

REVIEW OF THE B.S. IN PHYSICS

Classification of the Instructional Program (CIP) Code: 40.0801
Physics, General

OVERVIEW

The B.S. in Physics program at Illinois State University is housed in the Department of Physics within the College of Arts and Sciences. The department also offers a minor in physics. The department does not currently offer academic programs at the graduate level.

The B.S. in Physics program is designed to serve the needs of students seeking to apply physics to work in government or industrial research and development, pursue graduate education in physics or an allied field, teach high school physics or physical sciences, or pursue professional study in intellectual property law, patent law, or medicine. Students in the program select from four sequences: physics, computer physics, engineering physics, and physics teacher education. Students completing the physics sequence, the broadest of the four with respect to content, are qualified for a wide array of technical jobs and are prepared for post-graduate study in a variety of technical fields. Students in the computer physics sequence develop a working knowledge of computer simulation that gives them entrée into a variety of computationally-oriented careers. Students in the engineering physics sequence complete their first three years of undergraduate study at Illinois State and then complete two years in an accredited undergraduate engineering program at another institution. At the end of those five years, students receive both a bachelor's degree in physics from Illinois State and a bachelor's degree in engineering from the other institution. The physics teacher education sequence prepares students for initial teacher licensure in Illinois with a physics endorsement.

The Department of Physics at Illinois State University ranks in the top 20 among undergraduate physics departments nationally with respect to the number of graduates produced. The physics teacher education sequence ranks in the top three with respect to the number of high school physics teachers prepared. The sequence has received the 5+ Award from the American Institute of Physics for the past three years, recognizing Illinois State as one of the few institutions that each year graduate five or more students who qualify to teach high school physics.

Enrollment by Sequence, Fall Census Day, 2009-2016

B.S. in Physics, Illinois State University

First Majors Only

	2009	2010	2011	2012	2013	2014	2015	2016
Sequence:								
Physics	34	36	44	36	33	22	8	32
Computer Physics	7	4	4	5	4	2	2	2
Engineering Physics	39	45	40	48	49	48	46	45
Physics Teacher Education	35	37	36	39	41	33	29	24
No sequence	0	0	0	0	0	0	15	2
Total	115	122	124	128	127	105	100	105

Degrees Conferred by Sequence, Graduating Fiscal Year, 2010-2016

B.S. in Physics, Illinois State University

	2010	2011	2012	2013	2014	2015	2016
Sequence:							
Physics	4	9	13	9	5	NA	4
Computer Physics	4	0	0	2	2	NA	1
Engineering Physics	5	7	1	1	3	NA	8
Physics Teacher Education	4	7	3	5	7	NA	5
Total	17	23	17	17	17	17	18

EXECUTIVE SUMMARY PROGRAM REVIEW SELF-STUDY REPORT

Self-study process. For this program review the Department of Physics began its self-study in fall 2015 by having a group of faculty members collect data from the American Institute of Physics regarding enrollment, diversity, and employment opportunities. These data were supplemented with data from the Office of the Provost, the Illinois Board of Higher Education, and various other sources to obtain a clearer understanding of the department and the program. Throughout the 2015-2016 academic year, portions of faculty meetings were devoted to discussing issues identified through the research. In spring 2016 the department formed a writing committee that subsequently compiled the self-study report during the summer and early fall of 2016. There were four major authors of the self-study report.

Program curriculum. Excepting the engineering physics sequence through which students receive two bachelor's degrees in five years, students entering the B.S. in Physics program as first-time-in-college students should be able to complete their degree in four years. To assist students transferring into the program from another institution, the department often approves substitution waivers to provide students greater flexibility in meeting program requirements and to, in turn, reduce time to degree. The required number of credit hours in the discipline varies by sequence, ranging from 47 credit hours in physics to 77 credit hours in physics teacher education. The latter includes 22 credit hours in teacher education courses in addition to physics content courses. Many students in the physics teacher education sequence opt to take additional courses in either chemistry or mathematics to qualify for additional teaching endorsements from the state. The first two years of the physics program are nearly identical for all four sequences. Students take the introductory calculus-based physics sequence, Frontiers of Physics, and Methods of Theoretical Physics. In the final two years, required courses vary by sequence. Nevertheless, most students are also required to take Mechanics, Electricity and Magnetism I, and Quantum Mechanics. Closely integrated with the four sequences are the numerous co-curricular programs of the department, which offer students forefront research experiences, hands-on experience designing, building, and completing projects, and opportunities for public outreach and education.

Program or academic unit faculty. Over the past five years approximately half of the tenure-line faculty members in the Department of Physics have retired and have been replaced by a new group of teachers/scholars. By fall 2017, all faculty members in the department will have been at Illinois State at least one year. Additional changes to faculty membership are not anticipated in the foreseeable future. With respect to the number of faculty members, the Department of Physics is one of the smallest academic units in College of Arts and Sciences at Illinois State, with 12 tenured or tenure track faculty members including the department chairperson (as of fall 2016). Nonetheless, physics faculty members are highly visible at the University with respect to their teaching, research, and service. Two physics faculty members have been named Distinguished Professor, the highest rank bestowed on faculty at Illinois State. Physics faculty members have served as chairperson of the Academic Senate, chairperson of Academic Senate internal standing committees, and members of administrator search committees. With respect to their scholarship, physics faculty members compare favorably with their peers in physics departments at other public universities in Illinois, with their peers in physics and chemistry departments at undergraduate-focused institutions nationally, and even with faculty in the top 10 most research-productive physics departments in the country. Faculty and staff members of the department, collaborating with students in the physics program, have earned the department national recognition through its physics teacher education sequence, and computer physics sequence, undergraduate research program, and Solar Car Team.

Program goals and quality indices. Quality goals of the Department of Physics include research that adds to the understanding of the physical universe, innovative courses and curricula, and exciting student-centered co-curricular experiences. Measures of the degree to which these quality goals are achieved include many traditional measures of faculty and departmental productivity. Faculty productivity measures include publications, citations, successful grant proposals, invitations, and awards. Departmental productivity measures include enrollment, student quality, graduation rates, student achievement, and employment of students upon graduation. Teaching and educational indices are also used to measure achievement of goals. These indices include formal and informal student evaluation of faculty, courses, and curricula; alumni surveys; evidence of innovative teaching compiled in faculty teaching portfolios; and external recognition of teaching, including awards, invitations, publications, and grants.

Student learning outcomes assessment plan and process. Student learning outcomes assessment in the B.S. in Physics program includes both formal assessment conducted in accordance with assessment plans and less formal assessment of specific objectives on an as-needed basis. Each sequence in the program has its own assessment plan. The plan for the physics teacher education sequence is aligned with state teacher certification standards and with *Realizing the Democratic Ideal*, the framework for all educator preparation programs at Illinois State. The assessment plan for teacher education is updated regularly in response to changes in accreditation and teacher certification. A recent change, for example, was incorporation of the edTPA capstone assessment now required in Illinois for initial teacher licensure. Student learning outcomes assessment plans for the physics, engineering physics, and computer physics sequences are largely based on in-class performance-based measures including examination scores, written and oral reports for advanced laboratories, computer projects, and homework projects that focus on theoretical concepts. Modeling, analysis, and communication skills for students involved with research projects are also evaluated through student presentations at department seminars, the (Illinois State) University Research Symposium, and professional conferences.

Specialized accreditation. Physics teacher education is the only sequence in B.S. in Physics program that has an external accreditation body. The sequence is part of the teacher education unit at Illinois State accredited by the National Council for Accreditation of Teacher Education (NCATE). The most recent NCATE accreditation visit occurred in November 2012, and the next accreditation visit is scheduled to occur in spring 2019. For that visit the accrediting body will be the Council for the Accreditation of Educator Preparation (CAEP) as successor to NCATE. In conjunction with the 2012 review of the teacher education unit by NCATE, the physics teacher education sequence was reviewed and approved by the National Science Teachers Association, a specialized professional association affiliated with NCATE. The Department of Physics has opted not to pursue NSTA recognition in conjunction with the 2019 CAEP accreditation review.

Responses to recommendations resulting from the previous program review. The 2008-2009 review of the B.S. in Physics program resulted in recommendations by the Academic Planning Committee that the department refine its student learning outcomes assessment plan, increase minority recruitment, develop plans to more closely track alumni, identify aspirational institutions, and work with Milner Library faculty to ensure adequate research resources for students and faculty. The department has since addressed each recommendation. The department has made some changes to the student learning outcomes assessment plans for the sequences and expects to make additional changes in the coming year now that new faculty members are in place. The department has undertaken multiple activities to recruit faculty and students to the program, with extra emphasis on recruiting students and faculty members who identify with demographic groups traditionally underrepresented in physics. The department has attracted two new female faculty members and has a student body that is representative of physics departments across the nation. Tracking alumni is now done primarily by the Illinois State University Alumni Association. The department has supplemented Alumni Association efforts by creating several social media sites through which alumni can connect with the department. With respect to aspirational institutions, the department regularly reviews data compiled by the American Institute of Physics to identify physics programs that are growing and to identify practices those programs have that may be appropriate for the physics program at Illinois State. The department has a productive working relationship with the physics librarian at the University, who helps department faculty make decisions regarding allocation of library funds for research resources.

Changes in the academic discipline, field, societal need, and program demand. Since the 2008-2009 program review, the number of undergraduate physics degrees awarded nationally has increased from approximately 5,000 per year to over 7,500 per year. Combined enrollment in undergraduate physics programs in Illinois has increased from 1,079 students in 2009 to 1,535 students in 2015. A large fraction of the growth in Illinois occurred at the University of Illinois at Urbana-Champaign, where enrollment increased from 168 to 386 during that period. These enrollment increases are consistent with strong demand nationwide for physics degree holders. The average annual starting salary for physics graduates is approximately \$55,000, which is one of the highest average starting salaries among majors offered at Illinois State. The unemployment rate among physicists has consistently been about five percent nationally, even during the economic crisis of 2008.

Major findings of this program review self-study. The program review process has helped faculty and staff of the Department of Physics clarify what the department is doing well and what needs to improve. On the whole, the department can be proud of maintaining strong enrollments and high quality plans of study under very trying economic circumstances. At the same time, as the faculty composition has significantly changed in the last few

years, it is appropriate that the department begin a strategic planning process to chart the direction of the department. Information gathered through the program review self-study process provides a baseline for the strategic planning process.

Initiatives and plans for the next program review cycle. The primary initiative in the Department of Physics during the next program review cycle is developing a new strategic plan for the department and the B.S. in Physics program. Among the issues to be addressed through the strategic planning process are recruitment and retention of students; alignment of upper division electives with the expertise of new faculty members; general education offerings of the department; feasibility of a master's degree in physics, a master of arts degree in physics teacher education, and cross-disciplinary degree options such as biophysics and chemical physics; fundraising for additional student scholarships and improvements to the student learning outcomes assessment plan to include more feedback mechanisms to guide program improvement. The adverse economic climate as well as state budgeting and funding issues will likely impact decisions made by faculty regarding the future of the department and program.

PROGRAM REVIEW OUTCOME AND RECOMMENDATIONS FROM THE ACADEMIC PLANNING COMMITTEE

Review Outcome. The Academic Planning Committee, as a result of this review process, finds the B.S. in Physics program to be in Good Standing.

The Academic Planning Committee thanks the program for a concise, insightful, and forward-looking self-study report. The report evidences critical review of the program and opportunities for all faculty members to contribute to that review. Particularly noteworthy is the description in the report of comparator and aspirational programs and the discussion of actions the program at Illinois State might take to meet or exceed quality levels of those programs.

The committee congratulates program faculty and staff for maintaining a quality academic program during a period of significant change in program personnel; since the last program review in 2008 approximately half of the tenure-line faculty members are new to the program and a new department chairperson has been hired. The committee recognizes the commitment made by the department to diversifying its faculty as positions are filled and its success in doing so with respect to gender. Through these key personnel changes, the program has continued to be a top producer of physics bachelor's degrees among undergraduate-only physics departments nationally. The program also continues to be the top producer of high school physics teachers in Illinois and one of the top producers nationally. In addition to its teacher preparation sequence, the program offers plans of study in general physics, computational physics, and engineering physics. Through the latter, a student can earn an undergraduate physics degree from Illinois State and an undergraduate engineering degree from another institution within five years.

The committee commends program faculty and staff for the high level of individualized attention they provide to students in the program. Faculty members work with students as their academic advisors and as research mentors. Faculty members encourage students to participate in the University Honors Program, which students do at rates consistently higher than the rate across all undergraduate programs at the University. The committee also commends faculty for their contributions to scholarship and their service to their discipline. Faculty members publish at rates higher than the national average across undergraduate-only physics programs. Three faculty members are Fellows of the American Physical Society.

The committee recognizes the program for its enhanced efforts in recent years to recruit highly credentialed students. The program now annually sponsors an open house for high school students (Physics Discovery Day) and awards numerous merit scholarships and book awards to incoming students. Recognizing the importance of encouraging students to persist, the program has many endowed scholarships and achievement awards for continuing students. The program expends considerable resources to help transfer students successfully transition into the program. Faculty serve on state-wide panels that match community college physics courses to requirements of undergraduate physics programs at public universities in the state, with a goal of promoting timely graduation of transfer students from those undergraduate physics programs. The department chairperson meets personally with every transfer student to collaboratively plan a course of study.

Contributing to student recruitment and retention successes and to service by the program to the broader community are the many co-curricular opportunities offered by the program. These include co-curricular research teams, the

internationally-recognized Solar Car Team, the Physics Club, the Trebuchet Team, and the Illinois State University Planetarium. The program also sponsors a “Physics on the Road” program, through which faculty and students outreach to K-12 schools throughout the state, and the Innovative Design Project, through which students design, build, and test product solutions for local companies.

The program continues to do fine work in the area of student learning outcomes assessment. It is evident that assessment data are being collected and findings from those data are being used by faculty to make program changes intended to improve student learning. The committee encourages faculty to continue to refine its assessment plan for the program, with particular attention to feedback mechanisms, and to nurture and sustain the feedback loop characteristic of a meaningful assessment process. Resources of University Assessment Services are available to assist the program in its assessment efforts, including exploration of best assessment practices in the discipline. The committee asks the department to submit a revised assessment plan to the Office of the Provost by October 31, 2018, and a report on implementation of the plan by October 31, 2020. As the program revises and implements its assessment plan, the committee encourages attention by the program to sustainability of its assessment efforts. To that end, every student learning outcome need not be assessed every year nor is it necessary to evaluate the work of every student; staggering assessment of learning outcomes across multiple years and sampling student work are appropriate strategies.

Recommendations. The Academic Planning Committee makes the following recommendations to be addressed within the next regularly scheduled review cycle. In the next program review self-study, tentatively due October 1, 2024, the committee asks the program to describe actions taken and results achieved for each recommendation.

- The self-study report identifies strategic planning as a priority initiative for the department, to guide the department and its programs through the next program review cycle and beyond. The committee concurs. The committee recommends using the strategic planning process as a venue for addressing issues identified by faculty and staff through this review as well as issues identified by the committee in its recommendations that follow.
- A key theme of the program review self-study report is the need for ongoing attention to student recruitment. Recruitment is especially important to the future of the program given recent enrollment trends and anticipated increases in enrollment targets at comparator institutions. Fall enrollment of first or second majors in the program decreased 24 percent from 2012 to 2015, while enrollment in the largest undergraduate physics program in the state increased 60 percent. Accordingly, the committee recommends that a key component of strategic planning include development of a student recruitment and retention plan. A recruitment and retention plan could help the department achieve multiple goals: to achieve and maintain enrollments within targets established by the department, to continue to attract and retain high achieving students, and to diversify the student population with respect to females and persons of color. Many elements of such a plan are already in place and have already helped stabilize enrollment. The committee recommends that the department continue those approaches and consider additional approaches that would further diversify its recruitment efforts.

The Department of Physics is not alone in facing these challenges; numerous other programs at the University, including those related to science, technology, engineering, and mathematics (STEM) fields do as well. The committee suggests that the department investigate coordinating recruitment efforts with one or more of the other STEM programs at the University, perhaps through facilitation by the college office. Such coordination and collaboration could help each participating program expand the number of prospective students it reaches without having to commit additional resources. Whether the department works with other units or works separately, the committee suggests that the department carefully target its recruitment efforts to high schools with high achieving students and diverse student populations. The department might incorporate into this targeted effort elements of its successful Physics on the Road program and might consider establishing scholarships for students from traditionally underrepresented populations, if the department has not done so already.

- Ongoing review of the curriculum and program is essential for maintaining a program that is current, relevant, responsive to student needs, and responsive to needs of employers. This is particularly important in fast-changing STEM fields. The committee suggests periodic review of the existing curriculum and its sequences, perhaps through the strategic planning process, for their currency, demand, and sustainability. The committee

especially recommends attention to points within the curriculum that challenge students to the extent that their progress toward graduation is impeded or they choose to withdraw. One such point noted in the self-study report is the calculus requirement. The program might consider a bridge program to assist students through that requirement, perhaps in concert with other STEM programs at the University. Systematic communication with students contemplating withdrawing from the program could help identify others. The committee also suggests periodic review of the curriculum and its sequences to identify potential new plans of study. The committee supports the recommendations articulated in the self-study report for consideration of an applied physics plan of study as well as interdisciplinary courses or plans of study with Biological Sciences, Kinesiology and Recreation, and Mennonite College of Nursing.

- The department has done an admirable job developing and maintaining relations with program alumni, including building an alumni database, maintaining contacts with alumni through social media, and collaborating with Alumni Services and University Advancement on alumni outreach initiatives. The committee encourages the department to continue these efforts. The committee also encourages the department to strengthen its relationships with the companies and agencies that employ program graduates. These efforts could help students with their internship and job searches and could lead to increased giving for student scholarships. The department might consider organizing a program advisory board, if one does not already exist, as a venue for developing and nurturing relationships with both alumni and employers.
- According to the self-study report, the current inventory of research journals accessible through Milner Library meets the research needs of physics faculty and students. However, the report cautions that any combination of journal price increases and library budget reductions could severely compromise the ability of the library to continue meeting those needs. The committee recommends that the department continue working with library faculty to monitor this situation, maintain a prioritized list of journals for use should budget cuts be necessary, and continue to explore alternatives to traditional journal subscriptions such as the *Get it Now* per-use subscription model.