II. **SUMMARY OF ASSESSMENT** *(suggested length of 1-2 pages)*

A. **Program Learning Outcomes (PLO)**

List all your PLO in this box. Indicate for each PLO its alignment with one or more institutional learning outcomes (ILO). For example: "PLO 1. Apply advanced computer science theory to computation problems (ILO 2 & 6)."

The CSUEB Institutional Learning Outcome 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

C. **Summary of Assessment Process**

Summarize your assessment process briefly using the following sub-headings.

Instrument(s): *(include if new or old instrument, how developed, description of content)*
Sampling Procedure:
Sample Characteristics:
Data Collection: *(include when, who, and how collected)*
Data Analysis:

PLO A and B

- **Instrument(s):** Standardized tests (FCI/BEMA/GRE) and Homework Sets
- **Sampling Procedure:** Pre and post course completion of standardized tests
- **Sample Characteristics:** Limited sample due to small class size
- **Data Collection:** Physics 1001, 4001, 2004, 4002, 4003, and 4950 (Professors Furniss and Smith in Fall 2016/Winter 2017 and Spring 2017)
- **Data Analysis:** Percentage correct comparison of pre/post course tests, and comparison of raw homework score graded according to consistent rubric

PLO D

- **Instrument(s): Measuring "g" in lab**
- **Sampling Procedure:** middle of quarter in both lower and upper division major courses
- **Sample Characteristics:** Limited sample due to small class size
- **Data Collection:** Physics 1001, 2004 (Professors Kimball and Smith in Fall 2016/Winter 2017 and Spring 2017)
- **Data Analysis:** Labs graded according to consistent rubric and lower and upper division methods compared

D. **Summary of Assessment Results**

Summarize your assessment results briefly using the following sub-headings.

Main Findings:

RESULTS

Pre- and post-instruction tests/surveys: (SLOs: A,B,C for both BA and BS)

These exams give us a snapshot of the students' working knowledge in physics, conceptual

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A subset of the exams are given before and after instruction (at the beginning of the course and at the conclusion of the course) to provide a quantitative measure of student improvement during the course. The gain is calculated as the difference between pre- and post-instruction scores divided by the number of incorrect answers on the pre-test.

1. <u>Physics 1001 (Force Concept Inventory, FCI, a nationally normed assessment tool)</u>

The Force Concept Inventory (FCI) instrument 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 basb k. M T m o n c e p t i o n s a b o u t t h i s topic, gained from interviews.

	2016	2015	2014	2013	2012	2011
Gain between post- and pre-test:		45	56	27	30	31
Overall post-test score:		59	66	47	52	48

Studies have shown that in a traditional, well-taught lecture class, the FCI gain is measured to be around 20% while in a class employing a wide range of active engagement and peer-to-peer instruction techniques, the FCI gain can approach close to 50%.

For the overall post-test FCI score, the generally acknowledged threshold for understanding the material is an average of about 60%.

In 2015, the General Physics students were able to achieve an FCI gain of 45% and a post-test average 59%, indicating successful learning compared to national averages. Some relevant factors that have persisted between the relatively successful 2014 and 2015 versions of the course may have been the frequent use of peer-to-peer instruction activities (such as think-pair-share), implementation of weekly quizzes and reviews, and a reduction of material covered in order to focus more classroom time on core subjects.

2. <u>Physics 1003 (Brief E&M Assessment, BEMA, a nationally normed assessment tool)</u>

The Brief Electricity and Magnetism Assessment (BEMA) assesses what students know about the most basic and central concepts of the calculus-basb ntroductory E&M course. It is comprb ensive, covering topicsrom 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 usb by various instructors in various settings and has been judged an appropriate and fair 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-basb introductory courses.

2016 2015

Gain between post- and pre-test:	20	22	14

Subject area breakdown:

Subject	2016 results	2015 results	2014 results	2013 results	National Average
Classical mechanics:	--	27	29		

6. Comparison of Physics 2004 (2nd year) to Physics 4950 (4th year) results from 2015:

Subject	Physics 2004 (avg)	Physics 4950 (avg)
Classical mechanics:	27	22
Electromagnetism:	15	24
Optics:	28	18
Thermodynamics:	19	18
Quantum:	22	18
Special relativity:	23	5
Laboratory methods:	22	36
Special topics:	24	20

These data are from 2015Of concern, here too we did not observe significant gains between the lower and upper division performance.

Recommendations for Program Improvement: *(changes in course content, course sequence, student advising)*

(1) Basic physics knowledge taught in the General Physics sequence (PHYS 1001-1003, PHYS 2004) would continue to be emphasized throughout the upper-division curriculum by additional "basic" problems added on to homework assignments to give students extra practice at the basic concepts. This will be done, to as great a degree as possible, without sacrificing the advanced instruction that is part of the present curriculum.

(2) Weekly quizzes without notes and more in-class, peer-to-peer activities are a useful tool for reinforcing basic knowledge and problem-solving skills that can be used in upper division as well as lower division courses.

(3) We will continue to increase use of in-class presentations of problem solutions and peer-to-peer learning strategies in upper division classes to further emphasize and practice accessing the fund of physics knowledge.

(4) We will emphasize throughout lower and upper division the "Prepare-Solve-Assess" strategy of problem solving.

(5) We will expand use of peer evaluation to help teach students how to evaluate their own work.

Next Step(s) for Closing the Loop:

Other Reflections:

A Department goal is for our students to achieve at least the national average on all nationally normed exams. (This goal, in the case of the GRE exam, may be aspirational as we are comparing all our students to a subset of students who applied to graduate school in Physics.)

There are certainly some bright spots as we have achieved or have come close to achieving that goal for the Physics 1000 series, indicating that our General Physics instruction is successful and our teaching strategies are working.

However, the performance of our upper division students falls short of our goals, and in fact the performance of the 3rd and 4th-year students shows little improvement compared to the 1st and 2nd-year students. On the other hand, one should be careful about reading too much into the results as relatively few students (around 10) have taken the exams each year.

The Department held many meetings of the tenure-track faculty throughout the year to "close the loop" and strategize on what improvements might be made to curriculum and teaching methods.

It was the continued opinion of the faculty that based on these results, physics majors overall were suffering from a lack of a fund of knowledge about physics and had significant weaknesses in conceptual understanding and problem solving skills that needed to be addressed.

E. **Assessment Plans for Next Year**

Summarize your assessment plans for the next year, including the PLO(s) you plan to assess, any revisions to the program assessment plan presented in your last five-year plan self-study, and any other relevant information.

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Fall 2018

Physics 135 Lecture - pre and post-instruction FCI
Physics 137 Lecture - subset of questions from GRE-9277
Physics 137 Lecture – Problem Set assessment (4th problem set in 2014)
Physics 135 Lab – "measure g" experiment with presentation and notebook write-up assessment
Physics 137 Lab – "measure g" experiment with presentation and notebook write-up assessment

Physics 3302 QM II – Problem Set assessment (1st problem set in W 2014)

Spring 2019

Physics 136 pre and post-instruction BEMA
Physics 230 – complete GRE-0177