

## Unit Plan for Assessing and Improving Student Learning in Degree Programs

Unit: Physics

Unit Head approval:

Date: May 9, 2008

### SECTION 1: PAST ASSESSMENT RESULTS

1. Completed reform of calculus-based and algebra-based introductory courses ([http://research.physics.uiuc.edu/PER/Course\\_Revisions.html](http://research.physics.uiuc.edu/PER/Course_Revisions.html)).
2. Established Physics Education Research group (<http://research.physics.uiuc.edu/PER/>). One main activity is continued assessment of student learning and creation of course materials. One major development has been the creation of Interactive Examples, web-based exercises to promote concept-based problem-solving (<http://research.physics.uiuc.edu/PER/ie.html>).
3. Established one hour honors “add-on” courses for the introductory calculus-based sequence (PHYS 199HM, HO, and HT).
4. Established senior thesis sequence (PHYS 496, Summer Research Experience, and PHYS 499) that features technical writing, presentations and research.
5. Implemented major curriculum changes in Fall 2004 in which the number of required physics courses are reduced, but an elective option is added. This option can be professional physics which prepares students for graduate school in physics or it can be one that prepares the student for a wide variety of options that might benefit from a core physics base.
6. Established PHYS 123, a course for pre-service elementary education students; it is offered once per year and has an enrollment of 100 students.
7. In process of systematic revision of the advanced lab offerings for majors. PHYS 403 (Modern Experimental Physics) completed; it features updated experiments in nuclear and particle physics, atomic, molecular and optical physics, and condensed matter physics. PHYS 401 (Classical Physics Lab) is the current focus, featuring a reduced number of much improved experiments. Discussions are in progress concerning new courses in optical spectroscopy, the physics of music, and biophysics.

## **SECTION 2: REVISED ASSESSMENT PLAN**

### **(a) PROCESS:**

The outcomes assessment plan for the Department of Physics was developed by the Associate Head for Undergraduate Programs, Gary Gladding, in consultation with the Associate Head for Graduate Programs, John Stack, the faculty, the Undergraduate Studies Committee, and the Graduate Studies Committee.

### **(b) STUDENT OUTCOMES:**

The mission of the Department of Physics is to serve the people of the State of Illinois, the nation, and the world through leadership in science education, physics research, public outreach, and professional service.

We aspire *(i)* to instill in our students the skills, attitudes, values, and vision to prepare them for successful careers in physics and other fields and for lifetimes of continued learning; *(ii)* to remain at the vanguard of international research in physics, generating new knowledge of our physical universe and working, in consort with the colleagues from other disciplines, to apply the fundamental advances in physics to the benefit of society; *(iii)* to increase public scientific literacy through widespread outreach and advocacy, in order that our citizens be able to reach informed decisions on the technologically complex issues confronting society; and *(iv)* to provide leadership to our discipline and public institutions through professional service.

#### ***A. Specific Educational Objectives for Undergraduate Students***

The bachelor's degree graduates of the Department of Physics should have:

1. A thorough knowledge of the basic fields of physics, including mechanics, electricity and magnetism, thermodynamics, and quantum mechanics.
2. A thorough knowledge of mathematics to facilitate the description and manipulation of fundamental physical constructs.
3. The ability to use this knowledge to assess and solve real physics problems.
4. The ability to communicate effectively, both verbally and in writing.
5. The ability to use basic experimental apparatus common to the study of physical phenomena.

#### ***B. Specific Educational Objectives for Graduate Students***

In addition to the knowledge and skills expected of our undergraduate students, the graduate students of the Department of Physics should also have:

1. A mastery of the concepts and the literature of a specific subdiscipline of physics, such as theoretical condensed matter physics or experimental nuclear physics.
2. A basic understanding of computational techniques applied to the study of physical systems.
3. The ability to conduct original research (Ph.D. students)

(c) **MEASURES AND METHODS USED TO MEASURE OUTCOMES:**

1. Instructor and Course Evaluations

We use both campus-wide surveys (ICES) and web-based surveys designed for specific courses to solicit student input for the evaluation of the effectiveness of the courses we offer and the performance of the instructors who teach them. We also have an ongoing program of peer review to evaluate the teaching of non-tenured professors.

2. Studies of Student Performance on Final Exams in Introductory Courses.

One activity of the Physics Education Research group is the creation of new instructional materials and methods for the introductory courses. Since the final exams in these courses are secure, we can repeat final exam questions from previous years to measure the effectiveness of our interventions. We have completed this procedure for the Interactive Examples and plan to continue this practice for future innovations.

4. GRE Scores.

Since many of our students go on to graduate school, GRE scores are a good measurement of how well they are prepared. We will maintain the history of our students' GRE scores for regular review by the department administration and faculty.

5. Exit Survey

At the end of each academic year, we ask our graduating seniors to fill out an exit survey. We use these surveys to obtain information on the student's future plans and to determine the student's perception of his or her undergraduate education.

6. Physics Advisory Board

The Physics Advisory Board, a committee composed of 11 leaders primarily from industry, meets regularly, usually twice a year. The Board has been charged with providing advice and guidance to the departmental leadership on (i) maintaining the excellence of our education and research programs; (ii) developing stronger ties with the industries that hire our students; and (iii) establishing and maintaining a departmental infrastructure to support life-long learning.

## 7. Graduate Examinations

Ph.D. candidates are required to pass three exams. The *qualifying exam* is a written exam taken before the end of the fourth semester of a student's first enrollment in the graduate program that tests the student's proficiency in four main areas of physics (mechanics, electricity and magnetism, quantum mechanics, and statistical mechanics). The *preliminary exam*, which tests the student's readiness to perform original physics research, is an oral exam that is based on a paper of no more than 15 pages submitted by the candidate. This paper, essentially a research proposal, is on the student's proposed thesis or a closely related topic. The preliminary examination includes general questions on the physics fundamental to the proposed thesis, in addition to specifics of the topic. The examination also tests the student's familiarity with basic literature in the field. The *final oral exam*, at which the candidate presents the results of thesis research, is the last requirement for the Ph.D.

## 8. Ph.D. Theses

Candidates seeking the Ph.D. are required to produce a written thesis, based on their original research projects, in order to obtain their degrees. As noted in the foregoing section, the final exam is an oral defense of the written thesis.

## 9. National Surveys of Graduate Programs in Physics

We monitor the regularly published studies of the quality of graduate programs in physics produced by the National Research Council. Our program is currently ranked as one of the top ten programs in the country.

## 10. Alumni Surveys

With help from the University of Illinois Alumni Association, we are in the process of creating a survey of our alumni via mail. The survey will be designed to determine whether our learning goals for our students were obtained, and if these goals were indeed relevant to the alumni's current work.

## 11. Exit Interviews

Our current exit surveys gather very general information, but the response rate is not as large as we would like. By conducting formal exit interviews, we hope to reach all graduating seniors. The interview process should allow for more in-depth and individual information. The size of our graduating classes is increasing (we estimate 60 graduates this year), but we believe personal interviews are practical and will be conducted by the Coordinator of Special Programs as part of his or her regular job duties.

### **SECTION 3 : PLANS FOR USING RESULTS**

#### **(a) PLANS:**

- A. ICES results are reviewed by the department's administrative officers. The instructional staff are encouraged to use the ICES results to improve their teaching performance.
- B. The Physics Education Research group will analyze the data from repeated final exam questions as well as all other data that is generated from other means to determine the effectiveness of our innovations. Basic research into student learning is also done by the group.
- C. The department's administrative officers will monitor the performance of our graduates on the GRE exams, comparing their results to those of students worldwide who took these exams. Systematic reports will be made to the faculty.
- D. Exit survey data will be reviewed by the department's administrative officers. Ongoing analysis of this data will be provided by the Coordinator of Special Programs.
- E. The periodic reports of the Physics Advisory Board will be circulated to the faculty. The insights offered by the Board have proven quite useful in our current study of revisions in the undergraduate program. We expect our programs to benefit greatly from the continued activities of the Physics Advisory Board.
- F. Graduate qualifying, preliminary, and final exams are evaluated by faculty committees.
- G. Ph.D. theses are evaluated by faculty committees.
- H. National surveys of graduate programs in physics are monitored by the Associate Head for Graduate Programs, and the results are disseminated to the faculty.
- I. The alumni surveys will be collected and analyzed by the Coordinator of Special Programs. Results will be disseminated to the faculty.
- J. Exit interviews will be administered and analyzed by the Coordinator of Special Programs. Results will be disseminated to the faculty.

#### **(b) TIMELINE FOR IMPLEMENTATION:**

The planned new assessments are the alumni survey and the undergraduate exit interviews. The initial alumni survey will be posted during Fall 2008. The first exit interviews will be done in Spring 2009.