Pittsburg State University's Academic Program Review

Departmental Information

1. Program Identifiers

College:	Arts and Sciences			
Department:	Physics			
Degree Programs:	**CIP Code**	**Degree**	**Program Name**	**Options**
	400801	**Bachelor of Science**	**Physics**	**Professional Sequence, Applied Sequence**
	400801	**Bachelor of Science in Education**	**Physics**	**No Emphasis**
	400801	**Bachelor of Science in Education**	**Physical Science**	**No Emphasis**
	400801	**Master of Science**	**Physics**	**No Emphasis**

2. Department Profile

Student Information	**FY/02**	**FY/03**	**FY/04**	**FY/05**	**FY/06**
Number of Program Majors:					
Lower	14	16	9	15	13
Upper	5	11	17	15	13
Graduate	6	2	6	6	6
Number of Graduates:					
Bachelor	2	2	3	2	7
Masters	0	2	2	1	3
EdS					
Retention Rate:	NA	60.00	85.71	66.67	
ACT Scores of Majors:	27	24.4	26.1	27.4	26.8

Faculty Information	**FY/02**	**FY/03**	**FY/04**	**FY/05**	**FY/06**
Total FTE	6.2	6.2	6.2	6.45	6.45
Number T/TE	6	5	5	5	5
Number terminally qualified	6	6	4	3	5
Number Non-T/TE Full-Time	1	1	1	1	1
Number Non-T/TE Part-Time	0	0	0	0	0

Note: In Spring of 2007, we actually have 7 graduate students. One was not counted in the Fall of 06, because he was enrolled part time. Also, retention rates may be distorted by the inclusion of Pre-Engineering majors in the lower level program majors.

3. Departmental Resources

Resources	FY/02	FY/03	FY/04	FY/05	FY/06
Salaries and Benefits	552,404	533,593	518,163	533,593	585,167
OOE	35,496	28,032	23,345	28,032	45,201
External Funding – Grants, PD, Fees, etc.	2,607	2,607	37,983	55,483	79,107
Total	590,507	564,232	579,491	617,108	709,475

Note: The OOE allotment of $30,625 has not changed in decades. These OOE expenditures include purchases of new equipment funded by "Student Fee" tuition increases, startup funds for new faculty, and allotments for student workers.
External funding sources: Planetarium gate = $13,034.08 (2002 to present)
Backes: Northrup Grumman = $35,000 (2005-present)
Kuehn: NCLB Grant = $52,754 (2004-2005) and NMSU(NSF) $27,000 (2003-2006)
Blatchley: EPSCoR/NASA Grant = $50,000 (2006)

4. Departmental SCH

Credit Hour Production	FY/02	FY/03	FY/04	FY/05	FY/06
Lower Division	5,081	5,348	5,138	5,260	5,027
Upper Division	128	206	367	388	164
Graduate	57	71	36	93	114
Total	5,266	5,625	5,541	5,741	5,305

Note: 5,305 SCH / 6.45 FTE = 822 SCH/FTE.

5. Cost per Credit Hour

Credit Hour Production	FY/02	FY/03	FY/04	FY/05	FY/06
Lower Division	104.47	91.91	90.45	86.85	105.81
Upper Division	183.88	161.77	159.20	152.86	186.23
Graduate	588.19	517.48	509.25	488.98	595.72

6. Diversity

Explain what activities you have undertaken to increase faculty and student diversity within the department.

Of the last three Physics faculty hired, two were international, and one was a woman, demonstrating some focus on recruiting a diverse faculty. Our one full time temporary faculty member is also a woman. Considering the persistently low percentage of women in this field, this is a significant success, and we are very lucky to have such talented people. In the last search, we requested the extra funds needed to attract an African American physicist, but we cannot compete with the many other institutions that also seek diversity. Our percentage of female students has always been well above the national average, both at the graduate and undergraduate level. This also most likely reflects a positive and encouraging attitude by the faculty, and perhaps a tendency for female majors to stay in this area.

7. Instructional Technology

Explain how your department uses instructional technology to enhance teaching and learning.

We all use presentation software (Power Point), Black Board, optical reading (Scantron) answer sheets, Excel for record keeping and statistical analysis, and email. Several also use eInstruction RF student response systems (clickers) to facilitate feedback interaction with large classes. Our computational classes routinely use Mathematica and various programming languages. Our very positive face toward instructional technology is perhaps a reflection of the fact that much of it was developed by physicists, the first internet browser coming from CERN, for example.

Degree Program Review

1. Program Identifiers

College:	Arts and Sciences				
Department:	Physics				
Degree Program:	**PSU Degree Code**	**CIP Code**	**Degree**	**Program Name**	**Options**
	NA-01	**400801**	**Bachelor of Science**	**Physics**	**Professional Sequence**
	NA-02	**400801**	**Bachelor of Science**	**Physics**	**Applied Sequence**

2. Faculty That Support Program

Backes (phased retirement), Blatchley, Butler, Daniel (emeritus), Kuehn, Scarborough, Uran

3. Number of Majors

	FY/02	FY/03	FY/04	FY/05	FY/06
Lower Division	14	16	8	13	15
Upper Division	5	7	14	14	12
Graduate					
Total	19	23	22	27	27

4. ACT scores of majors

	FY/02	FY/03	FY/04	FY/05	FY/06
Ave ACT Score	27	30	26.6	27.4	28

5. Degrees Awarded

	FY/02	FY/03	FY/04	FY/05	FY/06
	2	2	2	1	6

6. Program Changes Since Last Review

Two upper level classes, Analytical Mechanics and Electricity/Magnetism were split into two sequential lecture courses. This was primarily in response to lower than expected achievement in these areas in our GRE-equivalent achievement tests, a response to assessment. By covering the same material in twice the time, the intention was to allow more time for drill problems and applications from later chapters in each text to insure mastery in these program critical areas. We have also added a senior research project and senior review and assessment classes, both to allow for better program assessment and to enable other functions of capstone courses.

7. Program Foundations

a. Program description:

The B.S. in Physics prepares students for careers in physics, engineering, physics-related technologies, and physical science teaching. The course offerings provide a competitive knowledge base and problem solving skills in mechanics, electricity, optics, thermodynamics, materials science, and quantum mechanics while promoting excellence in critical thinking, communication, and good citizenship. As determined by an ongoing assessment of students needs, the Department makes appropriate changes in curriculum to maintain effectiveness and relevance. Our graduates make valuable contributions to appropriate professional organizations, to the body of scientific knowledge, and to the betterment of humanity.

b. Accreditation status – if any: (If not accredited explain why.)

No accrediting agency. A National Task Force on Undergraduate Physics (NTFUP) continues to discuss the possibility of accreditation of physics programs nationally but has recommended against pursuing the issue with professional societies.

c. Program goals and objectives:

Professional Sequence: Primarily designed to prepare undergraduate majors for graduate study leading to the Ph.D. and is the preferred degree for those intending to immediately work as laboratory technicians, senior research staff, or research assistants. It includes a curriculum required by most nationally recognized advanced degree programs.

Applied Sequence: Prepares students, in both theoretical and practical laboratory experience, for immediate employment in selected specialized physics, scientific, or engineering related careers.

Both Sequences are designed to produce graduates who …

GOAL 1: … understand the theoretical and mathematical basis of our current understanding of physical phenomena in statics, dynamics, electricity, optics, thermodynamics, materials science, and quantum mechanics.

Objective 1: Accurately and rigorously apply fundamental mathematical principles and notation, including differential and integral calculus, differential equations, calculus of variation, analytic geometry, and special functions.

Objective 2: Demonstrate the principles and solve fundamental problems in mechanics, including the use of calculus, vector analysis, kinematics, and rotational translation.

Objective 3: Demonstrate the principles and solve fundamental problems in electricity and magnetism, including fundamental laws of circuits and classical electrodynamics using vector calculus.

Objective 4: Demonstrate the principles and solve fundamental problems in physical optics and modern physics, including various wave phenomena, Special Relativity, and wave/particle duality.

Objective 5: Demonstrate the principles and solve fundamental problems in condensed matter science, fluid mechanics, and the laws of thermodynamics.

Objective 6 (Professional Sequence ONLY): Demonstrate the principles and solve fundamental problems in statistical mechanics and quantum mechanics.

GOAL 2: …are able to use scientific instrumentation and safe laboratory procedures to design, conduct, and interpret basic scientific experiments.

Objective 7: Find and interpret relevant research and current theoretical understanding needed to plan, conduct, and interpret basic experiments in the physical sciences.

Objective 8: Formulate a testable scientific hypothesis.

Objective 9: Select and safely configure laboratory instrumentation to generate data relevant to a scientific hypothesis.

Objective 10: Use computers and appropriate software or programming language to analyze, reduce, and graphically present experimental data.

Objective 11: Based on a proper analysis of experimental data, draw an appropriate scientific conclusion.

GOAL 3: … are able to communication scientific ideas and information effectively using modern digital technology.

Objective 12: Organize and present scientific information in a written report using appropriate notation, format, and citations.

Objective 13: Organize and present technical information to a live audience using presentation software and effective speaking techniques.

Objective 14: Use technology to communicate informally with others in the field, for example, using email and web pages.

8. Curriculum

a. National/professional guidelines: (How does the curriculum align with national/professional guidelines?)

The American Physical Society, American Association of Physics Teachers, and the American Institute of Physics started joint workshops in 1998 to develop formal guidelines. In the past, such guidelines were not considered by these bodies, since most baccalaureate programs were designed to prepare for graduate degrees. That was the accepted standard, success in further graduate study. That was also part of the reason the tool of accreditation has not been applied to review undergraduate physics programs.

At one time, most students seeking the B.S. in Physics did go on to graduate study. That has changed significantly, especially over the last decade. Today only about 1/3 of those majoring in physics go on to graduate work, so a need to broaden our programs has been perceived. Our program is currently very consistent with preparation for graduate programs, and many of our graduates have been accepted and successful in Ph.D. programs in physics. We use the standard text books and sequences, along with the ETS Major Field Test for assessment.

Of 14 upper division undergraduate texts most commonly cited by 100 chairs of Ph.D. granting institutions expected of applicants to their programs (reported to AIP), we use 5:

Liboff, Richard L., Introductory Quantum Mechanics 2nd ed. (Illus.) (0-201-54715-5) Addison-Wesley

Marion, Classical Dynamics of Particles and Systems 4th ed. (003-097-3023) Harcourt Brace

Reif, Frederick, Fundamentals of Statistical & Thermal Physics (Fundamentals of Physics Ser.) (0 -07-051800-9) McGraw-Hill

Symon, Keith R., Mechanics 3rd ed. LC 75 - 128910 (Physics & Physical Science Ser.) (0-201-07392-7) Addison-Wesley

Zemansky, Mark W. & Dittman, Richard, Heat & Thermodynamics 6th ed. (Illus.) (0-07-072808-9) McGraw-Hill

b. Curricular alignment with external constituent needs:

Last year about 40 companies in Kansas, Missouri, and Oklahoma hired people with the B.S. in Physics. Such positions almost never have the word “physics” in the title, since this degree is often viewed as senior “engineer” or “technician.” The designation of “physicist” is almost always restricted to persons with the Ph.D. Our introductory physics and math courses are the same as those required for most engineering majors, with upper level physics courses instead of the engineering specialty classes. Thus, our B.S. in physics is essentially equivalent to an engineering degree with extra mathematics preparation. Plus, the focus on problem solving skills makes our curriculum an ideal preparation for engineering or technician type work.

c. Course sequencing: (Show the sequence of courses students should follow to graduate in 4-years.)

Year 1: Calculus I , General Chemistry I
Calculus II, General Chemistry II, Engineering Physics I

Year 2: Calculus III, Engineering Physics II
Differential Equations, Modern Physics, Intermediate Lab

Year 3: Mathematical Physics, Electives
(for Prof. Sequence, Statistical Mechanics)

Year 4: Electives, Senior Seminar, Project and Assessment
(for Prof. Sequence, Introductory Quantum Mechanics)

d. Program delivery methods:

All of the introductory courses include both a lecture component for theory and mathematics plus a laboratory component in which hands on practice is used to illustrate physical principles and provide familiarity with measurement techniques and modern equipment. Upper level elective options also include projects and guided research classes, in which a particular system or approach is expanded to fill an entire semester. Lecture classes primarily focus on solving drill problems, both in class and as homework assignments, with examinations to test the skills and knowledge developed. Some classes also include research projects in for which students read literature and use library resources to generate a written report. The laboratory classes focus on working with standard laboratory devices and instruments to perform experiments, analyze data, quantify measurement errors, draw justified conclusions, and prepare a written report.

9. Assessment of Student Learning: (From annual assessment report.)

a. Specific desired student outcomes: (What specific knowledge, skills, and experiences should a graduate of this program possess?)

A graduate of this program should be able to solve problems and express basic knowledge facts in mechanics, dynamics, electricity and magnetism, modern physics, physical optics, thermodynamics, and for the professional sequence, statistical mechanics and basic quantum concepts.

b. Assessment techniques/measures: (How do you assess student learning to know if your majors are achieving the desired outcomes?)

Previously, for about 15 years, we used a test of our own devising that had been calibrated to match the GRE Physics Achievement test to evaluate the objectives under Goal number 1. For the last three years, we switched to the ETS Major Field Achievement Test (MFAT), which has the advantages of being nationally normed, controlled and designed by others outside PSU, and relatively inexpensive. The first two years of results did not distinguish performance in the areas listed above, but only broke the score into "Upper level" and "Lower level" material. Now they do give us an indication of which areas are strong or weak. Goals 2 and 3 are assessed in the thesis or problem report and its defense and the Senior Project course. We also continue to survey our alumni as part of our annual newsletter and as part of the Foundation's Telethon in February. These surveys are what have continued to point to a need for modern research equipment.

c. Document student achievement: (Provide assessment data by outcome.)

MFAT Average scores scaled to percent achieving lower scores that year:

FY 2007 (1 student)
Introductory Physics: 73
Advanced Physics: 55

Assessment Indicator Title	Percent Score
Classical Mechanics & Relativity	64
Electromagnetism	83
Optics/Waves & Thermodynamics	67
Quantum Mechanics & Atomic Physics	75
Special Topics	17

FY 2006 (6 students)
Introductory Physics: 39.4
Advanced Physics: 36.0

Assessment Indicator Title	Mean Percent Score
Classical Mechanics & Relativity	70
Electromagnetism	30
Optics/Waves & Thermodynamics	35
Quantum Mechanics & Atomic Physics	37.6

Special Topics **15**

FY 2005 (0 students)

FY 2004 (2 students) **(No breakdown by sub-area)**
Introductory Physics: **31**
Advanced Physics: **25**

FY 2003 (2 students) **(No breakdown by sub-area)**

Introductory Physics: **40.5**
Advanced Physics: **47**

d. Changes based on assessment: (Demonstrate that assessment data is used to improve student learning and effectiveness of the program.)

The older Pre/Post Exams that had been correlated to the GRE Subject Achievement Test demonstrated that our program resulted in above average preparation for most graduates and very much above average for selected students. Results on the MFAT so far have been consistent with this, although in one case (in 2003) there was much better performance for upper level material than for lower level. As a result, we have incorporated the testing procedure into an assessment course, both to help students review for it and to give them better motivation for doing well on it. Student Satisfaction Surveys, both UD and Graduate, have generally been very positive. The one recurring complaint is over lack of modern instruments.

As described in Section 6 above on changes in curriculum since the last review, a second semester has been added to each of two courses, Analytical Mechanics and Electricity and Magnetism. These upper level subjects have consistently been named by students as more difficult than other material, although the MFAT scores in E&M have been quite acceptable. Most of the second semester of Analytical Mechanics covers topics that the MFAT categorizes under "Special Topics." We also added a Senior Seminar and Assessment course to insure that seniors prepare for and take the MFAT in an environment that includes some motivation to do well. A new Senior Project was also added to function as a capstone class, to allow another venue for assessment (Goals 2 and 3), and to insure that graduates have experience with relatively independent research.

Based on the MFAT scores for the last two years, the two subjects for which we split single courses into two three-hour classes have clearly benefited and are now the strongest areas tested. However, the one area where our students are consistently achieving low scores is in Special Topics. This area includes about 17% of the questions and covers condensed matter, nuclear and particle physics, laboratory methods, astrophysics, computer and mathematical methods, and Lagrangian and Hamiltonian formalisms.

Splitting Analytical Mechanics into two semesters should have helped with the Lagrangian and Hamiltonian mechanics. However, the other Special Topics are all covered in elective courses. Not all of our students take all of these electives. Some, for example, nuclear and particle physics, are not even in a legislated course. We have covered that material in recent years only in a "Special Topics" lecture. However, adding courses to the curriculum, particularly courses that would only apply to the small number of majors, will strain resources. Our last decision was therefore to simply focus on Special Topics in the capstone review. If that does not improve performance in this area, we will consider further course splitting or adding a credit hour (probably to Modern Physics and Mathematical Physics), or perhaps adding a course to cover these specific topics more thoroughly.

10. Continuous Improvement – Program Plan

a. Program strengths, weaknesses, opportunities, and threats analysis:

We have attempted to address student needs for modern equipment, particularly with various types of microscopy, X-ray, and Surface Analysis instrumentation, collaboration in research at BTI and the College of Technology, and use of newer computers and equipment in the introductory labs. We continue to operate a world class astrophysical observatory at Greenbush, a modest 1960s vintage planetarium, and a geophysics lab. Although we have continued to upgrade our seven PC computer lab, this format, even as a class room for computational physics, may soon disappear in favor of individual lap top computers.

A well respected study in 2005 by the APS showed that the key factor in maintaining the strength of baccalaureate physics programs was the availability of funded research projects through which students gained both valuable experience and financial support. Consequently, we continue to actively seek outside funding, with a track record of SBIR collaborations (NIH, DoD) and several smaller grants, including two recently from NASA, one to buy a gamma spectroscopy system through

the EPSCoR program and the other an instrumentation development collaboration with New Mexico State University, plus one in medical research from the hospital at Randolph AFB. We also employ many of our upper level majors to serve as graders or lab assistants in the introductory and General Education lab classes.

Although enrolling a limited number of majors may be perceived as a problem, it at least results in small class sizes, which in turn produce high quality learning experiences and individual attention, especially in the majors course sequence. Because of the difficulty of the material, such individual attention is often a necessity and not a luxury. As a result, even our average students often participate in individual research and present papers at regional conferences, usually through our active chapter of SPS (Society of Physics Students). We continue to have 100% of our graduates either employed or accepted for a Ph.D. program within one year of graduation. Our faculty have strong qualifications and share an interest in both guiding student research and in sharing expertise through various forms of public outreach, particularly those aimed at helping local teachers through the Science Education Center, with planetarium programs, workshops, and contributions to programs at Greenbush.

It should be noted that the national trend toward lower enrollment in the sciences has evidently started to turn around following a decade of advertising and educating by various professional societies, including the American Physical Society. A previous campaign had helped to improve the low enrollment of women.

b. Program changes currently being considered and those likely to be implemented within the next five years:

Our upper level courses that introduced quantum phenomena will be changed this next year to slow the pace and reduce the scope of the middle course (PHYS 716 Introductory Quantum Mechanics). We will be changing to a simpler non-standard text that emphasizes basic material introduced in PHYS 516 Modern Physics. This is in response to continued student difficulty and feedback about the standard approach to quantum. As a result, the graduate course, PHYS 816, may eventually need to be split into two, one at the level of the current 716, and one at the level of the current 816 to maintain the rigor of the M.S. program.

We have at times considered organizing the introductory sequence of three courses (PHYS 104, 105, 516), with a total of 11 credit hours, into four modular units of three (or four) credit hours each, including the laboratories. This would slow the pace slightly and allow some programs to pick and choose which modules they want to include. For example, Civil Engineering Technology may only be interested in mechanics and materials but not electricity or modern physics. However, this is a non-standard approach, and the scheduling problems entailed have been a serious deterrent.

We are still evaluating the effectiveness of our recent changes, splitting Analytical Mechanics and Electricity and Magnetism into two courses each. If this previous change continues to be effective in improving assessments in these two areas, we may also consider splitting Physical Optics or Statistical Mechanics, or at least extending their credits from three to four. The key issue is scheduling, whether we have sufficient FTEs available to cover the extra credit hours of these subjects. Mathematical Physics and Modern are two other candidates for splitting, or adding hours, in response to the MFAT results in Special Topics.

Degree Program Review

1. Program Identifiers

College:	Arts and Sciences				
Department:	Physics				
Degree Program:	**PSU Degree Code**	**CIP Code**	**Degree**	**Program Name**	**Options**
	NA	**400801**	**Bachelor of Science in Education**	**Physics**	**No Emphasis**
	NB	**400801**	**Bachelor of Science in Education**	**Physical Science**	**No Emphasis**

2. Faculty That Support Program

Backes, Blatchley, Kuehn, Shoberg, Butler, Scarborough, Daniel

3. Number of Majors

	FY/02	FY/03	FY/04	FY/05	FY/06
Lower Division	1	0	1	2	1
Upper Division	1	4	3	1	1
Graduate					
Total	2	4	4	3	2

4. ACT scores of majors

	FY/02	FY/03	FY/04	FY/05	FY/06
Ave ACT Score	23	22.8	21.5	28	

5. Degrees Awarded

	FY/02	FY/03	FY/04	FY/05	FY/06
	0	0	1	1	1

6. Program Changes Since Last Review

The BSEd in Physics is nearly identical in content area requirements to the BS Physics, so the changes listed for that part are repeated here. Two upper level classes, Analytical Mechanics and Electricity/Magnetism were split into two sequential lecture courses. This was primarily in response to lower than expected achievement in these areas in our GRE-equivalent achievement tests, a response to assessment. By covering the same material in twice the time, the intention was to allow more time for drill problems and applications from later chapters in each text to insure mastery in these program critical areas. We have also added a senior research project and senior review and assessment classes, both to allow for better program assessment and to enable other functions of capstone courses.

Physical Science is distinct from the other Physics majors, in that the science requirements are mainly introductory or survey courses designed to help meet Kansas Board of Education requirements for licensure. The same may be said for the minor in Earth and Space Science. Consequently, only minor changes in course content were made to adjust to changes in these requirements. The one major change was a substitution of PHYS 375 Solar System Astronomy for PHYS 175 Descriptive Astronomy, due to an emphasis in the PPST-Praxis admission examination not mentioned in the standards.

7. Program Foundations

a. Program description:

The BSEd in Physics prepares graduates as teachers for secondary education in the sciences, particularly in physics or chemistry. The aim of the BSEd in Physical Science is broader, allowing teaching of science at the secondary or middle school levels. The course offerings for the physics program provide a competitive knowledge base and basic problem solving skills in mechanics, electricity, optics, and materials science, while promoting excellence in critical thinking, communication, and good citizenship. Courses for physical science are primarily at the introductory levels in mathematics, physics, and chemistry, with survey classes in other sciences, including meteorology, geology, oceanography, and astronomy. Many of these "orphan" subjects could just as well be parts of geography or life science programs, but they have been consolidated under physics to simplify scheduling and management of course content.

b. Accreditation status – if any: (If not accredited explain why.)

Since these are technically specialties of the College of Education's BSEd major, they are accredited under the general umbrella of NCATE. They do not have more specific accrediting agencies.

c. Program goals and objectives:

The BSEd in Physics prepares students, in both theoretical and practical laboratory experience, for employment as teachers at the secondary level in physics. It is designed to produce graduates who …

GOAL 1: … understand the theoretical and mathematical basis of our current understanding of physical phenomena in statics, dynamics, electricity, optics, thermodynamics, materials science, and quantum mechanics.

Objective 1: Accurately and rigorously apply fundamental mathematical principles and notation, including differential and integral calculus and analytic geometry.

Objective 2: Demonstrate the principles and solve fundamental problems in mechanics, including the use of calculus, vector analysis, kinematics, and rotational translation.

Objective 3: Demonstrate the principles and solve fundamental problems in electricity and magnetism, including fundamental laws of circuits and classical electrodynamics using vector calculus.

Objective 4: Demonstrate the principles and solve fundamental problems in physical optics and modern physics, including various wave phenomena, Special Relativity, and wave/particle duality.

GOAL 2: …are able to use scientific instrumentation and safe laboratory procedures to design, conduct, and interpret basic scientific experiments.

Objective 5: Find and interpret relevant research and current theoretical understanding needed to plan, conduct, and interpret basic experiments in the physical sciences.

Objective 6: Formulate a testable scientific hypothesis.

Objective 7: Select and safely configure laboratory instrumentation to generate data relevant to a scientific hypothesis.
Objective 8: Use computers and appropriate software or programming language to analyze, reduce, and graphically present experimental data.
Objective 9: Based on a proper analysis of experimental data, draw an appropriate scientific conclusion.

GOAL 3: … are able to communication scientific ideas and information effectively using modern digital technology and instructional techniques.
Objective 10: Organize and present scientific information in a written report using appropriate notation, format, and citations.
Objective 11: Organize and present technical information to a classroom using presentation or instructional software and effective speaking techniques.
Objective 12: Use technology to communicate informally with others in the field, for example, using email and web pages.

Other Goals and objectives related to pedagogy are set and evaluated by the College of Education.

The BSEd in Physical Science prepares students for employment as teachers at the middle school level in science. It is designed to produce graduates who …

GOAL 1: … understand basic concepts of the physical sciences, including mechanics, chemistry, electricity, optics, geology, meteorology, oceanography, and astronomy.
Objective 1: Accurately and rigorously apply fundamental principles and notation of algebra and geometry.
Objective 2: Demonstrate basic principles and solve fundamental problems that occur in the physical sciences.

GOAL 2: …are able to use scientific instrumentation and safe laboratory procedures to reproduce and interpret important scientific experiments.
Objective 3: Find and interpret relevant research and current theoretical understanding of established experiments in the physical sciences.
Objective 4: Formulate a testable scientific hypothesis.
Objective 5: Select and safely configure basic laboratory instruments to generate data relevant to a scientific hypothesis.
Objective 6: Use computers and appropriate software or programming language to analyze, reduce, and graphically present experimental data.
Objective 7: Based on a proper analysis of experimental data, draw an appropriate scientific conclusion.

GOAL 3: … are able to communication scientific ideas and information effectively using modern digital technology.
Objective 8: Organize and present scientific information in a written report using appropriate notation, format, and citations.
Objective 9: Organize and present technical information to a class using presentation software and effective speaking techniques.
Objective 10: Use technology to communicate informally with others in the field, for example, using email and web pages.

Other Goals and objectives related to pedagogy are set and evaluated by the College of Education.

8. Curriculum

a. National/professional guidelines: (How does the curriculum align with national/professional guidelines?)

The Kansas Board of Education has revised its science standards to again conform to the National Research Council's "National Science Education Standards" and to the National Science Teachers' Association's "Pathways to Science Standards." Our program conforms to all of these.

b. Curricular alignment with external constituent needs:

The primary external constituent for these two programs is the Kansas Board of Education, to whose standards we adjust to maintain alignment.

c. Course sequencing: (Show the sequence of courses students should follow to graduate in 4-years.)

BSEd in Physics (content area only):

Year 1: Calculus I , General Chemistry I
Calculus II, General Chemistry II, Engineering Physics I
Year 2: Calculus III, Engineering Physics II
Modern Physics, Intermediate Lab
Year 3: Mathematical Physics, Upper level electives
Year 4: Senior Seminar, Project and Assessment

BSEd in Physical Science (content area only):
Year 1: Physical Science, College Algebra, Astronomy
General Chemistry I , Calculus I, Engineering Physics I
Year 2: General Chemistry II, Engineering Physics II
Modern Physics, Intermediate Lab
Year 3: Geology, Oceanography
Year 4: Senior Seminar, Project and Assessment
Meteorology

d. Program delivery methods:

Most of these courses include both a lecture component for theory and mathematics plus a laboratory component in which hands on practice is used to illustrate principles and provide familiarity with measurement techniques and modern equipment. Lecture classes primarily focus on illustrating principles to prepare for solving drill problems, both in class and as homework assignments, with examinations to test the skills and knowledge developed. Some classes also include research projects in for which students read literature and use library resources to generate a written report. The laboratory classes focus on working with standard laboratory devices and instruments to perform experiments, analyze data, quantify measurement errors, draw justified conclusions, and prepare a written report.

9. Assessment of Student Learning: (From annual assessment report.)

a. Specific desired student outcomes: (What specific knowledge, skills, and experiences should a graduate of this program possess?)

A graduate of the BSEd in Physics should be able to solve problems and express basic knowledge facts in mechanics, dynamics, electricity and magnetism, modern physics, physical optics, and thermodynamics.

A graduate of the BSEd in Physical Science should be able to express basic knowledge facts from a range of physical sciences, including mechanics, electricity, geology, astronomy, meteorology, and oceanography and to solve algebra based problems taken from the basic concepts and processes in these sciences.

b. Assessment techniques/measures: (How do you assess student learning to know if your majors are achieving the desired outcomes?)

The primary hurdle in both of these majors is the PPST-Praxis examination required for admission into the Teacher Education program by the State Board. Majors in the BSEd in Physics are also take the exams listed above for the B.S. in Physics, and their scores are mixed in with those.

c. Document student achievement: (Provide assessment data by outcome.)

PPST Praxis Scores

Year	Major/Degree	Physics (141)	Earth Science (150)	Middle School (149)
FA03-SP04				
W.B.	Physics/B.S. Ed			151.00
FA04- SP05				
M.B.	Physical Science/B.S. Ed	110.00	114.00	149.00
A.E.	Liscensure only		129.00	172.00
R.K.	Biology/B.S. Ed			183.00
M.S.	Biology/B.S. Ed	126.00	160.00	

M.S.	Chemistry/B.S. Ed		174.00	
S.Y.	Chemistry/B.S. Ed	125.00	132.00	165.00
FA05-SP06				
A.M.	Physical Science/B.S.Ed	134.00	148.00	
D.D.	Biology/B.S. Ed			178.00
Recent				
M.B.	Physics/Unknown	124.00		
P.B.	Liscensure only		153.00	
L.P.	Liscensure only			121.00
Average		123.80	139.63	159.86

d. Changes based on assessment: (Demonstrate that assessment data is used to improve student learning and effectiveness of the program.)

Somewhat low scores (below the licensure cut score of 141) for the Physical Science majors (listed under the Physics test) that have taken that exam indicated that they needed some review of the introductory physics material. Consequently, we added a senior review and capstone course to help them with this material. They do get the material in the introductory sequence, but they do not take any higher courses, which are usually needed to insure that the introductory material is thoroughly absorbed. To date, none of our majors have been denied licensure because of these tests, but we are working to insure that it does not happen in the future.

10. Continuous Improvement – Program Plan

a. Program strengths, weaknesses, opportunities, and threats analysis:

These BSEd degrees mostly piggy back on other programs. The major in Physics, in particular, is essentially a duplicate of the BS degree in the same area. It does not require any other resources or courses. Consequently, this major would be better listed with the BS in Physics, since these have the same goals, tests, and other documentation.

In contrast, the BSEd in Physical Science does require quite independent courses in Meteorology, Geology, and Oceanography. However, these courses are very popular for the Physical Science minor. Many of our education majors major in Biology or HPER but take Physical Science as a minor to improve their odds of employment. Consequently, there is great demand for these courses as service courses, even though we have relatively few majors. We would probably need to continue to offer these courses anyway, just to accommodate the demand for second field licenses.

b. Program changes currently being considered and those likely to be implemented within the next five years:

None, until the next State Board election or unless the BS in Physics changes (course splitting or added hours discussed above).

Degree Program Review

1. Program Identifiers

College:	Arts and Sciences				
Department:	Physics				
Degree Program:	**PSU Degree Code**	**CIP Code**	**Degree**	**Program Name**	**Options**
	NA	**400801**	**Master of Science**	**Physics**	**No Emphasis**

2. Faculty That Support Program

Backes, Blatchley, Kuehn, Uran, Butler

3. Number of Majors

	FY/02	FY/03	FY/04	FY/05	FY/06
Lower Division					
Upper Division					
Graduate	6	2	6	6	6
Total	6	2	6	6	6

4. ACT scores of majors

	FY/02	FY/03	FY/04	FY/05	FY/06
Ave ACT Score	NA	NA	NA	NA	NA

5. Degrees Awarded

	FY/02	FY/03	FY/04	FY/05	FY/06
	0	2	2	1	3

6. Program Changes Since Last Review

For the primary option, we have only made clarifications of policies in the Catalog. However, we have created two alternative options, one for pre-service teachers, designed to substitute a course in experimental design for the 800 level quantum mechanics. The second option is even gentler, allowing in-service teachers to meet the basic undergraduate requirements for licensure while earning credit for a Master's degree. We thought there might be some demand for such a program emphasizing grant writing instead of physics, because there were reportedly so many physics teachers in Kansas who had never taken the basic courses. So far, we have not a single inquiry for the last two options, which suggests that either that statistic was in error, or that there are too many ways for school boards to permanently circumvent the need for basic qualifications in the sciences.

7. Program Foundations

a. Program description:

The M.S. in Physics prepares students for careers in physics, engineering, physics-related technologies, and physical science teaching. Course offerings provide an advanced knowledge base and problem solving skills in classical mechanics, electrodynamics, and quantum mechanics while promoting excellence in critical thinking, communication, and good citizenship. A combination of upper level electives and independent research allow candidates to shape a field of specialization within physics. Graduates make valuable contributions to appropriate professional organizations, to the body of scientific knowledge, and to the betterment of humanity.

b. Accreditation status – if any: (If not accredited explain why.)

Not accredited. No appropriate agency.

c. Program goals and objectives:

The M.S. in Physics is primarily designed as a capstone for the Professional Sequence BS degree. Entrance requirements include the equivalent courses and test scores for that program. The result is either excellent preparation for further graduate study leading to the Ph.D. or for immediate work as a supervisory laboratory technicians, senior research staff, or research assistants. It includes a curriculum required by most nationally recognized advanced degree programs.

The M.S. in Physics is designed to produce graduates who …

GOAL 1: … understand advanced theoretical and mathematical bases for physical phenomena.
Objective 1: Accurately and rigorously apply advanced mathematical principles and notation of mathematical and computational physics.
Objective 2: Demonstrate principles and solve advanced problems in classical mechanics, including Lagrangian and Hamiltonian formalisms.
Objective 3: Demonstrate principles and solve advanced problems in classical electrodynamics.
Objective 4: Demonstrate principles and solve advanced problems in quantum mechanics, including perturbation theory and non-analytical techniques.

GOAL 2: …are able to use scientific instrumentation and safe laboratory procedures to conduct independent research.
Objective 5: Find and interpret relevant research and current theoretical understanding needed to plan, conduct, and interpret advanced experiments.
Objective 6: Use computers and appropriate software or programming language to analyze, reduce, and graphically present experimental data.
Objective 7: Based on a proper analysis of experimental data, draw an appropriate scientific conclusion appropriate for publication.

GOAL 3: … are able to communication scientific ideas and information effectively using modern digital technology.
Objective 8: Organize and present scientific information in a written thesis or problem using appropriate notation, format, and citations.
Objective 9: Organize and present technical information in a thesis or problem defence using presentation software and effective speaking techniques.
Objective 10: Use technology to communicate informally with others in the field, for example, using email and web pages.

8. Curriculum

a. National/professional guidelines: (How does the curriculum align with national/professional guidelines?)

In many Ph.D. programs, the M.S. degree is only awarded to students preparing to take the Ph.D. but unable to pass a rigorous candidacy examination. As a result, the standard definition is very close to qualifying for the independent research of a Ph.D. thesis. As a terminal degree, we require very much the same course work for this standard, but do not require the level of preparation needed for a candidacy examination. Consequently, the terminal M.S. is more accurately described as closer to the B.S. than to the Ph.D.

b. Curricular alignment with external constituent needs:

As a result, our students often view the M.S. as further preparation for the GRE examination and further graduate progression toward the Ph.D. or an advanced Engineering degree. As such, it is viewed by both students and employers as a "confidence builder" or "super" B.S.

c. Course sequencing: (Show the sequence of courses students should follow to graduate in 4-years.)

The M.S. can be completed in 18 months, not four years. The three core courses are in Classical Mechanics, Electrodynamics, and Quantum Mechanics, one taken each semester in whatever order is available, but most easily managed in this order. In addition, the student should complete electives plus six hours of independent graduate research totaling 31 (problem) or 33 (thesis) credit hours.

d. Program delivery methods:

Same as for the undergraduate degrees.

9. Assessment of Student Learning: (From annual assessment report.)

a. Specific desired student outcomes: (What specific knowledge, skills, and experiences should a graduate of this program possess?)

Same as for the B.S. in Physics but at the graduate level, i.e. solve problems in the specified areas, perform independent research, and report it effectively in written and verbal forms.

b. Assessment techniques/measures: (How do you assess student learning to know if your majors are achieving the desired outcomes?)

Goal 1 has been assessed by taking a Qualifying examination prior to beginning independent research and by the GRE examination, which was to be completed prior to graduation. However, this latter requirement was dropped by the Graduate Council, and none of our recent graduating M.S. students have opted to take the examination, even though the Department has a standing offer to pay for it. Consequently, we have switched to the MFAT test for both B.S. and M.S. candidates. By using the same test for each, this should help us assess the "value added" of the M.S. program. Goals 2 and 3 are still assessed by the committee that reviews their thesis, thesis defense, problem report, or problem seminar. We also continue to survey our alumni as part of our annual newsletter.

c. Document student achievement: (Provide assessment data by outcome.)

All students progressing in the program in this review period (a total of 10) eventually passed their Qualifying Examinations, although 7 had to undertake remedial work or take the test again. No GRE scores are available for the past review period. Students either did not take the test or chose not to share their scores with us. MFAT examinations have either not yet been completed or not yet returned from ETS for the three students expected to graduate this year.

d. Changes based on assessment: (Demonstrate that assessment data is used to improve student learning and effectiveness of the program.)

Most of the changes based on assessment at the M.S. level were made in the B.S. curriculum as discussed in those programs. In particular, common weaknesses in Electricity and Magnetism and in Classical Mechanics contributed to the decision to split those two undergraduate courses to better prepare students for graduate programs. The one major change in the M.S. courses has been the shift in focus of PHYS 716 Introductory Quantum Mechanics to more basic and introductory material. This change affects both B.S. and M.S. programs, but it also forces the graduate course, PHYS 816 Quantum Mechanics, to include material that had previously been in PHYS 716. Consequently, we may eventually need a second semester of this 800 level material to maintain the targeted level of rigor for the program.

10. Continuous Improvement – Program Plan

a. Program strengths, weaknesses, opportunities, and threats analysis:

Again, we have attempted to address student feedback expressing a need for modern equipment. The primary need for graduate students is for research grade equipment associated with particular faculty research or for travel funding to take students to facilities at other locations. We have two new faculty who are still putting together their research instrumentation, but this has been difficult, since the cost of modern research instruments is an order of magnitude or greater than the resources available locally. Consequently, if we are ever to acquire such equipment, funding must come from a grant from an outside funding agency, hence another motivation for our emphasis on grant proposal submissions.

The same 2005 APS study that showed baccalaureate physics programs needed funded research projects through which students gained both valuable experience and financial support, had similar recommendations for institutions with terminal M.S. degrees. As with the upper level undergraduate program, small class sizes help to insure high quality and individual attention. Such individual attention is also essential for guiding independent research.

Dr. Ratzlaff's experiment in increasing funding to GTAs has evidently been quite successful, since we now have twice as many graduate students in Physics as GTA positions. However, the current allotment of 3.5 positions per year is still not nearly enough to assist in the many service course labs in Physics I, II and General Education. For these, we often hire senior undergraduates to help, which may not provide the best learning experience or supervision in safety to students in these classes. Lab assistants are absolutely essential due to our high service course load, which amounts to about 94% of the 822 SCH/FTE generated in 2006.

b. Program changes currently being considered and those likely to be implemented within the next five years:

We plan to continue to seek additional outside funding for student research. Individual lab courses are being upgraded to include the most relevant and current experiments.