Department of Physics and Astronomy  
Assessment Report 2010

This assessment report is prepared on June 17, 2010 by Chris Taylor, on behalf of the Assessment Committee of the Department of Physics and Astronomy. The Committee membership is: Gary Shoemaker, Vassili Sergan, Chris Taylor and Hossein Partovi.

Background

First, some background information to provide context for the assessment report. The number of majors in the Physics program is small for departments on this campus, but is in fact large for similar departments at other universities across the United States. The American Institute of Physics (AIP) conducted a survey of the size of Physics departments for departments whose highest degree granted were either bachelors, masters or Ph.D. Among Physics departments whose highest degree was a bachelors, in 2008, the year of the survey, 59% granted between 0 to 4 degrees, 30% granted between 5 to 9 degrees, and 11% granted 10 or more. Our department granted 4 degrees that year, and our average from 2005 – 2010 is 5 per year. Furthermore, we had 7 graduates in AY 09/10, and expect higher numbers in the future as a result of actively recruiting new Physics majors. Although we are currently graduating Physics majors in greater numbers than 70% of all similar departments in the nation, having numbers in single digits makes a statistical analysis of learning outcomes difficult. The Assessment Committee has made an effort to use rigorous statistical measures when possible, but where numbers are insufficient for that kind of analysis, a qualitative study of course curricula and examples of student work were examined to assess student learning outcomes.

Learning Outcomes and Methods of Assessment

Physics Knowledge – Students should develop a broad understanding of basic principles of physics and mathematics and the foundation for acquiring new knowledge and applying it in a variety of situations.

The Physics Knowledge outcome is directly assessed in two ways 1) analyzing exams and final course scores in upper division physics courses on a rotating basis; and 2) analyzing examples of student work such as lab reports and journals, computational physics projects, faculty/student research projects, and work on the capstone senior project.

1) The Assessment Committee obtained copies of final examinations from the instructors of four upper division courses that were taught in AY 09/10: Phys 115, Phys 116, Phys 136, and Phys 156. Phys 115 and 136 are “core” courses in our major program, while Phys 116 and 156 provide in-depth coverage of electronics (116) and advanced physics topics (156) for students who wish to enter the job market or graduate school with higher levels of proficiency. Phys 115 and 116 are both hands-on, intensive laboratory courses.
Phys 156 is being assessed for the first time after a recent total revision in the course description to bring our major program into alignment with informal national standards for Physics programs. The instructors removed student names from the exams, and submitted three exams from each course, representing excellent achievement, satisfactory achievement, and poor (failing) achievement (when possible). Final project reports were also submitted as evidence for Phys 116 following similar guidelines as the exams for the other courses.

The Committee reviewed each of the exams to ensure they accurately reflected the required course content, and that the exams were neither too simple nor too difficult for the level of the course. The Committee looked at the scores assigned to the students of the three examples to ensure that grading was fair and represented a real evaluation of the abilities of the students. The Committee was satisfied in both regards (level of the exam and level of the grading) and established that the exams provided useful information on the students’ levels of physics knowledge. Since final course grades are largely based on exam performance and homework scores, the course grade distributions will accurately reflect the degree to which the body of students in each of the reviewed courses. The Committee also examined laboratory reports for Phys 116 and applied the same analysis as we did for the exams.

2) The Committee collected and reviewed five senior project reports that were completed during the AY 09/10. The Senior Project Coordinator (Shoemaker) made a comparison between these reports and those project reports that had been reviewed during the last two assessment cycles. Each report was analyzed to determine at what level the student author had demonstrated knowledge of physics -- excellent, satisfactory, or poor.

**Analytical Reasoning** – *In addition to Physics content, students should develop problem solving, critical thinking and analytical skills and be able to learn new skills as needed.*

The Analytical Reasoning outcome is assessed through 1) the analysis of final exams as previously described; and 2) analysis of student work, also described above.

1) The example student exams were studied by the Committee for evidence of mathematical reasoning and critical thinking. The exams are an excellent opportunity for this because the students are required to show their work, giving the Committee insight into their problem solving processes.

2) Examples of student work were studied for evidence of computational and experimental reasoning. For this year, the student work was the five senior project reports completed during AY 09/10. These projects are the capstone experience for our majors and require the students to demonstrate their competency in many areas. Projects include experimental and/or computational work explicitly and are perfect for this purpose. In the future the Committee will also look at examples of lab reports and computational projects completed for various courses.

**Technical Skills** – *Physics students must be exposed to a broad range of technical skills and should become proficient in many.*
The Technical Skills outcome is assessed primarily through analysis of student work. For the current year senior project reports and the sample of three final course projects from Phys 116 will be analyzed. The senior project pulls together all the competencies a student develops in carrying out the work, including use of experimental equipment, data analysis, design of novel instruments, and computational work. Each senior project report was examined to determine the degree of competency with which the student used her or his technical skills. These skills are taught in our laboratory and computational courses, so in future assessment cycles student work from these courses will also be examined. In Phys 116, students study advanced electronics practices and must complete a final project in which a novel electronic device is constructed.

**Communication Skills** – Students should develop the ability to clearly express their thinking in both oral and written form and to efficiently acquire new information from many sources.

The Communication Skills outcome is also primarily assessed through analysis of student work, including exams and senior project reports. While solving physics problems students must learn to communicate effectively using mathematical symbolism, and equally as important, learn to communicate in a written fashion the relationship between the math and the physical concepts the math is describing. Oral communication is also part of the senior project – every student must give an oral presentation on his or her work. Students receive feedback forms in which the audience (which is composed of Department faculty and majors) evaluates their performance. The Committee examined these feedback forms to look for evidence of effective oral communication skills.

**Programmatic Assessment**

In addition to assessing particular student outcomes, the Assessment Committee also initiated a broad look at the entire Physics program, to determine if the structure of the program facilitated student learning, and to determine if the students were achieving their own goals in Physics, be that admission to a graduate program, or entrance into a satisfying career path outside of academia. This year the Committee analyzed two sets of data: exit interviews conducted with seniors who graduated either Fall 2009 or Spring 2010, and the results of an alumni survey the department carried out during AY 09/10.

**Results and Discussion**

**Physics Knowledge**

The results from both assessments of Physics Knowledge indicate that Physics majors are meeting this learning goal.

1) Student final exam scores and course grades for Phys 115, 116, 136 and 156 and final course project reports for Phys 116 show that nearly all physics majors demonstrated satisfactory levels of physics knowledge by achieving passing grades. Many students
demonstrated excellent levels of physics knowledge by earning grades of B- or higher in these courses. Overall, about 70% of students earned grades of B- or higher. The lowest grade achieved by any student in the courses under review was C-, out of a sample of 24 grades assigned in the four courses. In the previous assessment cycle (AY 08/09) approximately 25% of the students received D grades, different from the current results. This may simply be a result of reviewing different courses than last year, especially since there are fewer purely theory-focused courses in this year’s review.

2) The results of the senior project reports were quite positive. The written reports continue to show that students are doing well in the mechanics of writing and the oral presentations were very strong this year. The current year of senior project reports was found to be lacking in two areas: 1) students did not place much emphasis on describing the physics background relating to their topics (with some variation from student to student); and 2) there was insufficient attention devoted in the reports to error analysis. The committee could not tell if the analysis had been performed and just not reported upon adequately, or if the analysis was skipped entirely.

**Analytical Reasoning**

The results from both assessments of Analytical Reasoning indicate that Physics majors are meeting this learning goal.

1) Student exam scores and course grades for Phys 115, 116, 136 and 156 show that students have demonstrated Analytical Reasoning at the satisfactory level or higher. These grades reflect a combination of Physics Knowledge and Analytical Reasoning, which go hand in hand in the Physics major.

2) The results from an examination of senior project reports also show that students have demonstrated Analytical Reasoning in pursuit of their senior projects. Students work with a high degree of independence on these projects, and each project showed that students were capable of planning their project, identifying problems as they occurred, and working out solutions to those problems.

**Technical Skills**

The results from assessment of senior project reports indicate that Physics majors are meeting the Technical Skills learning goal. Each of the reports demonstrated effective use of various technical skills to fulfill project goals. Technical skills are also a primary part of the curriculum in the two lab courses, Phys 115 and 116. Students are achieving at high levels in this learning goal, as evidenced by their high grades and the quality of the submitted final course projects in Phys 116.

**Communication Skills**

The results of assessing Communications Skills through exams and particularly the senior project reports and presentations indicate a significant closing of the gap in levels of
achievement for mathematical communication and written communication in reports, relative to our analysis of two years ago.

1) Analysis of student final exams shows that Physics majors can effectively communicate physics concepts using mathematical symbolism.

2) Analysis of senior project reports showed a significant improvement in the achievement by Physics majors in meeting the Communications Skills learning goal. Some student work is nearly at a level suitable for publication in a peer-reviewed journal; however, all of the projects exhibited a good grasp of essential writing concepts like grammar and organization.

Programmatic Assessment

Senior Exit Interviews:

The results of Programmatic Assessment through the senior exit interviews lend support to our previous results from the last two years that overall the Physics major is well structured and does facilitate student achievement in Physics.

The senior exit interviews of the graduating students resulted in wide ranging discussions using the pre-scripted interview questions as a starting point. Seven graduating students participated in the exit interviews, including one done by e-mail. The Committee reviewed audio recordings of each face-to-face interview to pull together a set of common themes, given here in no particular order:

- Students continue to be pleased with the very high level of accessibility of the faculty members. In particular, students who transferred from other institutions commented on the very high level of interaction between faculty and students in the Physics program here. This result was consistent in the case of transfers from both larger, and comparably sized programs.
- In general, students felt that advising in the Department was sufficient to make sure they progressed through the program as quickly as possible. More frustration was expressed that on a number of occasions courses were cancelled at the last minute, or never offered at all.
- Students uniformly praised the laboratory courses (Phys 115, 116, 145, 175) and the Shop course. In some cases students who did senior projects off campus reported that their employers, both in academia and industry, were impressed by the students’ hands-on skills.
- Students found the senior project to be a valuable experience.
- While students found that computer literacy appeared to be well addressed in the major, despite the fact that there is no formal requirement, two expressed regret that a dedicated computational course was not offered. The Department has already addressed this issue with two courses – a revised Phys 162 (Scientific Computing: Basic Methods) and a new course Phys 163 (Scientific Computing:
Modeling, Simulation and Visualization). Both are scheduled to be offered in AY 10/11.

Alumni Survey:
The Committee also reviewed the responses from the 2010 Alumni Survey carried out by the Department. The Survey received over 40 responses, some of which came from students who graduated 40 years ago. As the Physics program has undergone many changes over the years, the Committee decided that, for the purposes of this report, only responses from students who graduated over the past seven years would be reviewed. This gave a sample of 13 responses to review.

While responses to the Alumni Survey questionnaire were varied, several common themes emerged:

- Some of the respondents pre-dated the senior project requirement, but those who completed senior projects found it to be an extremely valuable experience that reinforced the technical skills and physics knowledge learned in previous coursework.
- Uniformly the respondents found the accessibility and availability of the faculty to the students to be one of the Department’s greatest assets. Some respondents referred to the “close knit” or “family” environment in the Department.
- A small number of respondents cited inadequate coverage of Physics topics in the curriculum as a weakness, especially for those students who go on to pursue a graduate degree in Physics. Similar comments had occasionally been offered in senior exit interviews over the years, and the Department has already taken steps to address them. Specifically the Phys 156 course was revised to offer advanced coursework in classical mechanics, thermodynamics and statistical mechanics. Similarly the Department has worked with the Math Department to revise the content and level of Math 105: Mathematical Methods, a course required of all Physics majors, in order to make it more suitable for physics-related applications.

Review of Submitted Student Work

The Committee determined after reviewing the course materials for the courses listed above, that the conclusions reached in our analysis were quite similar as regards student performance, and the content for these courses appear to be in-line with historical precedents and generally recognized expectations on the national level.

The Committee examined five senior project folders from AY 09/10, and the Senior Project Coordinator submitted an analysis of the project reports. The folders included the written reports with reviewer comments, the score sheets and statistics from the audience review of the oral presentations, and the mentor evaluation of student performance. In comparing these projects to projects from preceding years, the Committee agreed with the Coordinator that the oral presentations were of high quality all around, and that students were effective in the use of writing to describe the work they had done in their
The written reports showed marked improvement from two years ago in grammar, organization and content; this improvement was consistent with the improvement noted in last year’s assessment report. The oral presentations also appeared to have been better prepared given the general professionalism exhibited by their talks and the confidence that the students appeared to have during their presentations. Two areas of weakness appeared in this year’s senior project reports: a lack of presenting the project in the greater context of physics, and a lack of sufficient error analysis. Recommendations regarding both of these appear below.

Closing the Loop

Last year the Assessment Committee made the following recommendations to the Department:

1) Develop minimal standards for upper-division syllabi. The Department Curriculum Committee considered this issue and opted not to create a new policy as such a policy might tread too heavily on the academic freedom of faculty to teach their courses as most appropriate, within the established guidelines.

2) Develop guidelines for the use of take-home exams. The Curriculum Committee advised the Department for the potential for abuse of take home exams if they are not carefully written and requested that faculty take care in creating take-home exams.

3) Continue with mandatory advising, but spread the advising workload over more of the faculty. The Department enacted this recommendation and now advising is spread out among the faculty. It is too early to make a definitive assessment of the impact of the new advising policy on students’ decision making and overall performance.

Recommendations

Based on the analysis described above, the Committee makes the following recommendations to the Department for AY 10/11:

1) Examine the teaching of error analysis within the upper division curriculum to determine the best courses in which to strengthen this key scientific concept.

2) Revise the document given to students enrolled in Phys 191 (Senior Project) to emphasize the requirement that their work must be placed into the context of the underlying physics.

All members of the Assessment Committee felt that the review and analysis of the assessment data was a very helpful process and that it has provided a valuable look at the
goals and procedures of the Department. Following the recommendations outlined above will result in an immediate improvement in the quality of our Physics program. The Committee was satisfied that the Department made a more than satisfactory effort to put into place last year’s recommendations, and is delighted to see that some of these changes have already had a positive impact on our program. With the current report all upper division courses in the Physics major have been assessed.

Important assessment activities for the upcoming year include:

- Analyzing final examinations and course grade distributions for the following upper division Physics courses: Phys 110, 145, 162, and 163. Phys 162 has undergone a revision, and Phys 163 is a new course. Both are in the important area of scientific computing.
- Analyzing final examination and the course grade distribution for the following lower division Physics course: Phys 11A (the entry course for our majors). Physics 11 is being studied in depth next year as part of the Department’s program review.
- Empanelling the Student Assessment Committee in the Fall 2010 semester to make their biannual report to the Department.
- Continuing to collect and analyze senior project reports and the feedback forms from the oral presentations. This will be done in the spring semester for reports covering the entire academic year.

**Assessment Materials on File**

The following assessment materials used in the preparation of the 2010 report are kept on file in the Department of Physics and Astronomy office:

1) Audio recordings and transcripts of senior exit interviews.
2) List of questions used during senior exit interviews.
3) Examples of excellent, satisfactory and poor student work on final examinations for Phys 115, Phys 116, Phys 136, and Phys 156, for the academic year 09/10.
4) Syllabi for the same courses listed in (3) above.
5) Grade distributions for the same courses listed in (3) above.
6) Senior project written reports for all senior projects completed in AY 09/10.
7) Summaries of senior project oral presentation feedback forms for AY 09/10.
8) Additional documentation on written reports for the senior project.
9) A copy of the questionnaire used in the 2010 Alumni Survey.
10) Copies of responses to the 2010 Alumni Survey.