**PROGRAM REVIEW SURVEY**

**PHYSICS DEPARTMENT**

April 23, 2010

**Request for Information on Academic Quality as determined by Internal and External Measures**

***Note: As a time frame, we are most interested in the past 3-5 years and never more than ten years. Please specify the timeframe you use for each item. Also note that, for your information, we have listed types of data that we already have. These are in the Program binders in Ferguson 230, available between 8am-5pm. You will not need to provide these data, but you may want to check them for accuracy and completeness.***

**All items in BOLD are to be completed by the program.**

***1.)******EXCELLENCE IN STUDENT ACHIEVEMENT***

**Statement:** In 4 or 5 sentences, summarize the basis on which you believe student achievement in your program is best evaluated:

Assuming that “program” means the Physics major, the Combined Course Physics (“pre-engineering”) major, the major with secondary education certification, or the Interdepartmental Mathematical Physics major, the best single basis is the relative success that students have after graduation in the pursuit of their life’s work. For a majority of our students, this means graduate school or engineering school. Thus, the department’s assessment plan is constructed to evaluate the knowledge and skills that students need to have to be successful in advanced studies in engineering and physics. The department uses competitive admission to graduate school or engineering school, and the success that students have in these arenas, as principal indicators of collective student achievement for our program. We are aware that indirect assessment measures often have limited utility, but because the training of engineers and physicists is “linear” (that is, incremental in nature), and because admission is competitive, student success in subsequent graduate school and engineering school studies is a nationally accepted “norm” of program quality for undergraduate physics programs such as ours.

**Data:**

**Progress on Assessment (*Copy and paste from Assessment Plan responses items 1-4. For your current plan, contact Beth Lincoln*)**

**1. Physics Mission**

The Physics Department at Albion College is committed to providing intellectually rich and challenging learning experiences for students as part of their preparation for their life’s work. We are a learning-centered community of students and faculty that seeks to make relevant, qualitative, and quantitative conclusions from observations of the physical world.

Our program has several specific goals, including 1) to provide a high quality major program with sufficient depth and breadth of study in the core areas of physics to enable students to pursue advanced studies in physics or engineering or to be successful in physics-related careers, 2) to provide high quality major and minor programs for secondary education certification and the elementary integrated-science program, 3) to provide cognate courses for students in other sciences, including biology, chemistry, geology, and health sciences, 4) to provide the physics curriculum for the dual-degree program in engineering, 5) to provide high quality physics and astronomy courses for the general education requirement, and 6) to provide faculty as participants in interdisciplinary courses and programs, such as the Honors Institute, the First-Year Experience program and the Environmental ‘Category’ requirement.

**2. Goals and Outcomes**

**Learning Goals for All Areas**

1. Students in our program will develop proficiency in the theory and practice of physics as appropriate to their major, minor or program of study.

2. This proficiency will prepare students well for further education or careers as physicists, educators, or any other relevant life’s work.

**Desired Outcomes**

*Assessment Area: Physics major curriculum, Combined Course Physics major curriculum, Physics with secondary education curriculum, Mathematics/Physics major curriculum*

**OUTCOME I.** Physics graduates will have knowledge required to participate in advanced studies in Physics or related areas.

**OUTCOME II.** Physics graduates will have the skills necessary to participate in advanced experimental research in Physics or related areas.

**OUTCOME III.** Physics graduates will be able to clearly articulate theoretical and experimental concepts in oral and written presentations.

**3. Program Components**

Program components and learning objectives are identified in the table on the next page. Here, the Physics major program includes Phys 167, 168, 191, 243, 244, 245, 250, 291, 325, 336, 350, and one or more upper level courses. The Combined Course Physics major includes 167, 168, 191, 243, 244, and 245, and additional coursework that transferred from the engineering school. The Physics major with elementary education certification includes Phys 167, 168, 191, 243, 244, 245, 250, 291, 325, and 336 with two elective courses which can include Phys 105 or Phys 206. The Interdepartmental Mathematics/Physics major includes Phys 167, 168, 243, 244, 250, 325, 336, and 380 with additional mathematics courses. Also listed in the table below are the introductory and intermediate astronomy courses (105 and 206, respectively). Not included are courses in the “pre-medical” curriculum (115 and 116), and other “General Education” courses (101 and 102).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Outcome** | **Learning Objectives** | **105** | **105L** | **206** | **206L** | **167** | **167L** | **168** | **168L** | **191/291** | **243** | **244** | **245** | **245L** | **250** | **308** | **322** | **325** | **336** | **350** | **380** | **384** | **387** | **Assessment Measure** |
| 1. Students in Physics courses will demonstrate knowledge of the fundamentals of physics and/or or astronomy principles.  | Students will explain and apply their understanding of mechanics | X |   |  x |   | x |  x |   |   |   |   |   |   |   |   |   |   | x |   | x |   |   |   | MFT |
| Students will explain and apply their understanding of electricity, magnetism, and optics | X |   |   |   |   |   | x |  x |   |   |   | x |   |   | x | x |   | x | x |   |   |   |
| Students will explain and apply their understanding of thermo-dynamics |   |   |   |   |   |   | x |  x |   |   |   |   |   |   |   |   |   |   |   |   | x |   |
| Students will explain and apply their understanding of quantum mechanics |   |   |   |   |   |   |   |   |   |   |   |   |   | x |   |   |   |   | x |   |   | x |
| Students will learn to interpret and create mathematical models and/or simulations of physical phenomena.  |   |   |   |   | x |  x | x  | x  |   | x | x |  x |  x |   |   |   |   |   | x | x |   | x  |
| Students will be able to explain and apply their understanding of astronomical phenomena. | x | X | X | x |   |   |   |   |   | x | x |   |   |   |   |   | x |   |   | x |   |   |
| 2. Students who take laboratory courses in physics will be able to (C) conduct experiments using accepted experimental methodologies and/or (D) design experiments to explore problems of practical and theoretical importance.  | Students will learn the skills that are necessary to conduct experiments that seek to elucidate physical phenomena |   |   |   |   |   | C |   | C |   |   |   |   | C, D |   |   |   |   |   | C,D |   |   |   | Lab Exam |
| 3. Students will clearly articulate theoretical and experimental concepts in oral and written presentations. | Students will learn how to make effective oral and written presentations. | x |   |   |   |   | X | X | x | x |   |   |   | x |   |   |   |   |   | x |   |   |   | Presentation |

**Outcomes of Assessment (*Copy and paste from Assessment Plan items 5-6)***

**4. Quantitative Measures and/or Qualitative Indicators**

**ASSESSMENT I.** Physics graduates will receive scores on the Major Field Test which are consistent with national norms. Knowledge will also be assessed in introductory courses using pre-tests and post-tests that have national benchmark standards. Admission to graduate and professional schools will be used as an indirect indicator of student preparation for advanced work, as will alumni surveys.

**ASSESSMENT II.** Physics graduates will have satisfactory performance on a skills test that is administered in Phys 350, *Advanced Laboratory,* and those who participate in advanced independent research experiences will have, or will develop, the skills necessary to participate in those experiences. Also, external evaluation of student preparation for off-campus research experiences will be considered when available. Admission to graduate and professional schools will be used as an indirect indicator of student preparation for advanced work, as will alumni surveys.

**ASSESSMENT III.** Physics graduates will demonstrate proficiency in writing technical reports, in critically interpreting scientific literature and in delivering a technical oral presentation on primary or secondary scientific investigations.

**5. Analysis and Interpretation**

**Assessment I.**

The results of the Physics Major Field Test (MFT) administered to 2009 graduating seniors were added to our database of previous MFT scores, and the compendium of scores for the years 2005-2009 were analyzed for consistency with national norms and for trends. The results are shown in the table below. These data show that our graduates achieve receive scores that rank between the 5th percentile and the 95th percentile when compared to the nationally derived distribution of scores, and that the 2008-2009 subgroup received scores that were consistent with the national average. The highest scores received by Albion students are clearly in line with the highest scores in the national distribution, which is derived from a mixture of students from smaller colleges like ours and students whom attend highly technical physics programs at major universities. As a point of reference, GLCA schools represented in the national cohort include Albion College, Kalamazoo College, Kenyon College, and Oberlin College. The average scaled score of our student cohort is 147.8, which is commensurate with with both the individual score mean of the national cohort (149.0), and the individual score median of the national cohort (147.0). We consider that this performance to be respectable, considering that some of our students included in the Albion cohort have admitted to not taking this “un-credited" test seriously, as previously reported. Additionally, since the national cohort includes senior students from universities which offer Bachelor of Science programs, the national cohort includes scores from students at some universities that require considerably more courseswork in Physics than the eight or nine course units in Physics that Albion students typically receive.

When we consider the MFT subscores, separated into "introductory" and "advanced" coursework categories, we note that our students perform slightly below the national average in more advanced or specialized areas in physics (Quantum Mechanics/Atomic Physics, Special Topics, and Optics) -- the mean percentile of the Albion cohort is 47.1 as compared to the national average of 47.8, and above the average in the introductory classical areas of physics (Classical Mechanics/Relativity, Electromagnetism) -- the mean percentile of the Albion cohort is 48.5, as compared to the national average of 46.9. Because the number of students included in the Albion cohort (N=11) is small, this difference is not significant. The standard deviation of introductory and "advanced" percentile scores for Albion students is 28.2 and 32.5, respectively, as compared with corresponding standard deviations of 16.0 and 15.7 for the national group (N=1730). The standard deviation of the mean of "introductory" and "advanced" percentile scores for Albion students is 8.5 and 9.8, respectively, as compared with corresponding standard deviations of the mean of 0.4 and 0.4, respectively for the national cohort.

**Table 1. MFT Score Analysis**

|  |  |  |
| --- | --- | --- |
|  | **Ranked results of students who took Physics MFT between 2005-2009** |  |
|  | **Introductory** | **Percentile** | **Advanced** | **Percentile** | **Overall** | **Percentile** |
|  | 73 | 85 | 85 | 95 | 181 | 95 |
|  | 75 | 90 | 67 | 80 | 174 | 90 |
|  | 62 | 75 | 70 | 85 | 168 | 85 |
|  | 55 | 60 | 46 | 40 | 151 | 55 |
|  | 47 | 45 | 55 | 60 | 151 | 55 |
|  | 47 | 45 | 43 | 35 | 145 | 40 |
|  | 47 | 45 | 40 | 25 | 144 | 40 |
|  | 34 | 15 | 47 | 45 | 135 | 15 |
|  | 31 | 10 | 37 | 20 | 133 | 10 |
|  | 44 | 40 | 22 | 1 | 133 | 10 |
|  | 36 | 20 | 22 | 1 | 129 | 5 |
|  | 31 | 10 | 31 | 10 | 130 | 5 |
|  | **48.5** | **45.0** | **47.1** | **41.4** | **147.8** | **42.1** |
|  | std dev | 28.2 |  | 32.5 |  |  |
|  | std dev mean | 8.5 |  | 9.8 |  |  |
|  | national std dev | 16.0 |  | 15.7 |  |  |
|  | nat'l std dev mean | 0.4 |  | 0.4 |  |  |

An analysis of scores received in specific content areas is shown in Table 2. Our analysis reveals that the mean percentile of the Albion cohort in the area of Classical Mechanics and Relativity (75.0) is higher than the national mean (47.4), the mean percentile of the Albion cohort in the area of Electromagnetism (67.5) is above the national average (46.2), the mean percentile of the Albion cohort in the area of optics, waves and thermodynamics (36.7) is below the national average (40.6), the mean percentile of Albion students in the area of quantum mechanics and atomic physics (46.8) is slightly above the national average (46.0), and the mean percentile of Albion students in the area of special topics (36.7) is slightly below the national average (38.0). Because only the average of subscores in these areas in a given year is reported for Albion students, it is not possible to determine deviations, and thus it is difficult to make comparisons.

Given these results, we suspect that our introductory emphasis in classical mechanics, relativity, and electromagnetism, coupled with advanced coursework in these areas which we have offered every year until this year, has resulted in the apparently improved performance of Albion students in these areas. That our students seem not to do as well in the areas of optics and "special topics" (condensed matter, nuclear, laboratory methods, and Lagrange/Hamiltonian equations) is correlated with reduced advanced course offerings in these areas in recent years.

**Table 2. MFT Subscore Analysis**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Classical Mechanics / RelativityAverage Score** | **Percentile** | **Electromagnetism Average Score** | **Percentile** | **Optics/Waves Thermodynamics Average Score** | **Percentile** | **Quantum Mech., Atomic Physics Average Score** | **Percentile** | **Special TopicsAverage Score** | **Percentile** |
| 2006-071 | 57 | **75** | 33 | **5** | 42 | **50** | 31 | **1** | 33 | **25** |
| 2007-082 | 57 | 75 | 67 | 95 | 46 | 70 | 47 | 50 | 50 | 90 |
| 2008-093 | 57 | 75 | 53 | 70 | 31 | 10 | 48 | 60 | 28 | 5 |
|  | **57.0** | **75.0** | **54.3** | **67.5** | **37.8** | **36.7** | **44.8** | **46.8** | **36.2** | **36.7** |
| Nat’l mean |  | 47.4 |  | 46.2 |  | 40.6 |  | 46 |  | 38 |

1one engineering student from this class did not take this exam

2two students did not take this exam

3two engineering students did not take this exam

In addition to the assessment of graduating seniors, assessment of the first introductory course has been conducted. The results of a pre-semester and post-semester national mechanics assessment test in Physics 167 for Fall 2008 were analyzed (see R.R. Hake, "Interactive-engagement vs traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses," Am. J. Phys. 66, 64- 74 (1998)). The "gain factor" for our students, a performance indicator that is derived from pretest/posttest data, is consistent with the national norm for a physics classes with "traditional" instruction.

Finally we note that the three four-year majors who graduated in 2009 were all accepted into national graduate schools. These include The University of Toledo (PhD, astrophysics), Northwestern University (M.S. electrical engineering), and the University of Tennessee (M.S. Mechanical Engineering). The continued placement of students in R1 graduate programs in Physics or Engineering at either the M.S. or Ph.D. level provides additional indirect evidence that students have requisite knowledge to participate in advanced technical studies.

**Assessment II.**

Anecdotal results of student performance in on- and off-campus research experiences indicate students are adequately prepared and meet or exceed their advisors' expectations. Three students had off-campus research experiences (at Oak Ridge National Lab, the National Renewable Energy Laboratory, and the Tank Automotive Research, Development and Engineering Center) while three additional students had significant on-campus research experiments. Of the students who had off-campus research experiences, feedback from off-campus research mentors was received on only one student and that feedback, while very positive, was verbal. Of the three students who had on-campus research experiences, the students had the requisite skills to conduct the required research.

Direct evaluation of student skills is not yet available from Physics 350, which is offered for the first time Spring 2010. The continued placement of students in R1 graduate programs in Physics or Engineering at either the M.S. or Ph.D. level provides additional indirect evidence that students have requisite knowledge to participate in advanced technical studies.

**Assessment III.**

No assessment of student writing or presentation skills was conducted this year. This will be an integral component to Physics 350, our new advanced laboratory experience, which is offered for the first time in the spring 2010 semester.

**6. How will the data collected be used for decision-making, strategic planning**

It is difficult to know exactly how the data will be used for program planning purposes, but our approach to program planning is as follows:

1. The five-year database of MFT scores and improvement scores on national assessment measures for introductory Physics courses (Phys 167 and 168) form "baseline" data that we will use to evaluate the revised curriculum that we implemented this year. We also implemented "TabletPCs" in Phy 167 and 168 this year, and it is yet unknown how this instructional change will affect student learning in the future.

2. We are in the process of conducting an alumni survey that will provide feedback on the efficacy of our curriculum. For many years we have informally asked alumni for feedback on our curriculum, and their feedback has been taken into account in program planning. The implementation of written feedback will allow us to provide evidence of this.

3. As resources are available, we will continue to attend national workshops which focus on new approaches to teaching introductory and advanced coursework in Physics.

The committee to review assessment findings will comprise the entire department because our department is relatively small (4 faculty) and because it encompasses all of the areas in which the faculty have expertise. It doesn't make sense to us to form a smaller committee of the faculty. Since the department has assessment as one of its charges, the department will address assessment at its weekly meetings. Formal recommendations for assessment will come from the Chair of the department.

**List all student (all-college and external) awards and year awarded, (please do not include departmental awards).**

Jenkins Award (Honors thesis):

Phil Koppers (1993), Christine Riker (2004), Dan Coupland (2006), Ryan Graham (2009)

Sleight Leadership Award:

2009 Brandan Walters

Phi Beta Kappa Initiates:

2010 Laura Pollum

2009 Ryan Graham, Lesley Simanton

2008 Andrew Fidler, Adam Hashimoto, Marci Howdyshell

2006 Dan Coupland, Matt Kroge

Omicron Delta Kappa Intitiates:

 2009 Lesley Simanton

Sigma Xi Initiates:

2010 Culver Redd

2009 Laura Pollum (minor), Timothy Rambo, Lesley Simanton

2007 Andrew Fidler

2006 Daniel Coupland, Brian Dick

 2005 Katherine Brewer, William Green

Albion College Fellows:

 2010: Andrew Malicowski

 2006: Adam Hashimoto, Marci Howdyshell

Mortar Board:

 2009: Lesley Simanton

**Give the number of student publications/performances/presentations (off campus) and the timeframe of the data: *(Isaac presentations are requested elsewhere in this document)***

Five students since 2005 have had publications or presentations at national conferences:

 Samantha Strasser, ’11, AIP Conf. Proc **1099**, 154 (2009) <http://link.aip.org/link/?APCPCS/1099/154/1>

 Culver Redd, ’11, Nat’l Conf on Undergrad Res (NCUR), LaCrosse, April 2009.

 Lesley Simanton, ’09, Michigan Space Grant Consortium Meeting, Ann Arbor, October, 2008.

 Andrew Fidler, ’08, Nature Physics **4**, 327 (2008) doi:10.1038/nphys888

 Nicholas Moroz, ’05, Nucl. Instrum. Meth. Phys. Res. **536**, 11 (2004) [doi:10.1016/j.nima.2004.07.211](http://dx.doi.org/10.1016/j.nima.2004.07.211)

**Provide data on graduate school admissions (In whatever format and timeframe you can provide):**

During the past decade, 14 Physics or Combined Course Physics majors have attended graduate programs in physics, engineering, chemical physics, applied math, or physical chemistry. Two physics minors also have attended or will attend graduate programs in a physics-related area.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Yr.** | **Institution** | **Degree after Albion** | **2nd and 3rd degrees** |
| Laura Pollum\* | ‘10 | Oxford University | Physical Chemistry | Ph.D. |  |
| George Wimbrow | ‘09 | Michigan State | Civil/Env. Engineering | BSE | accepted to MS program |
| Lesley Simanton | ‘09 | U. Toledo | Astronomy | Ph. D |  |
| Tim Rambo | ‘09 | Northwestern | Engineering | M.S. |  |
| Ryan Graham | ‘09 | U. Tennesee - Knoxville | Engineering | Ph. D. |  |
| Andrew Fidler | ‘08 | U. Chicago | Chemical Physics | Ph. D. |  |
| Marcy Howdyshell | ‘08 | Ohio State | Physics | Ph.D. |  |
| Erich Owens | ‘08 | Columbia University | Engineering | B.S. | Brown, appl. Math (Ph.D) |
| Shane Walton | ‘08 | Wayne State University | Engineering | M.S. |  |
| Dan Coupland | ‘06 | Michigan State | Physics | Ph. D. |  |
| Kathleen Brewer | ‘06 | Yale | Public Health | M. S. |  |
| Nick Moroz | ‘05 | University of Michigan | Engineering | B.S.E. | U Mich (M.S., Ph.D) |
| William Green | ‘05 | UIUC | Mathematics | Ph.D. | Eastern Illinios (asst. prof.) |
| Christine Riker\* | ‘04 | Stanford | Engineering | M. S. |  |
| David Hansen | ‘03 | Northwestern | Applied Math | Ph. D. |  |
| Dan Holland | ‘03 | Cal. Inst. Technology | Physical Chemistry | Ph. D. |  |
| Art Bragg | ‘99 | Berkeley | Chemical Physics | Ph. D. | Johns Hopkins (asst. prof) |
| Phil Shaltis | ‘99 | Michigan | Engineering | M.S. | MIT (Ph. D.) |
| Kevin Chalut | ‘99 | Duke | Physics | Ph. D. | Cambridge U. (Post-doc) |

\*physics minor

**Provide data on employment of graduates (In whatever format and timeframe you can provide):**

A sampling of former student employment from the past decade includes the following:

2009 Ryan Graham MS, Engineering Fundamentals, University of Tennesee-Knosville

2009 Lesley Simanton PhD Astronomy, The University of Toledo

2009 Tim Rambo PhD Electrical Engineering and computer Science, Northwestern U.

2009 George Wimbrow BSE, Civil Engineering, Michigan State University

2008 Andrew Fidler PhD, Engel Group, University of Chicago

2008 Marci Howdyshell PhD, Physics, Ohio State University

2007 John Salvador BSE, UMich, United States Air Force, Edwards Air Force Base

2006 Nick Moroz BSE, MSE, Mechanical Engineering, U Michigan

2006 Dan Coupland PhD, Physics, Michigan State University National Cyclotron Lab

2005 Katherine Brewer M.S. Public Policy, Yale, Jewish Health Care Foundatin

2005 Dave Sun Caman Chemical in Ann Arbor

2005 Will Green PhD, Mathematics, University of Illinois Urbana Champagne, Assistant

 Professor, Eastern Illinois University

2004 Stephanie Rigot Pharmacist , St. Mary’s of Michigan, Saginaw

2004 Natalie Nelson BSE, Michigan, Nursing School, DePaul University

2004 Jon Lighthall PhD, Western Michigan University, Argonne National Laboratory

2004 Ryan Phillips MD, Wayne State University

2004 Kirsten Deenik Assistant Engineer, Turner Construction Company, Wyoming, MI

2004 Jason Dimaria BSE, Civil Engineering, Wayne State University, Assistant Project

Engineer, Paul C. Rizzo Associates, Pttsburgh

2004 Christina Riker Project Manager, Energy Solutions, Oakland, CA

2003 Matt Meyer Dentistry, University of Michigan

2003 Dan Holland Ph.D, Cosmochemistry, Cal-Tech

2003 Jenny Tobin Health Physicist, U.S. Nuclear Regulatory Commission

2002 Kyle Kidder BSE, U Detroit Mercy, development engineer for Asian OEMS

1999 Phil Shaltis Ph.D., Mechanical Engineering, MIT, Medical Industry consultant

1999 Art Bragg Ph.D., Chemical Physics, Berkeley, Asst. Professor, Johns Hopkins

1999 Kevin Chalut Ph.D. , Physics, Duke University, Postdoctoral Fellow, Cambridge

 University

**Provide any data and timeframe on student performance on standardized subject field tests administered by states or other external organizations:**

Students often take the GRE subject field test, but the results are not reported to us. Given student acceptance rates to graduate schools, we assume that they perform at a level that is competitive with their national small-school peer group.