Annual Assessment Report

Department: Physics and Engineering
Academic Year: 2020–2021
Date of Submission: August 31, 2021
Department Chair: Bob Haring-Kaye

I. Response to the previous year PRC's recommendations

Item: The PRC is pleased to see the thoughtful responses to the committee's previous recommendations. When comparing the Engineering Program with peer institutions, it may be beneficial to look at the following directory of Engineering Programs at Christian Colleges provided by the Christian Engineering Society, if you have not done so already.	**Response:** Thank you! This is very helpful information.
Item: The committee is pleased to see that the Physics Department is placing a strong emphasis on hiring candidates who clearly and wholeheartedly support the liberal arts mission of the college. As you move forward, the committee would encourage you to consider how you are measuring whether or not a candidate is a good fit for the liberal arts context. What consistent tools, questions, or surveys are you using with candidates to ensure fairness across the hiring process?	**Response:** During each interview, we used a common set of questions that were asked of each candidate, with a given question usually asked by the same committee member. We made sure to ask a broad range of questions that probe a candidate's fit within our Christian liberal arts identity. Each candidate also had the opportunity to interact with several administrators and students, and their feedback was an important part of the evaluation process.
Item: The Physics Department has a strong history of both collegiality and excellent student rapport. Amidst the shift in faculty members as new hires are brought on, we encourage you to think about: 1) What values would the department like to carry	**Response:** Providing a strong sense of community and belonging among the faculty and students in our department is an important core value that we plan to maintain. This will likely be especially important after a year of stringent social restrictions due to the pandemic. We also want to promote a community where everyone is encouraged to pray with and for each other. In order to help foster these traits, we

on? 2) What general and specific processes will be implemented to ensure continuity of these values through a transfer in leadership?	plan to launch a weekly PEP (Physics and Engineering Phellowship) rally among the departmental faculty and students this academic year where we can have casual conversation, play games, and share prayer requests. Dan Jensen (Director of the Engineering Program) is also coordinating a project with our administrative assistant where pictures of our students, their major, and some of their interests will be posted in the Physics and Engineering wing of Winter Hall. In terms of faculty collegiality and support, Dan Jensen and Bob Haring-Kaye (the incoming Department Chair) plan to provide strong support to all of our departmental colleagues, including mentoring our incoming faculty. In fact, we have already had multiple phone, email, and Zoom conversations with the new faculty members about various issues related to their transition to Westmont and the Santa Barbara community. Thankfully, both Michael Sommermann and Ken Kihlstrom are willing and able to help us with these and other forthcoming issues related to the leadership transition in our department.
Notes:	

II A. Program Learning Outcome (PLO) assessment

If your department participated in the ILO assessment you may use this section to report on your student learning in relation to the assessed ILO. The assessment data can be requested from the Dean of Curriculum and Educational Effectiveness.

Program Learning Outcome	**Critical Thinking**
Who is in Charge /Involved?	Department Chair
Direct Assessment Methods	Major Field Test (MFT) in Physics
Indirect Assessment Methods	

Major Findings	The MFT in Physics was administered to eight (*N* = 8) Physics and Engineering Physics majors in April 2021. The average scores in the subcategories of Introductory Physics and Advanced Physics, as well as the Overall Scaled Score and Percentile Ranking among national scores collected within a recent time period, are compared with those of the same majors in 2019 (*N* = 5), 2018 (*N* = 4), 2017 (*N* = 5), and 2016 (*N* = 5) in a histogram chart included with this report (see Appendix A). (The MFT was unavailable in 2020 due to the pandemic.) The results in each assessment category for the 2021 cohort are very similar to the others obtained within the past five years, with the exception of the 2018 cohort (which also has the smallest number of students among the comparison groups). In fact, each of the indicated average scores in the histogram for the 2021, 2019, 2017, and 2016 cohorts generally agree with each other within their respective statistical uncertainties.
Closing the Loop Activities	We plan to revisit the departmental student learning objectives and curricular map once the department is fully restaffed by (hopefully) the start of the 2022–23 academic year. Since the MFT exam is similar in content to the Physics GRE subject test, which some of our students take as part of their graduate school application, perhaps our students could benefit from a targeted review of the exam material and a related discussion of test-taking strategies in the fall of their senior year. This could potentially be integrated into either our existing senior seminar course or a new senior research capstone experience for our majors.
Collaboration and Communication The assessment data are shared among department faculty and discussions about closing the loop activities will be ongoing.	
Program Learning Outcome	**Skills: Oral/Written**
Who is in Charge /Involved?	Professor of Senior Seminar course (PHY–195), professor of PHY–022 (General Physics Lab I) and PHY–024 (General Physics Lab II)
Direct Assessment Methods	Science paper in PHY–195, individual abstracts and Discussion sections (primarily incorporating experimental error analysis, interpretations, and conclusions) in the final lab reports submitted in PHY–022 and PHY–024. In anticipation of the laboratory writing and experimental skills assessment next year (in accordance with our departmental assessment plan), a new laboratory assessment rubric was developed this year that follows the guidelines and structure of the Association of American Colleges and Universities (AAC&U) VALUE rubrics (see Appendix B). This rubric will allow a robust assessment of both writing and experimental skills across our entire laboratory curriculum. This year, abstracts and Discussion sections for each student in PHY–022 and PHY–024 were evaluated using assessment dimensions (rows) 1 and 4 of the new rubric.
Indirect Assessment Methods	

Major Findings	PHY–195: The science papers of six graduating senior majors were evaluated according to the corresponding assessment rubric (see Appendix C). The overall average score of 19.3 ± 0.5 indicates a high degree of proficiency (the maximum score is 20) with a small variance among the students. PHY–022 and 024: The new rubric described above was used to assess the individual abstract and Discussion sections of 26 (21) students in PHY–022 (PHY–024) during the Fall 2020 (Spring 2021) semester. The overall average scores in the "Understanding the Purpose of the Experiment" and "Interpretation of the Results" assessment dimensions for PHY–022 were 2.4 ± 1.0 and 2.3 ± 1.2, respectively. The corresponding scores in PHY–024 were 2.3 ± 1.1 and 2.4 ± 1.1, respectively. Referring to the rubric, these scores indicate a beginning "milestone" development in understanding and expressing the "big picture" of the experiment under study, perhaps not surprising given the introductory nature of the lab experience.
Closing the Loop Activities	We plan to use the same laboratory assessment rubric in PHY–026 (Modern Physics Laboratory) during the Spring 2022 semester to track longitudinal development in sophistication when writing abstracts in Discussion sections for some of the same students who were assessed in PHY–022 and PHY–024 this past academic year. This same rubric will also be used to assess laboratory skills (mostly data acquisition, analysis, and interpretation) across our lab curriculum this upcoming year. Very likely, however, an upper-level laboratory experience and/or senior research thesis will be required to reach the "capstone" level of understanding shown in the rubric. In any case, we will use the results of the writing and laboratory assessments to reevaluate how our laboratory curriculum helps fulfill our student learning objectives.
Collaboration and Communication The assessment data are shared among department faculty and discussions about closing the loop activities will be ongoing.	

or/and

II B. Key Questions

Key Question	The key question for the 2020–2021 academic year, as stated in our multi-year departmental assessment plan, was "Can we hire engineering profs?"
Who is in Charge/Involved?	All departmental faculty as well as Rick Ifland (Acting Provost), Eileen McQuade (Associate Dean of the Faculty and chair of search committee), Adam Goodworth (search committee member from the Dept. of Kinesiology), Nathan Huff (search committee member from the Dept. of Art), and Amanda Silberstein (search committee member from the Dept. of Chemistry).
Direct Assessment Methods	Results of the hiring process

Indirect Assessment Methods	
Major Findings	Will Allison (Westmont Class of 2013) was hired as the Physics and Engineering Lab Coordinator this past April, filling a crucial role in our department. He will be primarily responsible for operating and maintaining the machine shop as well as teaching lab-based courses in physics and engineering. Dr. Dan Jensen officially joined the faculty this July as the Director of the Engineering Program. Two other engineers (Dr. Johan Estrada and Dr. Doug Fontes) were hired to join the faculty this upcoming academic year, although they will not be able to start until January 2022 due to delays in obtaining their work visas. Thus come January we will fill the current staffing needs of the engineering program (3 full-time faculty and a lab coordinator). There are still faculty staffing needs in the physics program, however (see Sec. IV).
Recommendations	As stated in last year's annual assessment report, upholding the liberal arts nature of the program is important. The new faculty appear to understand this emphasis and seem committed to its implementation. In addition, fundraising remains a critical component so we don't burden the college operating budget (see Sec. III).
Collaboration and Communication: All members of the engineering program are involved in ongoing discussions.	

III. Follow-ups

Program Learning Outcome or Key Question	1. Building the engineering program, including the addition of faculty members 2. Fundraising
Who was involved in implementation?	All department members as well as Rick Ifland, Eileen McQuade, Reed Sheard, and search committee members (see Sec. II B).
What was decided or addressed?	1. In the search for new faculty, the search committee included strong voices for the liberal arts and each candidate was questioned on their views and understanding of the liberal arts. Their responses played an important role in the committee's evaluation. Offers were made only if the candidate showed a clear passion for an engineering program grounded in the liberal arts. 2. The ongoing fundraising efforts specifically target capital equipment, facility needs, endowment for staffing, and ongoing operating expenses. We are also looking into the possibility of fundraising to support the (increasingly expensive) housing needs of the new faculty.

How were the recommendations implemented?	1. See previous statement. 2. Dan Jensen has been collaborating with Reed Sheard and his staff on this front, securing grants from the Fletcher Jones Foundation ($475,000), MERICOS Foundation ($300,000), and the Miller Foundation (grant amount TBD).
Collaboration and Communication: All departmental faculty we involved and there were ongoing discussions with Eileen, Reed, Rick, and the search committee members.	

IV. Other assessment or Key Questions related projects

Project	Hiring new physics faculty
Who is in Charge /Involved?	Search committee including all departmental faculty as well as Michael Everest (Chemistry) and Carolyn Mitten (Education).
Major Findings	We were successful in hiring Dr. Ben Carlson, who will begin this August, to replace Ken Kihlstrom (who retired this past May). We will have an active search this coming academic year for Michael Sommermann's eventual replacement.
Action	All action items associated with the hiring process.
Collaboration and Communication: Ongoing discussions between the search committee members as well as with Rick Ifland.	

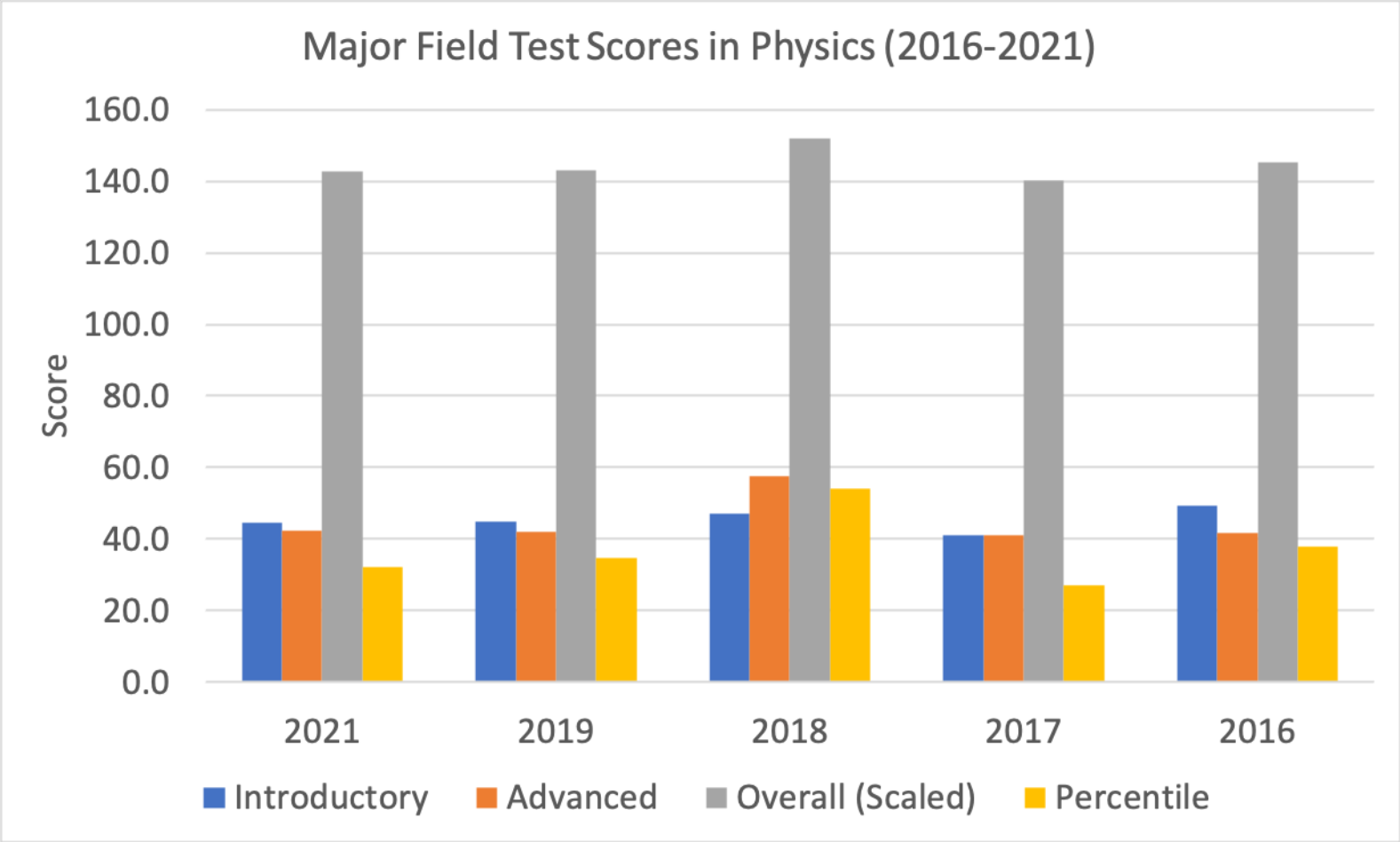
V. Adjustments to the Multi-year Assessment Plan (optional)

Proposed adjustment	Rationale	Timing

VI. Appendices

A. Prompts or instruments used to collect the data
B. Rubrics used to evaluate the data
C. Relevant assessment-related documents (optional)

Appendix A


Major Field Test Scores in Physics (2016-2021)
Score
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
2021
2019
2018
2017
2016
Introductory
Advanced
Overall (Scaled)
Percentile

Appendix B

WESTMONT PHYSICS LABORATORY EXPERIENCE VALUE RUBRIC

Definition

All physics majors in the Department of Physics and Engineering are required to complete a three-course laboratory sequence (PHY–022, 024, and 026) at the beginning of their major coursework. This rubric assesses the students' work and understanding as demonstrated longitudinally throughout this laboratory sequence. *Evaluators are encouraged to assign a zero to any work sample or collection of work that does not meet the benchmark (cell one) level performance, or use N/A.*

	Capstone 4	**Milestones** 3	2	**Benchmark** 1
Understanding the Purpose of the Experiment *Ability to appreciate why the experiment is performed and what will be learned from it*	Correctly **identifies** and **articulates** the relevant physical concepts and **adapts** and **applies** these concepts to generate new ideas related to the questions at hand. Sees the big picture and not just the details/calculations, yet is cognizant of nuances and assumptions. Able to identify and discuss how results add to or reinforce previous works about the topic under study.	Correctly **identifies** and **articulates** the relevant physical concepts and **applies** these concepts to the questions at hand. Sees the big picture and not just the details/calculations.	**Identifies** many of the relevant physical concepts and **correlates** these concepts to the measurements being performed.	Demonstrates a basic understanding of the physics ideas related to the experiment, but perhaps incompletely and/or with some errors.
Quality of the Data *Ability to perform careful measurements and obtain meaningful results*	Designs and effectively implements appropriate measurement methods or numerical calculations to collect or generate high-quality data that can be processed for further analysis and interpretation.	Measurement methods or numerical calculations allow students to collect or generate **high-quality** data that can be processed for further analysis and interpretation.	Measurement methods or numerical calculations allow students to collect or generate reasonable data that can be processed for further analysis and interpretation.	Measurements contain errors that are not recognized or accounted for.
Quality and Sophistication of Data Analysis *Ability to analyze data correctly using appropriate methods and strategies*	Analyzes data appropriately and thoroughly. Carefully considers and analyzes potential sources of systematic and random error and mediates the sources to the extent possible. Sophisticated methods (such as computer coding) are used to provide appropriate quantitative estimates of the degree of random error.	Analyzes data appropriately. Considers and analyzes potential sources of systematic and random error. Properly infers indirect measurements (with their uncertainties) from graphs. Data tables are properly organized and labeled, and data values have appropriate significant figures based on the estimated measurement precision.	Data analysis includes some quantitative error analysis (such as the determination of the degree of random error) and graphs with appropriate titles, axes labels, units, and curve fits. Data tables are properly organized with appropriate column labels.	Data analysis is simplistic, incomplete, and/or contains several mistakes.
Interpretation of the Results *Ability to correctly discuss the meaning and significance of the results.*	Discussion of the significance of the results is clear, compelling, correct, complete and sophisticated. Interpretations and conclusions convey a deep understanding of the topic under study, and may point toward insightful improvements if the experiment was repeated.	Discussion of the significance of the results is clear, correct and complete. Interpretations and conclusions convey a solid understanding of the topic under study.	Discussion of the significance of the results is largely correct, but may be incomplete. Interpretations and conclusions suggest the student understands most of the topic under study.	Interpretations and conclusions are basic, and may be incomplete and/or may contain misunderstandings or errors.

Appendix C

Physics Scientific Paper Rubric

	Below Basic	Basic	Proficient	Exemplary
Depth of Understanding of Physical Principles	Contains mistakes of substance, misunderstands concepts	Accurately covers concepts on a level for a popular audience but nothing beyond	Describes nuances of the concepts and some applications	Shows thorough understanding from multiple sources. Provides info beyond the professor's knowledge
Integration of Various Branches of Physics	Makes little effort to draw in the different branches of physics to the topic	Shows awareness of the how at least a couple of different areas come into play	Demonstrates how the various branches relate to the topic	Demonstrates the development of the field from the various sub-areas
Mechanics of writing (Grammar, etc.)	Poorly written with numerous mechanical mistakes and problems of grammar	Occasional mistakes, writing is readable but doesn't flow very well	Few, if any, mistakes. Writing is fairly clear and straightforward	Writing shows an elegance of wording that draws the reader along. Enjoyable to read
Clarity of Explanation	Not clear the writer understands the topic.	There are basic explanations but do little to address obvious questions	The explanations are understandable to a reasonable reader. They anticipate questions and answer them	The explanations are clear and creative allowing the reader to have a good understanding on a first read
Overall Quality	Most categories rated as below basic. Clearly not much time and effort put into the paper	Categories range from below basic to proficient. Writer clearly gained knowledge in writing the paper	All areas at least basic with most in the proficient range. The knowledge gained by the writer is clearly expressed in the paper	All areas at least proficient. The paper in enjoyable to read and brings new knowledge to the reader (even a physics professor)

Grade:

2021 results:

Student	Rubric score
A	20
B	20
C	20
D	19
E	19.5
F	17
AVERAGE	19.3
ST DEV	1.2
ST DEV MEAN	0.5