Assessment Plan
Department of Physics & Astronomy
February 20, 2014

Departmental Mission Statement

The Department of Physics & Astronomy strives to develop in our students a theoretical framework to understand the physical universe and the skills to apply this framework to real-world situations and physical systems. We build this framework from the content of courses. We build student skills, including problem-solving techniques; critical thinking and writing; experimental design, technique and analysis; and hands-on research experience, through our whole program. We seek to create knowledgeable and driven graduates that are well-prepared for various career tracks, including graduate study, industry, and teaching.

Departmental Learning Goals and Outcomes

The Department teaches three categories of students. Students throughout the college take our conceptual level courses; science majors take our introductory physics sequence; physics and astronomy majors and minors take both introductory and advanced courses. We have formulated goals specific to each group as well as a cumulative goal for all students:

- **Students in our conceptual courses**
  Our goals are to kindle and sustain interest in physics and natural science, and to give students a basic understanding of current physical models of the universe.
- **Science Majors:**
  We strive to provide a solid introduction to physics to support the development of young scientists. We also seek to give students tools for analytical and quantitative studies of the natural world.
- **Physics Majors:**
  Our goal is to provide a rigorous introduction to the theory and practice of physics, including a survey of the major areas of physics at the appropriate level, introduction to basic experimental techniques, and experiential introduction to research in the physical sciences.

  Learning Outcomes for Physics and Astronomy graduates:

  1. Physics and Astronomy graduates indicate a broad and deep understanding of physical concepts.
     Assessment strategy: ETS Field Exam
  2. They demonstrate a broad range of problem solving skills.
     Assessment strategy: ETS Field Exam
  3. They are able to carry out scientific research. They are able to apply and combine a broad set of skills, including experimental, observational, computational, and theoretical techniques to answer a research question. They are able to read and understand scientific material to put their research results in a context.
     Assessment strategy: Capstone Presentations and Capstone Papers.

4. They are able to present research results in an effective way to an audience.
   Assessment strategy: Capstone Presentations and Capstone Papers.

- **Cumulative Goal:**
  The Department of Physics and Astronomy seeks to support student professional development in physics, engineering and the other natural sciences, by giving students the tools to succeed in top-tier graduate programs. We support student professional development in all areas by endeavoring to give students the appropriate scientific background to succeed.
  Learning Outcomes for Physics and Astronomy graduates:
  5. Students who choose to pursue graduate degrees in science and engineering are successful in gaining admission to selective programs, and are well-prepared for those programs.
     Assessment strategy: Alumni Survey
  6. Students entering industry or other fields have the necessary skills and knowledge base to be successful in their chosen occupation.
     Assessment strategy: Alumni Survey

Specific indicators of student success in achieving learning outcomes:

- Comprehensive Exam. Physics and astronomy majors will indicate the breadth and depth of their understanding of physical concepts and development of their problem solving skills by their performance on comprehensive exams (e.g., the ETS Field Exam; see next section). Standardized tests also allow direct comparison with other schools.
- Capstone Presentations. Presentation by seniors communicating their capstone research results. Quality assessed by physics and astronomy faculty.
- Capstone Papers. Papers by seniors communicating their capstone research. Quality assessed by peer review and physics and astronomy faculty.
- Alumni Survey. Survey administered to physics and astronomy alumni cohorts two and five years after graduation.

Sustainable Assessment Plan:

- **Measuring student knowledge base and problem solving skills via the ETS Field Exam** (Learning goals 1 and 2)
  Physics majors take a standardized, comprehensive exam during their senior year. We use the Major Field Test in Physics offered by the Educational Testing Service for this purpose. Advantages of this instrument are (a) it is written and graded by an independent body, reducing internal biases; (b) the ETS provides comparison information against other institutions using the test; (c) it is similar to other comprehensive exams our students may encounter, including the Physics Graduate Record Exam, and the preliminary exams given at the outset of many graduate programs. Apart from providing data for assessment purposes, taking this exam is therefore a valuable experience for many students.

- **Measuring student research ability and presentation and reporting skills via the capstone presentations and capstone papers** (Learning goals 3 and 4)
  The Department of Physics and Astronomy tracks student performance on capstone research projects, papers and presentations during PHYS 489 (Senior Seminar). These presentations and papers are evaluated every year by the faculty and by student peers using a standard rubric.
- **Measuring career preparation** (Learning goals 5 and 6)
  The Department of Physics and Astronomy surveys recent graduates (2 and 5 years after gradation). We ask students to comment on the strengths and weaknesses of our program, and the extent to which our program has prepared them for their current career stage. In particular, we ask those in graduate school to comment on their preparation versus other students in their graduate program. We also compile data about student outcomes at this stage (numbers in graduate school, other career paths, etc.). We have implemented a simple online survey that is made available to the appropriate cohorts once a year.

Analysis and Use of Assessment Data:

- **Measuring student knowledge base and problem solving skills via the ETS Field Exam** (Learning goals 1 and 2)
  Faculty use this instrument to make changes to the curriculum in areas of weak student performance. For example, if students consistently underperform in one particular area of the exam, the department can add required courses and/or modify existing course contents to increase students' exposure to that area.
- **Measuring student research ability and presentation and reporting skills via capstone presentations and capstone papers** (Learning goals 3 and 4)
  Student capstone presentations and papers are evaluated by the faculty and by student peers. The department uses these evaluations to address the quality of the collective research experiences that students receive at Macalester or elsewhere, and to assess student presentation and reporting skills. Based on these results we may seek to guide the type of on-campus and off-campus research experiences students have. We may also change the types of presentations students give and the papers they write in our curriculum before the capstone.
- **Measuring career preparation** (Learning goals 5 and 6)
  Results from surveys of recent graduates are used as a yardstick of the strength of our major program compared to peer institutions. Combined with the results of the ETS field exam and the "Capstone Presentation", we use these interview results to inform curricular changes that will make Macalester graduates more competitive in academia and in industry.

Assessment analysis schedule (data for each learning goal is collected every year)

- **2014:** Learning goals 1 and 2
- **2015:** Learning goals 3 and 4
- **2016:** Learning goals 5 and 6
- **2017:** Learning goals 1 and 2