

## Physics 2015-2016 Assessment Plan

### 1. Program Mission Statement

Physics holds as its mission to train students to think quantitatively about the workings of the physical universe. Whether our students make explicit use of our curriculum in their jobs or in furthering their education, or, as happens just as often, their physics training in breaking a problem down into its essential components, which is implicit throughout our curriculum, 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.

### 2. Physics Program Goals

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

*Goal 2: To be able to apply quantitative thinking to problems in physics*

*Goal 3: To have gained practical knowledge and experience about real-world issues where physics plays a role*

*Goal 4: To understand how the study of physics leads to a successful post-Wells career/education*

*Goal 5: To accurately communicate physical laws and processes in clear natural English*

### 3. Physics Program Learning Objectives

*Goal 1: To have 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: 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 be able to apply quantitative thinking to problems in physics*

Learning Objective 2.1: Successfully apply quantitative thinking to problems and processes that occur in the natural world, be they mechanical, electromagnetic, thermodynamic, or quantum-mechanical

Learning Objective 2.2: Learn to set up and operate physical equipment and successfully obtain accurate and reliable experimental data

*Goal 3: To have gained practical knowledge and experience about real-world issues where physics plays a role*

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 underpin those fields

*Goal 4: To understand how the study of physics can lead to a successful post-Wells career/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

*Goal 5: To accurately communicate physical laws and processes in clear natural English*

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 Objective 5.2: To complete a senior capstone 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

#### 4. Physics Program Learning Outcomes

*Goal 1: To have 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: 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 1.2.1: 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 1.2.2: By completing the program with diligence and a spirit of authentic inquiry, demonstrate thorough knowledge of the fields of physics*

*Goal 2: To be able to apply quantitative thinking to problems in physics*

Learning Objective 2.1: Successfully apply quantitative thinking to problems and processes that occur in the natural world, including mechanical, electromagnetic, thermodynamic, and quantum-mechanical subjects

*Learning Outcome 2.1.1: 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 2.1.2: Understand and appreciate the importance of the historical development of physics and become familiar with how the ideas evolved as a human endeavor*

Learning Objective 2.2: Learn to set up and operate physical equipment and successfully obtain accurate and reliable experimental data

*Learning Outcome 2.2.1: 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 2.2.2: 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 3: To have gained practical knowledge and experience about real-world issues where physics plays a role*

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 underpin 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*

*Goal 4: To understand how the study of physics can lead to a successful post-Wells career/education*

Learning Objective 4.1: Through outside-the-classroom work, develop the kind of critical thinking and problem-analysis skills physicists' use

*Learning Outcome 4.1.1: Through STEM-based internships and/or functioning as a teaching assistant or other types of mentoring, gain experience in connecting the abstract ideas of physics to potential careers*

Learning Objective 4.2: Wherever appropriate, 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*

*Goal 5: To accurately communicate physical laws and processes in clear natural English*

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 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*

#### 5. Means of Assessment of Outcomes (see attached table)

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.

#### 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. 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]

Outcomes	Courses	MA111	MA112	MA211	MA213	PHYS111L	PHYS212L	PHYS302	PHYS303	MPS402	MPS403	*CHEM107L	*CS131	**PHYS221L	**PHYS307	**PHYS340	**CHEM301	**CS132	**>100-level	Means of Assessing Outcome
1.1.1		x				x						x								Qualitative observations of sufficient ability to proceed
1.1.2		x				x						x								Evidence of past exposure to physics; observation in 111L
1.2.1									x	x										Evaluation by rubric of senior thesis process, presentation, and document
1.2.2						x	x	x	x					x	x	x	x			Successful completion of major requirements
2.1.1		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			Graded examinations and regular homework assignments, and labs (L)
2.1.2							x	x						x	x	x	x			Graded written reports and homework assignments
2.2.1						x	x					x								Qualitative observations of laboratory practice
2.2.2														x	x					Graded laboratory reports; qualitative observation
3.1.1						x	x	x				x	x				x	x	x	Qualitative observation of student awareness and commitment
3.1.2									x	x	x	x	x					x	x	Faculty-faculty discussion of student progress across the curriculum
3.2.1				x	x							x	x				x	x	x	Faculty-faculty discussion of student progress in advising choices
4.1.1																			x	Participation in internship opportunities and/or as physics/math tutor
4.2.1								x	x	x	x			x	x	x				Qualitative observation of student willingness to help

