research report was written consecutively in sections: introduction, methods, results, discussion, abstract, and conclusion. Each section was shared and the student received feedback from the course coordinator and two other students. Final evaluations of all five students based on the completed long research report were completed by the course coordinator using the physics rubric. All nine students scored 3 (competency) or 4 (mastery) in all seven criteria in the final assessment with 30 out of 63 scores rated as 4 and the remaining 33 scores being 3. In comparison with our targets, 100% of students achieved at least 3 (competency) on each criterion in the rubric and 48% of the scores were 4 (mastery). The average score on each of the criteria in the rubric were: A. Develop research questions - 3.2 B. Collect appropriate data - 3.4 C. Analyze and interpret data - 3.6 D. Formulate new
Details of Action Plans for This Cycle (by Established cycle, then alpha)

Curriculum Evaluation
Physics BS Curriculum will be re-evaluated in light of assessment data. New courses are needed (such as Relativity and Computational Physics). Some change to math preparation requirements has been proposed as has introduction of new upper division lab courses. New curriculum committee has been formed in the department. New courses are being added and some evaluation of current requirements is planned in 2013-2014.

Established in Cycle: 2011-2012
Implementation Status: In-Progress
Priority: Medium
Projected Completion Date: 05/2014
Responsible Person/Group: Brian Thoms

Analysis Questions and Analysis Answers

ACADEMIC PROGRAM QUESTION 1: What changes in the assessment process has your degree program made since last year's assessment report? (e.g. revised learning outcomes, measures, targets, etc.) Why were these changes made? What changes and improvements in the assessment process will you make in the coming academic year?

In Summer 2013 the department created a new committee structure including a standing assessment committee. In Fall 2013 this committee will begin restructuring the assessment and reporting responsibilities to better assure successful assessments.

ACADEMIC PROGRAM QUESTION 2: What is the impact of the data obtained from assessment findings on your educational degree program? What changes and improvements to your educational program will be made based on this year's assessment data? (e.g., revised curriculum, courses, sequence, etc.) If changes to curriculum or courses are made for other reasons, please explain.

Over the last few years the numbers of students in the upper division physics courses have increased dramatically. The assessments of both content knowledge and scientific skills has shown a decrease in this time period, but not a very large one. Although maintaining similar results to the evaluations despite significantly larger class sizes could be viewed as some success, the assessment results were below targets to begin with. In response to low scores in research skills, a number of changes are being made to the Advanced Physics Laboratory course, Phys3300, beginning in fall 2013. More intentional instruction in experimental design, critical thinking in physics, and scientific writing are being added to the course.