Department of Physics and Astronomy Self-Study Executive Summary

The learning goals for physics majors at Millikin University are:

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Department of Physics and Astronomy Self-Study

I. Goals

In the opinion of the Department of Physics and Astronomy, upon the completion of a physics major at Millikin University, a student should be able to:

1. Solve complex problems that require integrating knowledge from a variety of subfields, including classical mechanics, classical electrodynamics, thermodynamics, atomic and nuclear physics, and quantum mechanics, as well as incorporating sophisticated mathematical techniques such as partial differential equations, tensor mathematics, calculus of vector fields, and linear algebra.

2. Follow the scientific method to design and carry out informative and professionally interesting experiments, utilizing laboratory techniques sufficiently advanced as to

The number of physics majors has remained fairly steady over the past three years. During AY 2018-2019 we had 13 physics majors and graduated two students:

Every course we teach above the freshman level is offered every other year (except for Senior Research, for obvious reasons). Therefore, the exact path a student will follow depends on whether s/he enters during an odd or an even year. Here, we explain what a student entering in Fall 2018 would take. As sophomores, Physics majors would take PY 253, an introduction to Modern (20th-century) Physics, and PY 325, Mathematical Physics. In Modern Physics, students will be introduced to Mathematica™, the most popular and powerful computational and analysis software package, and in Mathematical Physics, they will focus on integrating knowledge from a variety of math classes as well as filling in gaps of material not commonly covered in traditional mathematics courses. In both of these courses, they will also begin the process of learning how to write scientific articles as well as present their research orally in a seminar-style symposium.

During their junior year, physics majors will take PY 262, Experimental Physics I, focusing on Electronics, which will introduce them to National Instruments' LabVIEW™ as well as Python, and Origin: industry and academic standards in experimental control and data acquisition. In the spring, they would take PY 362, Experimental Physics II, where they would focus on data acquisition and experimental design. These courses are where students will first experience substantive experimental design, and will also involve instruction in writing of scientific papers. The courses will culminate in seminar-style presentations that will be open to other physics majors, minors, and faculty. Similar presentations will occur at the end of the junior and senior years, at the end of which students will present work from a senior research project. In addition, they will complete the two-term Electrodynamics sequence (PY 403/404).

As seniors, the only core physics courses left would be Theoretical and Applied Mechanics (PY 352) and Quantum Mechanics (PY 406), along with their Senior research project(s) (PY481/482). The relative absence of physics courses from the senior year is intentional, so that students preparing to take the GRE in the fall of their senior year are as prepared as possible and all students have ample time to complete their capstone research projects.

Along with these courses will be a number of math and other science classes, such as

IV. Methods

The goals described in section I will be met in many different courses, which are listed in the curriculum map attached in the appendix. For the purposes of this study, assessment and data collection will take place in the following courses:

Goal 1: Progress towards goal 1 will be measured in two ways:

1) Students in PY 151 will take the Force Concept Inventory as a pre-test and post-test. The FCI is a test containing 30 questions on Newtonian mechanics and is nationally used as a benchmark for student learning in first semester introductory physics classes. The results are reported as average percent gain, (Post Test – Pre Test)/(30 – Pre Test)*100. This allows us to compare the improvement of students who begin

For goals 2 and 3, we have developed rubrics which will produce numerical results that can be used to assess learning, but the core of the evaluation process will be the discussion between the student researcher, faculty, and other students. In the future, we expect to be able to analyze student research and presentations in sophomore, junior, and senior courses. This will allow for a three-year process wherein students can reflect on their work and use the evaluations to improve their presentations and experimental design each year.

Note: In 2010, we modified the expectations for three of the following rubrics, since

Goal 3: Students in PY 253, PY 362, and PY 481/482 will present their results in written and oral form to an open audience of faculty and other students. These presentations will also frequently take place in PY 352, 403, 404, and 406, and when this occurs, the data will be gathered for analysis as well. The rubrics for evaluation are as follows:

Oral Presentations:

	Excellent	Adequate	Nominal
Clarity of Presentation	[3 points] Clear logic and structure of presentation. Good ability to project voice and make eye contact. Strong command of language and grammar. Clear confidence in command of material.	[2 points] Reasonably clear overall, but fails to meet a significant amount of criteria for excellence.	[1 point] Poorly organized presentation – no clear structure or logic. Unclear speaking voice, little or no eye contact.
Length	[3 points] Length of presentation appropriate for forum. Included enough material to keep presentation consistently strong, but not too dense. No filler.	[2 points] Presentation a little too long or too short, but otherwise lacking filler and not too dense.	[1 point]

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For goal 2, we applied the above rubric to the project designs and work products (summary papers and poster presentations) of seniors completing clean energy research.

Seniors: 14.0 (Senior Research)

For goal 3, we applied the above rubrics for oral and poster presentations of students in PY 253 and PY 325 and seniors for the senior seminar talks. The results were as follows:

Goal 3: Our students are already quite successful at written and oral communication, and we will maintain the emphasis on both in the vast majority of our advanced courses. Additionally, we have incorporated a more significant writing component in our introductory lab courses (PY 171 and 172), which will hopefully help students build a stronger foundation earlier in their college careers.

Appendix I – Curriculum Map

	Problem Solving	Experimentation	Communication
PY 100 – The Planets	YES		
PY 101 – Stars and Galaxies	YES		
PY 104/105 – Lab	YES	YES	
PY 106 – Physics of Sports	YES		
PY 111/171 – College Physics I	YES		
PY 112/172 – College Physics II	YES		
PY 151/171 – University Physics I	YES	YES	
PY 152/172 – University Physics II	YES	YES	
PY 253 – Modern Physics	YES	YES	
PY 262 – Experimental Physics I		YES	YES
PY 300 – Astrophysics	YES		YES
PY 303 – Physical Chemistry I	YES		
PY 304 – Physical Chemistry II	YES		
PY 401 – Mathematical Physics	YES		
PY 352 – Theoretical and Analytical Mechanics	YES		YES
PY 362 – Experimental Physics II		YES	YES
PY 381, 382 – Advanced Topics in Physics	YES	YES	YES
PY 403 – Electromagnetism I	YES		YES
PY 404 – Electromagnetism II	YES		YES
PY 406 – Quantum Mechanics	YES		YES