Physics Bachelor of Science and Bachelor of Arts

Assessment Report 2022-2023

I. SUMMARY OF ASSESSMENT

A. Program Learning Outcomes (PLO)

Physics B.S. Program Learning Objectives: (words in bold highlight difference between BS/BA)

1. *Fundamental Principles: **Explain** the fundamental principles of Physics and be able to apply these core ideas to analyze physical processes (ILO 2: Communication)*
2. *Problem Solving: **Apply** quantitative reasoning and critical thinking to solve complex problems, both theoretical and experimental in nature; (ILO 1: Thinking and Reasoning)*
3. *Technical Skills: **Independently** learn new technical subjects and skills; (ILO 1: Thinking and Reasoning)*
4. *Conduct and Analyze Experiments: **Design**, construct, assess and troubleshoot experiments, quantitatively analyze the results using appropriate statistical procedures and tests of systematic errors, and draw meaningful conclusions; (ILO 1: Thinking and Reasoning)*
5. *Communication: Effectively discuss scientific ideas, both theoretical and experimental, to diverse audiences through written and oral presentations, both formal and informal; (ILO 2: Communication)*
6. *Teamwork and Collaboration: Work professionally, effectively, and inclusively as a member of diverse collaborations to solve problems. (ILO 3: Diversity & ILO 4: Collaboration)*

Physics B.A. Program Learning Objectives:

1. *Fundamental Principles: Describe the fundamental principles of Physics and be able to apply these core ideas to analyze physical processes; (ILO 1: Thinking and Reasoning)*
2. *Problem Solving: Use quantitative reasoning and critical thinking to solve problems, both theoretical and experimental in nature; (ILO 1: Thinking and Reasoning)*
3. *Technical Skills: Learn new technical subjects and skills; (ILO 1: Thinking and Reasoning)*
4. *Conduct and Analyze Experiments: Construct, assess and troubleshoot experiments, quantitatively analyze the results using appropriate statistical procedures and tests of systematic errors, and draw meaningful conclusions; (ILO 1: Thinking and Reasoning)*
5. *Communication: Effectively explain scientific ideas, both theoretical and experimental, to diverse audiences through written and oral presentations, both formal and informal; (ILO 2: Communication)*
6. *Teamwork and Collaboration: Work professionally, effectively, and inclusively as a member of diverse collaborations to solve problems. (ILO 3: Diversity & ILO 4: Collaboration)*

The CSUEB Institutional Learning Outcome (ILO) numbers referred to above correspond to the following:

(1) **Thinking and Reasoning:** think critically and creatively and apply analytical and quantitative reasoning to address complex challenges and everyday problems.

(2) **Communication:** communicate ideas, perspectives, and values clearly and persuasively while listening openly to others.

(3) **Diversity:** apply knowledge of diversity and multicultural competencies to promote equity and social justice in our communities.

(4) **Collaboration**: work collaboratively and respectfully as members and leaders of diverse teams and communities.

(5) **Sustainability**: act responsibly and sustainably at local, national, and global levels.

B. Summary of Assessment Process

Instrument(s):

We utilize standardized tests (Force Concept Inventory (FCI), Brief Electricity and Magnetism Assessment (BEMA) and an ETS (Educational Testing Service) Major Field Tests Physics Exam) to assess PLOs 1 and 2. These exams have multiple choice questions on introductory and advanced physics concepts, and are accepted as standard measures of content within the physics field. For example, the FCI is designed to assess student understanding of the most basic concepts in Newtonian physics. This forced-choice instrument has 30 questions and looks at six areas of understanding: kinematics, Newton's First, Second, and Third Laws, the superposition principle, and types of forces (such as gravitation, friction). Each question offers only one correct Newtonian solution, with common-sense distractors (incorrect possible answers) that are based upon student's misconceptions about that topic, gained from interviews. The BEMA assesses what students know about the most basic and central concepts of Electricity and Magnetism. It is comprehensive, covering topics from the Coulomb force law to magnetic induction, but omitting radiation because it is very common for the introductory course not to get that far. It has been used by various instructors in various settings and has been judged an appropriate assessment of introductory E&M by physicists experienced in teaching E&M at various levels. It is not aimed at any particular curriculum but contains only those elements common to all calculus-based introductory courses.

In order to assess PLOs 3 and 5 we have utilized writing and oral presentation rubrics that have been created by CSU East Bay Physics faculty and have been adopted as standard within the Physics Department. The Rubrics allow a scaling of specific measures of quality written problem solutions, written research papers and presentations. The rubrics, each of which is provided to the students as part of the introduction to the assignment, were developed by the physics faculty independently, through a collaborative comparison of assessment criteria utilized within their own grading policies. Specifically for PLO3, assessment of learning new technological skills is gauged using grades on the skills taught and the grade on the final project, in which students are required to use these skills to solve a problem.

Sampling Procedure: The standardized testing assessments are given to the students in class. The rubric assessments are applied to the student final presentations and research papers at the end of the term. It is important to note that the students have access to these rubrics ahead of the assignment deadline, but do not have any access to the standardized tests in any form aside from when given during the class meeting.

Sample Characteristics: The standardized testing sample is a specific percentage of correct answers at the end of the term as compared to correct answers at the beginning of the term. The overall improvement is used as an assessment of the effectiveness of the teaching methodologies utilized to communicate the specific PLOs.

Data Collection: The data is collected on scantron or in a google form for the standardized tests, and recorded in rubrics.

Data Analysis: An assessment of whether students have mastered the PLOs is made based on the results of the rubrics. Comparison of improvements from one year to the next year is also reviewed.

C. Summary of Assessment Results

PLO Assessed: PLO 3 Technical skills, assessed in Physics 381, Advanced Lab: Computational Physics using the grades on 4 "New Skills" modules and the final assignment. For the final assigment students were required to solve a problem using a python program and were encouraged to evaluate the result using statistical analysis.

Main Findings: The majority of students showed successful mastery of the new skills and are able to use programing and/or statistical skills learned in this course to complete a final project. Out of 13 students, 10 passed the mastery of four main new skills with 82% or higher, and 8 out of 13 students passed the final project with an 82% or higher.

Next Step(s) for Closing the Loop: *(recommendations to address findings, how & when)* Results of this assessment will be shared at the departmental meeting and will be passed to the next instructor for this course. BS students are required to take two additional semesters of advanced lab, after Phys 381. They are expected to use the skills gained in this course, Phys 381, to complete their other advanced lab course projects.

Other Reflections: In the future more emphasis will be placed on best practices for taking existing code from the internet. Online resources are a valuable tool in programing, and students are allowed to look for help online. Assignments were designed specifically so that solutions could not be directly taken from existing code, but any amount of copying of code poses the risk that students miss fully understanding the code's logic. Future assignments will concentrate more on asking students to articulate the logic used in their programs and statistical analysis.

Recommendations for Program Improvement: Departmental meetings at the start of each semester should review assessments from previous semesters. If students are not meeting specific PLOs, more focus can be made to emphasize those skills during the semester. The department assessment coordinator has reviewed the university report on last year's assessment of the Teamwork and Collaboration ILO and will share suggestions gained from the report at department meetings.

D. Assessment Plan for 2023/2024 Academic Year:

The department 5-year assessment plan lists PLO2 as the focus of assessment in the 2023-2024 academic year. This will be assessed in Analytic Mechanics (Physics 330). This is described in the table below.

Year 4: 2023-2024	
1. *Which PLO(s) to assess*	PLO 2
2. *Is it aligned to an ILO?*	Yes
3. *If yes, list ILO.*	ILO 1 Thinking and Reasoning
4. *Course name and number*	PHYS 330 Analytic Mechanics
5. *SLO from course*	Students will be able to develop models and apply advanced mathematical techniques, such as vector calculus differential equations, and Fourier series, to solve physics problems. Students will be able to identify an appropriate coordinate system, and analyze physics problems in several different coordinate systems. Students will be able to explain the behaviors of physical systems that are undergoing oscillations (including coupled oscillators), under the influence of a central force, in a non-inertial reference frame, or undergoing rotation.
6. *Assessment activity*	Specific problem set solved by students (same set each year)
7. *Assessment Instrument*	Rubric used to score problems
8. *How data will be reported*	Qualitative
9. *Responsible person(s)*	Dr. Kathryn Grimm (Department assessment coordinator)
10. *Time (which semester(s))*	Fall 2023
11. *Ways of closing the loop*	Qualitative results are included in assessment report for annual department report, comparing scores according to rubric.

Additionally, as part of the university-wide assessment program in the 2023-2024 academic year, the physics department's advanced lab course, Physics 480, will be used to assess the Written Communication ILO for the College of Science. This will also be helpful for department assessment because the department's Communication PLO was not assessed during the pandemic. The students' final lab reports will be used for the assessment. The CSUEB Revised ILO Written Communication Rubric, Approved by Academic Senate 10-11-22, will be shared with the students and then used to evaluate their reports. The lab report will need to be at least 750 words and will need to include Introduction+background, methods, results, discussion sections.

Graduating seniors will also be given the ETS Major Field Tests Physics Exam, assessing PLO1 and PLO2.