Annual Assessment Report

Department: Physics
Academic Year: 2022–2023
Date of Submission: September 1, 2023
Department Chair: Bob Haring-Kaye

I. Response to the previous year PRC's recommendations

Quality of Evidence and Measurement Instruments: If the department plans on annually administering [the Alumni] survey, it may want to consider the impact of survey fatigue on response rate or altering its survey to include more quantitative response options.	**Response:** We discussed the possibility of shortening the One- and Five-Year Alumni Surveys and considered adding more quantitative response options. Since any given student will only have to fill out each survey once (one year and five years after they graduate), we decided to keep the surveys as they are for now.
Use of Evidence: For additional evidence of the department's effectiveness using a larger sample size [referring to the MFT exam results], the department could consider including statistics aggregated across years.	**Response:** We incorporated this suggestion into this year's report.
Evidence of Collaboration and Communication: The PRC would appreciate greater specificity about the departmental discussions and faculty collaboration occurring within the department regarding the assessment data and closing the loop activities.	**Response:** We addressed this more thoroughly in this year's report.
Summary Recommendation #1: Knowing your seven-year report is due on September 20, 2026, and given that only the Engineering program is accredited by ABET, the PRC believes that two separate reports, one each for Physics and Engineering, need to be submitted. We would like to collaborate with the department regarding the level of integration of the ABET standards into the report for Engineering.	**Response:** This issue was discussed with Dan Jensen and we agree.

Summary Recommendation #2: The PRC appreciated the scope of your assessment endeavors and accomplishments; in order to keep your assessment activities manageable, we encourage the department to focus on one PLO, or one PLO and one key question, per year.	**Response:** Thank you. Since the Key Question posed for this year in our Multi-Year Assessment Plan has been postponed (see details below), we are addressing two PLOs in this year's report. Note that the Oral/Written Skills PLO was addressed thoroughly in last year's report, so we are not addressing it again this year.
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 three (*N* = 3) graduating Physics and Engineering Physics majors in April 2023. 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 2022 (*N* = 2), 2021 (*N* = 8), 2019 (*N* = 5), and 2018 (*N* = 4) in a histogram chart included with this report (see Appendix A). (The MFT was unavailable in 2020 due to the pandemic.) The results are also shown in aggregate for our majors who have graduated since 2016 (*N* = 32 excluding 2020) in a separate histogram chart given in the same appendix. Longitudinally, the average overall scores rank somewhat below the national median, though it is interesting to see an upward trend in scores over the past two years compared with the results from 2019 and 2021. We note that the systematically lower scores of the combined 2019 and 2021 cohort (*N* = 13), which represents a significant fraction of the

	comparison group, played an important role in lowering the overall aggregate score. Nevertheless, each of the indicated average scores in the histogram for the 2018–2023 cohorts generally agree with each other within their respective statistical uncertainties.
Closing the Loop Activities	The physics faculty of the department (Bob Haring-Kaye, Ben Carlson, and Jen Ito), along with the department Lab Manager (Will Allison), will meet early in the fall semester to review these outcomes and discuss ways of potentially improving them.
Collaboration and Communication The physics faculty will debrief the entire department on their deliberations regarding the MFT results during a department meeting early in the fall semester. This meeting will be dedicated to the discussion of departmental assessment of student learning in general and will focus on strategies for improvement during the current academic year. We will dedicate another department meeting early in the spring semester to review our strategies and discuss whether anything needs modified for the remainder of the academic year.	
Program Learning Outcome	**Skills: Experimental**
Who is in Charge /Involved?	Instructors of PHY–022 (General Physics Lab I), PHY–024 (General Physics Lab II), PHY–026 (Modern Physics Laboratory), and PHY–170 (Advanced Physics Laboratory)
Direct Assessment Methods	Individual abstracts and discussion sections (primarily incorporating experimental error analysis, interpretations, and conclusions) in the final lab reports submitted in PHY–022 (Fall 2022), PHY–024 (Spring 2023), PHY–026 (Spring 2023), and PHY–170 (Fall 2022). (Note that PHY–022 and PHY–024 are typically taken by first-year majors, PHY–026 by second-year majors, and PHY–170 by either third- or fourth-year majors.) We used our own laboratory assessment rubric inspired by the Association of American Colleges and Universities (AAC&U) VALUE rubrics (see Appendix B) to perform the assessment in each lab course. This year, abstracts and discussion sections written by students in all four lab courses were evaluated using the four dimensions (rows) of the rubric. Data quality and analysis were also assessed using other sections of the reports.
Indirect Assessment Methods	
Major Findings	PHY–022 and 024: A total of 29 (19) students in PHY–022 (PHY–024) were assessed by two different instructors, with PHY–024 representing a smaller subset of the students who took PHY–022 the previous semester. Since the students, course structure, and experiment difficulty are largely the same between the two courses, we combined their rubric scores (producing an overall sample size of $N = 48$) and averaged the values for each assessment category of the rubric. These average scores are shown graphically in Appendix C, each with a maximum statistical uncertainty of $\sigma = \pm 0.2$ points. The

	results are consistent with the picture of an initial "milestone" development (as defined on our assessment rubric) expected at the introductory level. PHY–026: Appendix C shows the average scores obtained by applying the same rubric to the three students who submitted final reports in this course with individually-written abstracts and discussion sections. The assessment was performed by a different instructor than the two who assessed the PHY–022/024 students. Comparing the results to the overall average scores obtained from both introductory lab courses, we see a statistically-significant improvement in the Understanding the Purpose of the Experiment and Quality of the Data categories ($\sigma = 0.0$ points for PHY–026). Perhaps not surprisingly, these scores suggest that the students' overall understanding of a given experiment and the quality of their data are generally stronger than that in the introductory physics environment. However, their average interpretive skills, reflective of the Quality and Sophistication of Data Analysis and Interpretations of the Results categories, show no evidence of improvement compared to those in the introductory lab courses within the statistical uncertainties of the scores. Again, these results are not surprising given the difficulty and time-intensive nature of developing sophisticated interpretive skills in experimental physics. Of course, our conclusions are necessarily limited by the fact that different experiments, groups of students, and assessing instructors are included in these comparisons. PHY–170: Appendix C also shows the average scores obtained by applying the rubric to an individual lab report submitted by each of the two students in our Advanced Physics Lab course last fall. The abstract and discussion sections were evaluated by the same instructor who taught and assessed PHY–026. Each rubric category score agrees with the corresponding ones obtained for PHY–026, albeit with a different student population. This indicates no statistically-significant improvement in any laboratory skill development, although the small sample sizes involved in the comparison make meaningful interpretations difficult.
Closing the Loop Activities	Next year, we plan to use our laboratory assessment rubric to track the longitudinal development of two students throughout all four courses of our physics laboratory curriculum. Although we can only draw very limited information from just two students, it will be the first time that the impact of all three levels of our laboratory curriculum can be assessed for the same students. The assessments will help us evaluate how our laboratory curriculum helps fulfill our student learning objectives. Longer term, we also wish to see if a "Capstone" level of lab skill development is consistently achievable through our Advanced Lab course, or whether additional student support is necessary (such as through research experiences).

Collaboration and Communication

We will have a dedicated meeting among the physics faculty and our lab manager early in the fall semester to discuss these results and determine the appropriate strategies and action steps necessary to foster consistent longitudinal growth throughout our lab curriculum. One of our first discussion items will be a determination of when, where, and in what context should the Python coding language be

instituted in the curriculum as both a data analysis and graphing tool. Currently this is done in PHY–026, but we are considering moving it earlier into the introductory lab curriculum. This would fit well with our recommendation for our majors to take CS–010 during their first year.

or/and

II B. Key Questions

Key Question	Can we get the Engineering Program accredited by ABET? This is the Key Question for 2022-2023 stated in our 2018–2024 departmental assessment plan.
Who is in Charge/Involved?	All engineering faculty and department chair
Direct Assessment Methods	Results of the accreditation process
Indirect Assessment Methods	
Major Findings	Due to the sudden and unexpected departure of Johan Estrada in December 2022, and our failed search for a replacement during the 2022-2023 academic year, we have decided to postpone our official application for accreditation until the 2023-2024 academic year.
Recommendations	Hiring a tenure-track faculty member to replace Johan will be critical to the success of the accreditation process.
Collaboration and Communication: Dan Jensen has been working closely with the Engineering Advisory Board on our ABET accreditation, including the development of program educational objectives following the standards mandated by ABET. The Engineering Program will submit their own annual assessment report based on these objectives.	

III. Follow-ups

Program Learning Outcome or Key Question	
Who was involved in implementation?	
What was decided or addressed?	
How were the recommendations implemented?	
Collaboration and Communication:	

IV. Other assessment or Key Questions related projects

Project	Reevaluation of Physics Program Student Learning Objectives (SLOs) and Curricular Map (CM)
Who is in Charge /Involved?	All physics faculty
Major Findings	We have not started this process yet.
Action	We hope to begin conversations about what changes, if any, we wish to make in the SLOs and CM during the 2023-2024 academic year. So far, the current SLOs have been useful drivers of the curricular changes we implemented last year [such as the requirement of CS–010 (Design/Impl Solut Comp Prob), PHY–170 (Adv Phys Lab), and PHY–198 (Research) for the BS in Physics Major]. The CM will almost certainly need updated to reflect these changes, however.
Collaboration and Communication: Physics faculty conversations outside of our regular department meetings will need to take place for this to move forward.	

Project	Alumni Surveys
Who is in Charge /Involved?	Department chair
Major Findings	Since we first administered our one- and five-year alumni surveys during the summer of 2022 (see last year's annual report for more details), we have received only 2 completed surveys (both one-year surveys) out of 19 total requests (an 11% response rate). Although the feedback from the two surveys were generally positive, indicating strong academic preparation for future work, a helpful and supportive departmental community, and good research opportunities, it is difficult to draw meaningful conclusions from such limited feedback. Going forward, we may consider either shortening the surveys and/or replacing some free response questions with quantitative ones, as suggested by the PRC. Reminder emails were sent to the current group of one- and five-year survey respondents in August.
Action	
Collaboration and Communication: Physics faculty conversations outside of our regular department meetings will need to take place for this to move forward.	

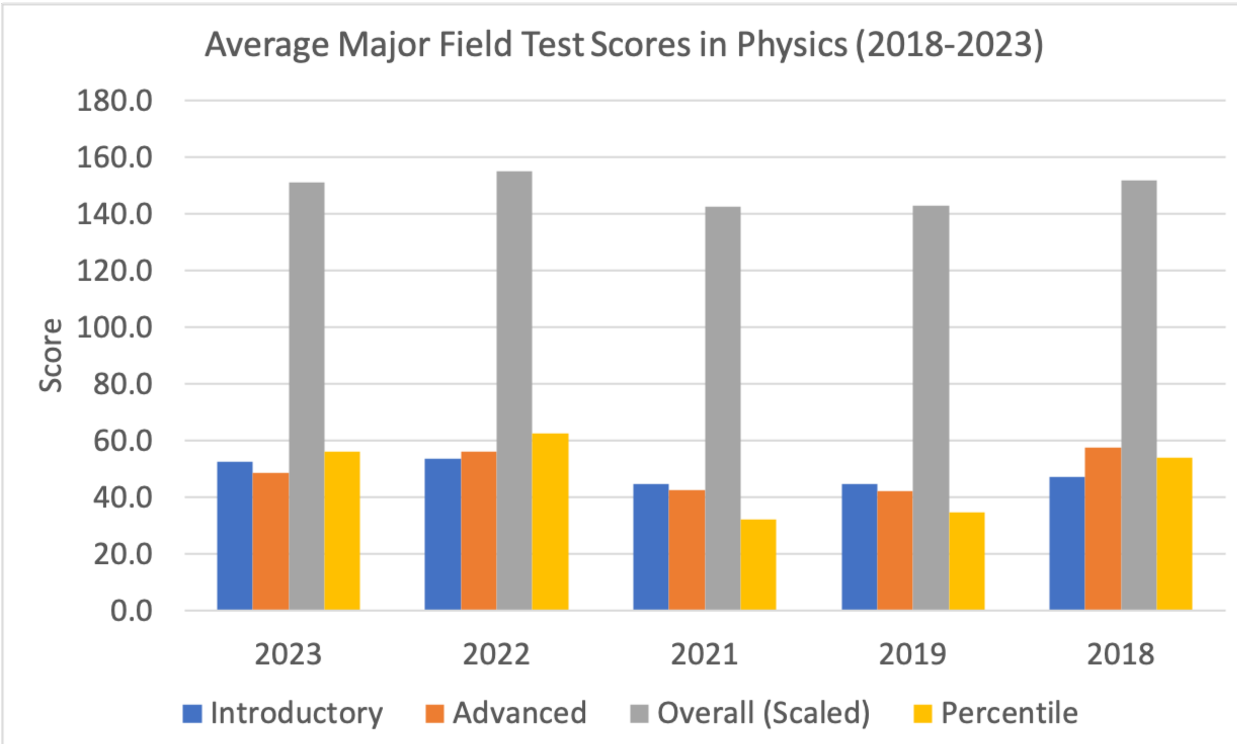
V. Adjustments to the Multi-year Assessment Plan (optional)

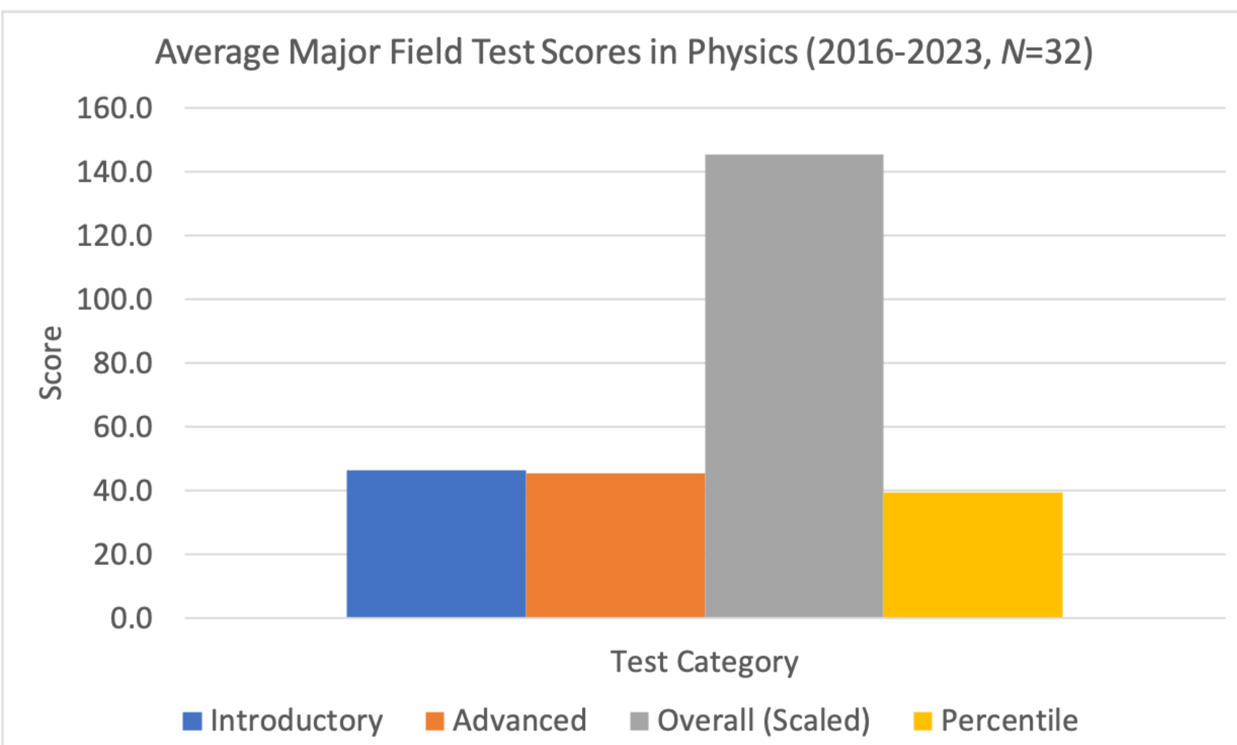
Proposed adjustment	Rationale	Timing

VI. Appendices

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

Physics Annual Assessment Report 2022–2023
Appendix A





Appendix B

WESTMONT PHYSICS LABORATORY COURSE 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.

Physics Annual Assessment Report 2022–2023
Appendix C