# Physics Department Undergraduate Assessment Plan

## University Mission

Wichita State University is committed to providing comprehensive educational opportunities in an urban setting. Through teaching, scholarship, and public service, the University seeks to equip both students and the larger community with the educational and cultural tools they need to thrive in a complex world, and to achieve both individual responsibility in their own lives and effective citizenship in the local, national, and global community.

High quality teaching and learning are fundamental goals in all undergraduate, graduate, and continuing education programs. Building on a strong tradition in the arts and science, the University offers programs in business, education, engineering, fine arts, and health professions, as well as in the liberal arts and sciences. Wichita State has 113 degree programs that range from the associate to the doctoral level; non-degree programs are designed to meet the specialized educational and training needs of individuals and organizations in south central Kansas.

Scholarship, including research, creative activity, and artistic performance, is designed to advance the University's goals of providing high quality instruction, making original contributions to knowledge and human understanding, and serving as an agent of community service. This activity is a basic expectation of all faculty members at Wichita State University.

Public and community service activities seek to foster the cultural, economic, and social development of a diverse metropolitan community and of the state of Kansas. The University's service constituency includes artistic and cultural agencies, business and industry, and community educational, governmental, health, and labor organizations.

Wichita State University pursues its mission utilizing the human diversity of Wichita, the state's largest metropolitan community, and its many cultural, economic, and social resources. The University faculty and professional staff are committed to the highest ideals of teaching, scholarship, and public service, as the University strives to be a comprehensive, metropolitan university of national stature.

## Program Mission

The mission of Wichita State University is not merely that of a trade school, but to provide “comprehensive” education. A good university education teaches students to think critically, and to use the wisdom of the past to understand the present and to develop a vision for the future. Physics is an essential part of this goal. Physics can be defined as the attempt to understand the behavior of matter and energy in terms of a few general laws or principles. Physicists try to understand the cosmos, all the way from stars and galaxies down to the elementary particles that make up nuclei and atoms. The laws of physics underlie the electronic intricacies of computers as well as the biological

complexities of the human brain. Understanding the cosmos and the human brain are perhaps the boldest goals of 21st century physics, but of course there are also more down-to-earth problems being tackled by physicists today. In fact, the creative processes used in physics – the logic, the discipline, the approach to analyzing the single tree without being overwhelmed by the forest – also have important applications in many other areas if not in all.

Physics is the fundamental science and forms the core of every discipline in one way or another. The physics department provides the following service courses to the general education program of the university and for the science, health professions, and engineering majors: Physics 111, 131, 195, 213, 214, 313, 314, 315, 316, 320, and 395.

For Physics majors we offer two Bachelor's degrees, the BA and the BS. In addition to the basic courses which are a part of every physics major's preparation, we take pride in offering our students unique opportunities to be involved in fundamental original research as a significant part of their degrees. Physics degrees from WSU prepare our students with the tools necessary either to carry on their education in graduate studies or to seek careers in industry, government service or education. WSU Physics graduates are currently well employed in industry as engineers, in software development companies, and in the teaching profession as educators.

As part of the University's goal of making original contributions to knowledge and human understanding, the Physics Department faculty are expected to have nationally competitive research programs, seek external funding, and attend national and international conferences.

The department as a significant part of the metropolitan advantage takes pride in serving the community and region via public education activities such as presentations and speeches. Lake Afton Public Observatory and the Fairmount Center of Science and Mathematics Education were both started and nurtured in our department. Every year our faculty members play a disproportionately large role in Science Olympiad and the Kansas Junior Academy of Science, and we are proud to do so. More recently we have been collaborating significantly with the College of Education as well.

## Program Goals and Objectives

1. To provide high quality introductory physics courses for other program's majors, and for WSU's general education program.
2. To provide high quality instruction, a solid undergraduate program, and research mentoring for physics majors.
3. To produce high quality fundamental physics research, as measured by published articles and books, presentations, and external funding; involvement in current areas of physics and collaborations with researchers in other fields and at other institutions; and national and international recognition.
4. To engage in educational outreach.

## Learner Outcomes

Students who have taken introductory physics courses from WSU should be a) well prepared for the next course, if taking another physics course; b) well-prepared in the physics background they need to succeed in their chosen major, if not taking another physics course; and c) well-grounded in the basic understanding that physics provides of the universe as a whole. Students graduating with a physics degree from WSU should be well-prepared for graduate school, professional school, or for entering the work force, based on their knowledge of physics and their technical skills in problem solving, modeling, computers, and electronics.

## Assessment of Program Goals

1. Scientific productivity: number of articles, quality of articles, number of presentations, quality of venues, number of citations, quality of citations.
2. Number of external and internal grants and dollar amount of grants.
3. Number and breadth of collaborations, number and quality of external invitations for talks, panel service, grant refereeing, paper refereeing.
4. Number, size, and quality of educational outreach activities.

## Assessment of Learner Outcomes

**Introductory Courses**:
The Physics Department plans to integrate its assessment plan into the fabric of our larger goals as a department. We are primarily a service department: Most of our credit hours, and a majority of our faculty's time, is spent in teaching majors from other departments. Our work is none the less vital for that fact, however. Instruction in physics is fundamental for all of engineering, physical and life sciences. Accrediting agencies from ABET to ACS all require that students learn the basics, which in most cases requires a year of introductory physics at either the algebra or the calculus level. The Physics Department therefore offers Physics 213-214 and Physics 313-314-315-316 for the two respective levels. Each sequence is a total of 10 credit hours, including labs. The first semester (213 or 313-315) covers classical mechanics, heat, and wave motion; the second (214 or 314-316) covers electricity, magnetism, and light. In addition, 214 covers the small amount of modern physics that life sciences students need (especially to pass the MCAT.)

One of the major problems we (like most physics departments) face is a very high dropout rate in these basic courses. We have tried to address this problem in two ways: we have created a second-half-of-the-semester course, Physics 151, for students who find that their preparation is less than adequate; and we have instituted a Physics Help Lab (at the moment inadequately staffed by volunteers) to assist students having trouble. Unfortunately both are underutilized. Professors estimate that something like a third of the students enrolling in 213 or 313 (amounting to dozens in total) are underprepared, but

enrollment in 151 this semester was only 3. Many are probably deciding to take the easier course at a community college, which experience teaches will probably only set them up for failure in the next course. But even if they did all enroll in 151 after dropping out of 213 or 313, it would be much better if we could direct him/her to the correct course in the first place.

We therefore propose that we set up a system similar to that the Mathematics Department has followed for years: a placement examination to determine the readiness of students for entering 213 or 313, and an exit exam for each course which can also serve as a placement exam for 214 or 314. Students demonstrating insufficient preparation for 213 or 313 could be directed to take the preparatory problem-solving course, 151, or the conceptual physics course, 111. Students with low but passing scores would be forewarned that their preparation was somewhat weak, and would know ahead of time to expect to have to work harder or to need Help Lab assistance.

In addition to going a long way towards solving our dropout problem, these exams can also serve the purpose of assessment – of the bulk, if not the whole, of our program. Collecting the data over only a couple of semesters will give us respectable numbers, enough for reliable statistics. One suggestion has been to use a nationally available, and normed, qualitative test (like Force Concept Inventory) for the conceptual physics part of the placement exam; this would have the advantage that we could then compare our results with those from physics departments across the country. In addition, by comparing averages for exit exams of large sections taught by different methods we could also objectively evaluate those methods' efficacy.

A committee of four faculty members (Drs. Axmann, Behrman (chair), Ferguson (undergraduate coordinator), and Foster) has been set up to construct the five examinations (placement, 213 exit, 313 exit, 214 exit, and 314 exit.) We hope to have these worked out and ready for Fall Semester, 2005. For Spring Semester 2005 we will gather preliminary data using the Force Concept Inventory as pre- and post-test for 111, and as pre-test for both 213 and 313 classes; for post-tests we plan to use (part of) the AP Physics tests at the appropriate levels.

**Upper Division Courses**:

The major as a whole also needs to be objectively evaluated. The major difficulty here is that we have so few majors – only a handful graduate every year – that it will take many years before statistics of any worth can be generated. However that is no reason not to start. We propose that graduating seniors take the Graduate Record Exam in Physics. This is a well-known, respected, and nationally normed examination that covers the entire undergraduate physics curriculum. There are parts of the exam that cover subjects a small department like ours cannot teach, like elementary particles or general relativity; however, these sections are small and in analyzing the results we can make allowances for these omissions.

Unfortunately this exam does cost almost $200 to take, and this may well be an expense many who were not planning on going to graduate school immediately cannot afford. If we cannot find the money to cover this for our students we can construct a number of similar exams from preparation books, and administer it ourselves.

## Results

We have no results yet.

## Feedback Loop

Since this process is new to us, we have not yet finalized either the assessment instrument or its method or standards of analysis. For the coming semester we will administer, as both pre- and post-test for 111, and as pre-test for the 200 and 300 level, the Force Concept Inventory. Our committee will construct preliminary versions of the post-tests for the 200- and 300-level courses from AP Physics tests. In May of 2005 we will meet as a faculty to discuss the results. Our analysis will provide important data for the committee of four, which will have been working on the design of the five examinations and the databases we will need for their administration. It will also, we hope, provide us with important information about how we can better teach our courses.[1]

[1] Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. American Journal of Physics, 66, 64-74.

Can be accessed from:
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