

Physics 2016-2017 Assessment Plan

1. Program Mission Statement

Physics holds as its mission to train students to think quantitatively about the workings of the physical universe. We seek to provide as complete as is feasible undergraduate major, both in physical theory (conceptual and mathematical) in hands-on laboratory work. Students who complete the program, may make explicit use of our curriculum in their chosen career path, or in furthering their education by way of graduate training in physics or engineering. Other students who take one or more courses with us use their physics training to intelligently break down a problem down into its essential components (an implicit objective of our entire curriculum), which will serve them well in nearly any future endeavor. Our major is at the heart of STEM fields, and consequently our graduates have significant success in obtaining employment in engineering and the physical sciences. Therefore, because of its intellectual challenge and the ways in which it teaches students how to grapple with complex problems, the major fits very well with Wells's overall mission and recent commitment to a curriculum that can be used in practical careers. Physics courses are requirement in several other majors at Wells and are also mandatory for students interested in careers in the health sciences.

2. Physics Program Goals

Goal 1: To provide thorough foundational background knowledge in physics and related disciplines

Goal 2: To enable students to be able to apply quantitative thinking to problems in physics, using appropriate mathematical tools, including but not limited to algebra, differential and integral calculus in one and higher dimensions, differential equations, and estimation and approximation techniques

Goal 3: To enable students to gain practical knowledge and experience about real-world issues where physics plays a role, by solving physics problems that are presented in a realistic context, including in the laboratory

Goal 4: To have our students understand how the study of physics can lead to a meaningful and satisfying life/career after Wells, which may or may not be closely related to the remainder of a student's Wells education

Goal 5: To have our students accurately communicate physical laws and processes in clear natural English, both spoken and written

Goal 6: To support the general education curriculum of the College

3. Physics Program Learning Objectives

Goal 1: To provide thorough foundational background knowledge in physics and related disciplines

Learning Objective 1.1: Undertake any necessary remedial work in mathematics and physics, along with other disciplines (including writing) so as to streamline future learning and comprehension

Learning Objective 1.2: At the introductory level, to be able to apply physics training to other scientific coursework

Learning Objective 1.3: By the time of completion of the program, to have strong and broad understanding of the ways in which physics helps humans understand the workings of the physical universe

Goal 2: To enable students to be able to apply quantitative thinking to problems in physics, using appropriate mathematical tools, including but not limited to algebra, differential and integral calculus in one and higher dimensions, differential equations, and estimation and approximation techniques

Learning Objective 2.1: Master a variety of mathematical techniques for their own sake, irrespective of their applicability to problems in physics, in order to develop critical and analytical thinking

Learning Objective 2.2: Successfully apply quantitative thinking to problems and processes that occur in the natural world, be they mechanical, electromagnetic, thermodynamic, or quantum-mechanical

Goal 3: To enable students to gain practical knowledge and experience about real-world issues where physics plays a role, by solving physics problems that are presented in a realistic context, including in the laboratory

Learning Objective 3.1: Have a clear sense of the fundamental role physics plays in all of the natural sciences, through reading and writing and classroom exposure to these notions

Learning Objective 3.2: Choose appropriate elective choices in related fields, to broaden understanding of the physical principles that help understanding of those fields

Learning Objective 3.3: Gain competence in application of theoretical physics concepts to observation of actual physical phenomena, and to learn to set up and operate physical equipment, and to successfully obtain accurate and reliable experimental data, and to understand the how measurements may be made with precision and confidence

Goal 4: To have our students understand how the study of physics can lead to a meaningful and satisfying life/career after Wells, which may or may not be closely related to the remainder of a student's Wells education

Learning Objective 4.1: Through internships and other kinds of hands-on activity, develop the kind of critical thinking and problem-analysis skills physicists use

Learning Objective 4.2: Wherever appropriate, function as mentors to upcoming students, in order to reinforce learning and communication skills across STEM areas

Learning Objective 4.3: At every opportunity, to support increased diversity of all kinds in the practitioners of the physical sciences

Goal 5: To have our students accurately communicate physical laws and processes in clear natural English, both spoken and written

Learning Objective 5.1: In addition to proper and appropriate use of mathematical language, emphasis is placed on verbal explanations, both written and oral, to supplement the mathematics

Learning Objective 5.2: To complete a senior capstone thesis

Goal 6: To support the general education curriculum of the College

Learning Objective 6.1: In courses meant for non-majors, to preserve as high a level of accuracy and rigor as is commensurate with the background and abilities of students

Learning Objective 6.2: In all of its courses, the physics program will strive to integrate itself into a comprehensive liberal arts curriculum

4. Physics Program Learning Outcomes

Goal 1: To provide thorough foundational background knowledge in physics and related disciplines

Learning Objective 1.1: Undertake any necessary remedial work in mathematics and physics, along with other disciplines (including writing) so as to streamline future learning and comprehension

Learning Outcome 1.1.1: Demonstrate mathematical ability using algebraic methods and calculus, along with demonstration of ability to write clear technical prose

Learning Outcome 1.1.2: Demonstrate competence in basic principles of physics and related disciplines at the entry-to-college level

Learning Objective 1.2: At the introductory level, to be able to apply physics training to other scientific coursework

Learning Outcome 1.2.1: Demonstrate mastery of the material offered at the introductory level calculus-based physics

Learning Outcome 1.2.2: Possess a sophisticated understanding of the role physics plays in underpinning all of the sciences

Learning Objective 1.3: By the time of completion of the program, to have strong and broad understanding of the ways in which physics helps humans understand the workings of the physical universe

Learning Outcome 1.3.1: Successfully complete the coursework sequence required of a physics major

Learning Outcome 1.3.2: Complete a senior thesis which evidences enthusiastic curiosity about physics theory and experiment, along with displays of technical ability in the field, and which is on a topic that is relevant to important problems

Learning Outcome 1.3.3: By completing the program with diligence and a spirit of authentic inquiry, demonstrate thorough knowledge of the fields of physics

Goal 2: To enable students to be able to apply quantitative thinking to problems in physics, using appropriate mathematical tools, including but not limited to algebra, differential and integral calculus in one and higher dimensions, differential equations, and estimation and approximation techniques

Learning Objective 2.1: Master a variety of mathematical techniques for their own sake, irrespective of their applicability to problems in physics, in order to develop critical and analytical thinking

Learning Outcome 2.1.1: Gain competence in college-level mathematics as an abstract body of thought

Learning Outcome 2.1.2: Learn specific mathematical techniques and problem-solving skills

Learning Objective 2.2: Successfully apply quantitative thinking to problems and processes that occur in the natural world, be they mechanical, electromagnetic, thermodynamic, or quantum-mechanical subjects

Learning Outcome 2.2.1: By means of assigned problems, examinations based on the material in text and lecture, and one-on-one interactions with faculty, achieve the objective, in each of the topic areas

Learning Outcome 2.2.2: Understand and appreciate the importance of the historical development of physics and become familiar with how the ideas evolved as a human endeavor

Goal 3: To enable students to gain practical knowledge and experience about real-world issues where physics plays a role, by solving physics problems that are presented in a realistic context, including in the laboratory

Learning Objective 3.1: Have a clear sense of the fundamental role physics plays in all of the natural sciences, through reading and writing and classroom exposure to these notions

Learning Outcome 3.1.1: Make clear connections in discussion and written work about the ways in which physics operates in providing a mathematical understanding of the processes of the universe

Learning Outcome 3.1.2: Succeed in connecting what is learned in the physics program to the meaning and value of a full liberal arts education

Learning Objective 3.2: Choose appropriate elective choices in related fields, to broaden understanding of the physical principles that help understanding of those fields

Learning Outcome 3.2.1: By selecting courses in fields that are allied to physics, from across STEM fields both within the MPS program or in other sciences, gain a real understanding of the relationships of physics to other technological and scientific endeavors

Learning Outcome 3.2.2: For students specializing in physics, to nevertheless maintain awareness and competence in connection the methods of physics to other technical fields

Learning Objective 3.3: Gain competence in application of theoretical physics concepts to observation of actual physical phenomena, and to learn to set up and operate physical equipment, and to successfully obtain accurate and reliable experimental data, and to understand the how measurements may be made with precision and confidence

Learning Outcome 3.3.1: At the introductory level, show patience, leadership, and skill in the physics laboratory, both in operating equipment and recognizing the connection of experiment to classroom theory

Learning Outcome 3.3.2: At the upper level, exhibit mature experimental problem-solving skills on a variety of kinds of physics equipment, which will require that the students learn the accompanying theory independently by reading and understanding manufacturer's literature as well as online resources

Goal 4: To have our students understand how the study of physics can lead to a meaningful and satisfying life/career after Wells, which may or may not be closely related to the remainder of a student's Wells education

Learning Objective 4.1: Through internships and other kinds of hands-on activity, develop the kind of critical thinking and problem-analysis skills physicists use

Learning Outcome 4.1.1: Working with Wells's career services support, obtain meaningful STEM-based internship experiences

Learning Outcome 4.1.2: Obtain whenever feasible research experience in REU (Research Experiences for Undergraduates) programs at other institutions.

Learning Objective 4.2: Wherever appropriate, to have our declared majors function as mentors to upcoming students, in order to reinforce learning and communication skills across STEM areas

Learning Outcome 4.2.1: Through informal presentations and conversation, participate in class activities that engage the physics material

Learning Outcome 4.2.2: Through TA opportunities, have our upper-class students help beginning students to master important subject areas

Learning Objective 4.3: At every opportunity, to support increased diversity of all kinds in the practitioners of the physical sciences

Learning Outcome 4.3.1: To foster in our students a welcoming atmosphere toward others, and to make all feel welcome in our classes

Goal 5: To have our students accurately communicate physical laws and processes in clear natural English, both spoken and written

Learning Objective 5.1: In addition to proper and appropriate use of mathematical language, emphasis is placed on verbal explanations, both written and oral, to supplement the mathematics and in many cases to obviate such analysis

Learning Outcome 5.1.1: When solving physics problems, accompany the mathematical analysis with clear explanations of what is being done

Learning Outcome 5.1.2: In the laboratory, provide clear verbal explanations of the experiment and its results

Learning Objective 5.2: To complete a senior capstone thesis

Learning Outcome 5.2.1: Engage in the process of developing an appropriate project topic in physics, through literature research and brainstorming

Learning Outcome 5.2.2: Complete a thesis that contains both well-crafted discussion of the topic and its ideas, along with significant technical content that is sophisticated in its ideas and presentation, using coherent notation

Goal 6: To support the general education curriculum of the College

Learning Objective 6.1: In physics courses meant for non-majors, to preserve as high a level of accuracy and rigor as is commensurate with the background and abilities of students

Learning Outcome 6.1.1: Students demonstrate quantitative competence in a field of physics that has relevance to the liberal arts

Learning Outcome 6.1.2: Students demonstrate the ability to communicate technical information clearly and compellingly, both orally and in writing

Learning Objective 6.2: In all of its courses, the physics program will strive to integrate itself into a comprehensive liberal arts curriculum

Learning Outcome 6.2.1: Students gain awareness of how the ways of thinking in physics can deepen insight to any topic in the liberal arts.

5. Means of Assessment of Outcomes

Outcomes are assessed in a formal way by use of regular homework assignments and examinations, both of which are assigned a numerical grade, along with (if appropriate) laboratory activity, which is assessed via written reports and observation. In the capstone courses (the senior thesis), outcomes are assessed by evaluation of the student's commitment to the process in terms of submission of regular status reports, textual drafts, and in-class presentation.

Summary of alignment of courses listed in the Physics major and the major's learning outcomes.

[*choose either course; ** choose 6 courses from among these 6, but two of them can be any MPS course above the 100-level]

2.2.1						x	x	x			x			x		x			Graded examinations and regular homework assignments
2.2.2							x							x	x	x			Qualitative observations; occasional written reports
3.1.1						x	x	x			x	x		x	x	x	x		Qualitative observation of student awareness and communication
3.1.2									x	x	x	x					x	x	Qualitative observation of student awareness and communication
3.2.1						x	x	x			x	x				x	x	x	Faculty-faculty discussion of student progress across the curriculum
3.2.2									x	x									Faculty-faculty discussion of student progress across the curriculum
3.3.1						x	x				x								Graded laboratory reports; qualitative observation
3.3.2									x	x				x	x				Maintenance of a lab notebook; one-on-one discussion
4.1.1																		x	Participation in internship opportunities and/or as physics research assistant
4.1.2																			Qualitative observation of student motivation to participate in research
4.2.1									x	x	x			x	x	x			Qualitative observation of student willingness to help
4.2.2																		x	Discussions with TA about issues pertaining to student success
4.3.1																			{this is an important programmatic goal but is not course-specific}
5.1.1						x	x	x						x					Graded prose responses on homework and exams
5.1.2						x	x							x		x			Graded laboratory reports; lab notebooks at the upper level
5.2.1									x										Regular meetings and written activities, culminating in a paper
5.2.2										x									Regular meetings and written activities, culminating in a paper
6.1.1																		x	[non-majors courses not tabulated]; simple quantitative
6.1.2																		x	[non-majors courses not tabulated]; written and oral activities
6.2.1																			[an important programmatic goal that pertains to all courses]

6. How Assessment Data Will Be Utilized

Apart from the heavily quantitative information on student performance that is gleaned from graded homework and examinations, which indeed does provide the student with clear and meaningful feedback about subject areas where improvement is needed, there is ample opportunity for faculty to observe students as they pursue their learning. This qualitative data is equally valuable for student success. Written comments on homework and exams guide the student toward clearer comprehension of the ideas. One-on-one interaction in lab courses with the instructor and with fellow lab team members serves as an extremely timely and useful way to become aware of misconceptions and to mitigate them. In the capstone experience, on-going give and take between faculty and students as the project takes shape is integral to the process of student intellectual growth; feedback provided after rehearsed verbal presentations demonstrably improves the final product; we will continue to use a written rubric as an assessment tool for students in this pair of courses.

Summary of alignment of courses listed in the Physics major and the major's learning outcomes.

[*choose either course; ** choose 6 courses from among these 6, but two of them can be any MPS course above the 100-level]

