CSM

Physics/BS

Student Outcomes Assessment Plan (SOAP)

Revision 1: October 8, 2014

I. Mission Statement

The mission of the Department of Physics at California State University, Fresno, is to recruit diverse students and provide them with a rigorous and thorough understanding of the ideas and methods of physics, as well as the crucial role of the findings of physics as they relate to society in terms of technology, engineering, medicine, energy policy, and our collective understanding of the fundamental nature of the universe.

A graduate with a BS in physics will exhibit the habits of a scientist and will be fully prepared to continue their education to Masters or Doctoral programs in Physics or related fields, will be ready to engage in a career in industry or government alongside engineers and applied scientists, be qualified to become a teacher of science, or be competitive and competent for all appropriate physics and science related career paths including medicine. A graduate with a MS in physics will in addition have made a significant contribution to the field, and be further prepared for continuing their education at the Doctorial level, teaching at a junior college, or entering industry or government as an expert in their chosen discipline of physics.

II. Goals and Student Learning Outcomes

Goal 1. Physics majors will obtain a comprehensive background in ***essential core disciplines*** identified as fundamental in physics: 1) classical mechanics, 2) electricity and magnetism, 3) thermodynamics and statistical mechanics, 4) optics, 5) special relativity, and 6) quantum mechanics. In addition, elective courses will have students integrate and synthesize knowledge from these core disciplines through study of specialized areas including: 7) astrophysics, condensed matter physics, health physics, high energy physics, and theoretical physics among others. Core and elective courses will deliver crucial ***core skills*** including: 8) advanced knowledge of math, 9) information literacy and the role of peer evaluation, and 10) scientific writing and public speaking. Core laboratory courses and independent study (research experience) will embed specific ***core skills*** considered crucial to experimental physics including: 11) experimental methods including the proper application of statistics and error analysis, 12) computer programming and computational techniques, and 13) a working knowledge of electronics and metal working/machine shop skills.

Outcome a. Students will develop mastery of problem solving in the following core disciplines described in textbooks that are universally recognized as standards in undergraduate physics education:

Classical Mechanics at the level of
Classical Dynamics of Particles and Systems by Stephen Thornton and Jerry Marion,
Electricity and Magnetism at the level of
Introduction to Electrodynamics by David J. Griffiths,
Thermodynamics at the level of
Thermal Physics by Ralph Baierlein,
Optics at the level of
Optics by Eugene Hecht,
Quantum Mechanics at the level of
Introduction to Quantum Mechanics by David J. Griffiths,
and Relativity and Modern Physics at the level of
Modern Physics for Scientists and Engineers by Stephen Thornton and Andrew Rex.

Outcome b. Students shall have mastery of a specialize area of physics, and will be encouraged to engage in research.

Outcome c. Students will acquire core skills in math, computer programming, applied statistics, and error analysis.

Outcome d. Students will be able to write scientific papers in a format and manner appropriate to publishing in leading journals of physics, and be practiced in the preparation and presentation of scientific ideas and findings.

Outcome e. Students will have mastery of experimental design and methods, and those interested in experimental physics will develop firsthand knowledge of metal working and machine shop skills, and working knowledge of a wide variety of experimental apparatus.

Goal 2. Non-majors will learn general physics principles and receive grounding in the problem solving methods and research techniques characteristic of physics in a variety of courses. Conceptual physics and astronomy courses are available and made accessible to non-science majors to fulfill general education goals. More rigorous general physics course sequences (with and without calculus) are provided to students of other science-based majors based on the needs as determined in consultation these major departments and the Department of Physics.

Outcome a. Engineering students will master physics topics at the level defined by the textbook **Physics for Scientists and Engineers** by Serway and Jewett, and meet standards as set by the Accreditation Board for Engineering and Technology (ABET).

Outcome b. Biology, premedical, prevetrinary, and prepharmacy students will master physics topics at the level of the textbook **College Physics** by Serway, and at the level to allow high performance on the physics and problem solving components of the MCAT medical school entrance examination or equivalent.

Goal 3. The physics department will engage the community and encourage K-12 and community college students towards a career in physics and science with an emphasis on diversity. Our service learning course, Physics Pedagogy and Outreach, Phys 168s should play a role in achieving this goal.

Outcome a. The number of enrolled physics majors will increase and stay above 100.

Outcome b. The quality of incoming students in terms of GPA and preparation for a career in science will increase.

Outcome c. The physics department will graduate 10 or more students with BS degrees on average.

Outcome d. Enrolled and graduated students shall trend towards reflecting the diversity of the community.

III. Curriculum Map (Matrix of Learning Outcomes X Courses)

Physics BS Curriculum Map

B = beginner/introduction
I = intermediate/reinforcement
A= advanced/mastery

	Outcomes	REQUIRED COURSES																				Physics ELECTIVES																
		Chem 1A	Math 75	Phys 4A	Phys 4AL	Math 76	Chem 1B	Phys 4B	Phys 4BL	Math 77	CSCI 40 or IT 52	Phys 4C	Math 81	Phys 102	Phys 104	Phys 105A	Phys 105B	Phys 107A	Phys 110	Phys 115	Phys 140	Phys 171: Capstone	PSci 131	PSci 168	Phys 100	Phys 107B	Phys 135	Phys 136	Phys 137	Phys 150	Phys 151	Phys 162	Phys 168S	Phys 170A	Phys 175T: Comp	Phys 175T: HEP	Phys 175T: Plan Ops	Phys 180: Seminar	Phys 190: Ind Study
1	Essential Core Physics: Classical Mechanics			B	B			B	B			B		B		I	A			I		I	B	B	B					A		I	B	B	I		B		A
2	Essential Core Physics: Electricity & Magnetism						B	B	B			B		B	B			I	I	B		I	B	B	B	A	I	I	I	I		I	B	B	I	A	B		A
3	Essential Core Physics: Thermodynamics & Statistical Mechanics	B					B	B	B			B		I	B			B		B	A	I		B						I	I	I	B		I				A
4	Essential Core Physics: Optics											B			B				A			I	B	B	B	I				A	A	I	B				B		A
5	Essential Core Physics: Special Relativity											B		A	B							I				A				A	A					A			A
6	Essential Core Physics: Quantum Mechanics	B					B					B		I	B				B	A	B	I			B					I	I	A		I		A			A
7	Exposure to fields of Physics: Astro/ Condensed Matter/ high energy/ radiation/ health physics																					I					A	A	A	A		A				A	A	A	A
8	Skills: Math B: Algebra/ Trigonometry I: Calculus/ Applied Analysis A: Complex Analysis	B	B	B	B	B	B	B	B	B	B	B	I	I	I	A	A	A	I	A	A	A			A	A	I	I	I	I		I		A	I	I			I
9	Skills: Information Literacy Peer evaluation																													I	I				I			I
10	Skills: Presentation Scientific Writing Scientific Presentation				B				B						I				I											I	I		I				I	B	I
11	Skills: Experimental Methods Statistical Analysis Error Analysis	B			B		B		B						I			I			I	B					I	I	I	I	I	I						A
12	Skills: Computing Computer Programming Computational Techniques										I																							A					I
13	Skills: Advanced Laboratory Electronics Machine Shop Techniques								B		I				I				B								I	I	I	I	I	I						A
14	Recruitment, Retention, Graduation																																A				I	

Chem 1A, 1B	General Chemistry
CSCI 40	Intro to Programming
IT 52	Electricity and Electronics
Math 75, 76, 77	Calculus I, II, III
Math 81	Applied Analysis
Phys 4A	Mechanics and Wave Motion
Phys 4AL	Laboratory
Phys 4B	Electricity, Magnetism, and Heat
Phys 4BL	Laboratory
Phys 4C	Light and Modern Physics

Phys 100	Concepts of Quantum Mechanics
Phys 102	Modern Physics
Phys 104	Experimental Techniques
Phys 105A, B	Analytical Methods
Phys 107A, B	Intermediate Electricity and Magnetism
Phys 110	Physical Optics
Phys 115	Quantum Mechanics
Phys 135	Introduction to MRI/MRS
Phys 136	Radiation Physics
Phys 137	Radiation Measurements Laboratory
Phys 140	Thermodynamics and Kinetic Theory
Phys 150	Astrophysics

Phys 151	Observational Astronomy
Phys 162	Condensed Matter Physics
Phys 168S	Physics Pedagogy and Outreach
Phys 170A	Mathematical Physics
Phys 171	Capstone: Analytical Methods
Phys 175T	Introduction to High Energy Physics
Phys 175T	Computational Physics
Phys 175T	Planaterium Operations
Phys 180	Seminar in Physics
Phys 190	Independent Study
PSci 131	Concepts in Callsical Physics
PSci 168	Energy and the Environment

IV. Assessment Methods

A. Direct Measures

1. Physics majors will take the Physics Major Field Test (MFT) in their senior year. The MFT is a product of Educational Testing Services (ETS). According to the ETS website, “ETS offers comprehensive national comparative data for the Major Field Tests, enabling you to evaluate your students' performance and compare your program's effectiveness to programs at similar institutions nationwide.” The MFT will be administered to all physics majors within the required capstone course Analytical Methods, Phys 171, as the final exam, ensuring that all majors will take the MFT exam and be adequately prepared for it.

   Benchmark: The Fresno State institutional average should be at or above the 50th percentile of the Physics MFT institutional average scores for the 8 year running average supplied by ETS.

2. Physics majors must complete the Analytical Methods capstone course (Phys 171), which will include assessment exams in each of the ***essential core disciplines*** outlined in Goal 1. These exams will be reviewed by the instructor of Phys 171 and reported to the assessment committee. Performance on these exams will also be reported to the respective instructors responsible for each of the upper division courses relating to each core discipline. These instructors will also be consulted in the crafting of these assessment exams, so that the results can be informative on the retention of the skills and knowledge obtained by the students from these courses, including Phys 4ABC, 105A, 102, 107, 110, 140, and 115.

   Benchmark: A standard will be sought after the first year of data collection, and trends in scores for each core discipline will be monitored. After a few years of data collection, longitudinal studies should be able to set benchmarks. Although initially firm benchmarks will not be available, any extremes in performance will be thoroughly investigated.

3. Outcomes in service courses Phys 2AB and Phys 4AB will be monitored via embedded questions in final exams. For each specific course (e.g. Phys 4A) , final exams will contain three standardized embedded questions which will be shared across sections and from semester to semester. These questions will be identical in all but numerical values and will represent three areas of course specific essential knowledge as defined by committees of the prospective instructors of these courses. Exam questions for these courses will be curated by the department chair who will be responsible for reminding the instructors of these courses towards the inclusion of these questions into final exams.

   Benchmark: Once again, standards will be sought after the first year of data collection, and trends in scores for each course will be monitored. Comparisons will be made both longitudinally, from semester to semester, and through cross-sectional analysis, via comparison of concurrent sections. After a few semesters of data collection, longitudinal studies should be able to set benchmarks. Although initially firm benchmarks will not be available, any extremes in performance will be thoroughly investigated.

4. The total enrollment, number of graduates, and diversity of physics majors shall be reviewed each year. Data will be provided by the Office of Institutional Effectiveness.

   Benchmarks

   Graduation rates: The most recent (2008) data and analysis from the professional organization, the American Institute of Physics (AIP), show that Masters granting institutions graduate on average 6 BS degrees per year (62 US physics departments in the survey). The goal is to meet or exceed that number.

   Diversity: Analysis of the most recent (2008) data from AIP indicate that for the past decade that undergraduate physics degrees earned by women is at 20%, and BS degrees earned by minorities was at 18%. The goal is to meet or exceed these numbers.

5. Assessment of Scientific Writing: We have identified two upper division courses that require significant writing in the form of laboratory reports, Phys 104 (Experimental Techniques in Modern Physics) and Phys 110 (Physical Optics), with Phys 104 offered every Spring and Phys 110 is offered every Fall. The assessment procedure is as follows:

   a.) The instructor of 104 of 110 will select at the end of the semester one lab report from each student enrolled, and this lab report shall reflect the best work of the student (e.g. a report that earned the highest grade for the semester). Typical enrollments for these two courses are 8 to 20 students.

   b.) The collected laboratory reports will be scored with an appropriate rubric by a writing committee of not less than 3 physics faculty, and the committee will not include the instructor for the course from which the lab reports were collected.

   c.) The chair if the writing committee will collect the scored rubrics and provide analysis for the departmental assessment committee. The rubric uses the following scale: 1 (deficient), 2 (limited), 3 (competent), 4 (strong) and 5 (outstanding). Our benchmark is that the aggregate score averaged over the 28 items on the rubric should be above 3.0 (competent) for all students.

6. Direct measures of the rest of the essential skills 8) through 11) are under development. Please see the timeline for implementation for details concerning our ongoing effort to enhance our SOAP.

B. Indirect Measures

1. A survey of alumni will be conducted every five years to obtain data concerning each graduate's career path and any further achievements towards educations goals. Alumni will also be solicited for feedback on the quality and adequacy of their physics education at Fresno State.

2. Incoming physics majors, both freshman and transfer students, will be interviewed by the undergraduate advisor during their first consultation. The physics department has

developed a number of strategies to recruit students into our program, most prominently our Phys 168s course and associated program, Physics Pedagogy and Outreach, which targets students of all ages throughout the valley. This interview will collect and record information about how each student became aware of our program, and why they decided to be at Fresno State.

V. Student Learning Outcomes X Assessment Methods Matrix

	Physics BS Outcomes v. Assessment Methods Matrix Outcomes	Physics MFT	Capstone: Phys 171 Analytical Methods course with assessment exams	Embedded Exam Questions Phys 2AB Phys 4AB	Assement of Scientific Writing	Review of enrollment and university data	Advisor survey of incoming majors	Alumni Survey
1	Essential Core Physics: Classical Mechanics	x	x	x				
2	Essential Core Physics: Electricity & Magnetism	x	x	x				
3	Essential Core Physics: Thermodynamics & Statistical Mechanics	x	x	x				
4	Essential Core Physics: Optics	x	x	x				
5	Essential Core Physics: Special Relativity	x	x					
6	Essential Core Physics: Quantum Mechanics	x	x					
7	Exposure to fields of Physics: Astro/ Condensed Matter/ high energy/ radiation/ health physics	x						
8	Skills: Math B: Algebra/ Trigonometry I: Calculus/ Applied Analysis A: Complex Analysis	x	x	x				
9	Skills: Information Literacy Peer evaluation							x
10	Skills: Presentation Scientific Writing Scientific Presentation		x		x			x
11	Skills: Experimental Methods Statistical Analysis Error Analysis							x
12	Skills: Computing Computer Programming Computational Techniques							x
13	Skills: Advanced Laboratory Electronics Machine Shop Techniques							x
14	Recruitment, Retention. Graduation					x	x	

VI. Timeline for Implementation of Assessment Methods and Summary Evaluations

Assessment frequency: **Yearly**

The following assessment methods will be carried out on an annual basis:
At least two of the Direct Measures 1 though 5
Indirect Measure 2

Assessment Frequency: **Every five years**
The following assessment method will be carried out every 5-year period:
Indirect Measure 1

Schedule for development of additional measurement methods
AY 2013-2014: Essential Core Skills 10 and 12
AY 2014-2015: Essential Core Skills 11 and 13
AY 2015-2016: Essential Core Skill 9

VII. Process for Closing the Loop

The Department of Physics, will convene on an annual basis an Undergraduate Committee responsible for monitoring the undergraduate program, suggesting curriculum and other catalog changes, and reviewing changes proposed by others. The Chair of this committee is also the Assessment Coordinator.

The members of the Undergraduate Committee are responsible for designing and carrying out assessment activities with the help of the entire faculty as needed. The Undergraduate Committee also analyzes the resulting data and suggests changes to the program as necessary. Assessment data and suggested program changes are presented to the entire faculty during a regular faculty meeting, and the entire faculty will decide whether to implement any changes (and they are also free to suggest their own changes).