UNIVERSITY OF SAN FRANCISCO | College of Arts and Sciences

ASSESSMENT REPORT
FOR ACADEMIC YEAR 2017-2018

PHYSICS MAJOR, PHYSICS MINOR & ASTROPHYSICS MINOR

Department of Physics & Astronomy

University of San Francisco

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1 LOGISTICS & PROGRAM LEARNING OUTCOMES

1.1 PHYSICS & ASTRONOMY CONTACT PERSON (FACULTY ASSESSMENT COORDINATOR).

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1.2 PHYSICS & ASTRONOMY DEPARTMENT MISSION STATEMENT

No changes were made to the program mission statement since the last assessment cycle in October 2017.

> The mission of the Physics & Astronomy Department is to provide our students with the fundamental knowledge and the practical tools of a rigorous physics education that will help them be players and leaders in shaping a more humane world. The Physics program is implemented via a comprehensive coverage of experimental, theoretical, and computational physics, and by combining coursework together with on- and off-campus research and exposure to cutting-edge equipment and laboratory techniques. This rigorous training prepares students for careers and/or graduate studies in any discipline within fundamental or applied science (physics, astronomy, mathematics, chemistry, biology, etc); in any of the standard engineering fields; in education; in medicine and related disciplines; and many other fields, such as law, financial analysis, or positions in the high-technology sector of the global economy.

1.3 PHYSICS MAJOR & PHYSICS MINOR LEARNING OUTCOMES (PLOs)

No changes were made to the program learning outcomes (PLOs) since the last assessment cycle in October 2017.

1. - **PLO 1 (a).**
   Demonstrate mastery of the core concepts and general principles of physics.
   - **PLO 1 (b).**
   Demonstrate competent knowledge of the specific concepts, principles, and problems of each of the basic subfields and some areas of application in physics.

2. • **PLO 2.**

   Conduct experiments for a comparison with physical models and theories, and *examine* the results with the statistical methods of error analysis.

3. • **PLO 3.**

   Formulate, solve, and interpret problems by the use of physical principles, via mathematical and computational techniques.

1.4 ASTROPHYSICS MINOR LEARNING OUTCOMES (PLOs)

No changes were made to the program learning outcomes (PLOs) since the last assessment cycle in October 2017.

These PLOs for the Astrophysics Minor are essentially identical to the ones for the Physics Major and Minor programs, with the inclusion of some astrophysical content. Thus, assessment is effectively equivalent for all the 3 programs.

1. • **PLO 1 (a).**

   Demonstrate mastery of the core concepts and general principles of physics.

   • **PLO 1 (b).**

   Demonstrate competent knowledge of the specific concepts, principles, and problems of the main *astrophysics* areas and applications.

2. • **PLO 2.**

   Conduct experiments for a comparison with physical and *astrophysical* models and theories, and *examine* the results with the statistical methods of error analysis.

3. • **PLO 3.**

   Formulate, solve, and interpret problems by the use of physical and *astrophysical* principles, via mathematical and computational techniques.

1.5 PROGRAM LEARNING OUTCOME(S) ASSESSED FOR THE ACADEMIC YEAR 2017-2018

The Program Learning Outcome assessed for this one-year period involves one of three major learning goals relevant to physics and astronomy: application of physical principles to novel

situations both in the classroom and in research settings, through critical thinking, problem solving, mathematical and computer modeling, and laboratory experimentation.

- **PLO 3.**
  Formulate, solve, and interpret problems by the use of physical principles, via mathematical and computational techniques.

2 METHODOLOGY

2.1 Methodology.

Assessment activities in the Physics Major/Minor and Astrophysics Minor programs were undertaken as planned during the AY 2017-2018, following multiyear departmental guidelines.

2.1.1 Generic Assessment Procedures.

The program learning outcome above was assessed in the following courses: PHYS 110 (General Physics I), PHYS 210 (General Physics II), and PHYS 341 (Upper-Division Lab). The whole process was organized at the departmental level with cooperation of all the instructors involved, and according to our multiyear departmental guidelines. The data were stored electronically. The faculty members teaching these courses were responsible for the required data collection: Brandon Brown (PHYS 312), Horacio Camblong (PHYS 330), Seth Foreman (PHYS 340), Milka Nikolic (PHYS 110), and Aparna Venkatesan (PHYS 240). And the team work was coordinated by Horacio Camblong.

3 Assessment Procedures and Data Analysis.

The relevant learning outcomes were assessed by means of direct measures consisting of embedded questions (problems) and/or multiple-choice exams. All of the above consist of problems formulated mathematically that provide the essential ingredients for an effective PLO 3 assessment.

- Exam-embedded questions/problems (on the final exams) were used for Learning Outcome 3 in PHYS 110, 240, 312, and PHYS 340.

These were selected as representative, standard problems with significant mathematical content. These are problems that combine fundamental physics knowledge with its formulation and interpretation using physical principles leading to its solution via mathematical and computational techniques.

In each case, the chosen material is central to the content of the given courses,

- In addition, the whole set of multiple-choice questions on the final exam for PHYS 330 was assessed. These questions typically involve significant mathematical content and problem-solving skills, similar to the ETS Physics Major Field Test and/or GRE Physics Test.

The learning outcomes were gauged with a ternary metric system: above average, average (benchmark standard), and below average. It should be noticed that these are meant to be categories defined by comparison with the benchmark standard, regardless of the statistical course average for any given class section. This classification refers to the level of mastery of the skill and knowledge set involved in the learning outcome. "Average" is meant to represent a benchmark standard set up to correspond to an overall mastery of the outcome (involving most parts of the assessed problem or question), but allowing for errors or omissions whose correction would otherwise lead to considerable performance improvement. The "above average" mark reflects almost complete command of the relevant skill and knowledge set. The "below average" mark does not necessarily imply failure to perform on the given outcome, but reflects incomplete mastery of the relevant skill and knowledge set, leading to significant gaps in understanding and/or problem-solving outcomes.

For all assessed courses in this cycle, student performance was evaluated on the basis of a representative sample of embedded questions or GRE-style multiple choice questions (as described above). The data were collected and graded by the faculty teaching the courses, and subsequently discussed at two Physics & Astronomy Department meetings.

4 RESULTS & MAJOR FINDINGS

The results for the courses selected for assessment are summarized below:

- PHYS 110 (General Physics I), Fall 2017: A representative embedded problem was selected and graded, for a total of 18 students. The selected problem is a typical multi-step classical-mechanics problem for General Physics I, involving a set of fundamental

concepts (Newton's laws, energy, oscillatory motion) of introductory Newtonian mechanics.

Number of Students: 62;
Above Average: 48 students (77%); Average: 10 students (16%); Below Average: 4 students (7%).

- PHYS 240 (Modern Physics), Fall 2017: Two representative embedded problems were selected and graded, for a total of 13 students. The selected topics are central to the content of Modern Physics, including relativity and quantum physics. The problems mostly covered electronic and nuclear properties with quantum-mechanical behavior (atomic levels, tunneling, and relativistic nuclear binding energies)

  Number of Students: 13;
  Above Average: 11 students (85%); Average: 2 students (15%); Below Average: 0 students (0%).

- PHYS 312 (Statistical & Thermal Physics), Spring 2018: Two representative embedded problems were selected and graded, for a total of 13 students. The selected problems covered thermal properties of gases, partition functions, and relevant thermodynamic energy calculations (all central to the content of Statistical & Thermal Physics).

  Number of Students: 13;
  Above Average: 11 students (85%); Average: 2 students (15%); Below Average: 0 students (0%).

- PHYS 330 (Quantum Mechanics), Fall 2017: A multiple-choice final exam was administered for 9 students. All the problems were at or above the level of a Physics GRE exam, and their content is typical of Quantum Mechanics, covering the whole range of topics of this course.

  Number of Students: 9;
  Above Average: 6 students (67%); Average: 3 students (33%); Below Average: 0 students (0%).

- PHYS 340 (Optics), Fall 2017: Two representative embedded problems were selected and graded, for a total of 12 students.

The selected topics are central to the content of Optics, including classical (geometrical and physical) and quantum properties of light and electromagnetic waves.

Number of Students: 12;
Above Average: 10 students (83%); Average: 2 students (17%); Below Average: 0 students (0%).

5 CLOSING THE LOOP

5.1 Follow-Up Discussion and Decision-Making.

Two Physics & Astronomy faculty meetings addressed various aspects of assessment (February 6th and September 26th, 2018). The discussions included a review of our official assessment plan, the learning outcomes, and the results of this assessment cycle. In addition, follow-up discussions are planned for the ongoing 2018-19 Physics Department meetings.

The following conclusions were drawn:

- All in all, the results of the assessment activities show a relatively high level of performance by most students, with an excellent command of analytical skills and problem-solving within physics, as relevant for PLO 3—both for lower- and upper-division level physics courses.

- In the latest 3-Year Assessment Plan (2015–2018), targeted curricular questions were proposed for each year of this 3-year cycle. We specifically addressed the question:

  – Learning Outcome 3: Are physics majors proficient in problem-solving techniques for "complex problems" (involving multi-step tasks)?

  From the assessment of this learning outcome, we found that students, both lower- and upper-division, are learning the basic tools to solve a variety of problems over a broad range of physics fields, and with all degrees of complexity.

- The External Program of the Academic Program Review conducted in Spring 2018 praised our assessment program as follows.

  > "The overall P&A assessment program is well designed and appears mature. The probes are robust and appropriate, and the reports provided by the department are easy to interpret and contain useful information about student

performance. P&A does very good work in many areas and students are a dominant focus in much of that work. ... The assessment program for P&A is more than sufficient, and it is managed extremely well."

This is consistent with our own self-evaluation.

- No significant curricular changes are planned/required for AY 2018-19.