Learning Outcomes and Assessment for the Ph.D. program in Applied Physics

Learning Goals
In the Applied Physics Ph.D. program, we want to ensure that first and foremost, the candidates know how to “think like an applied physicist”. This implies that they have mastery of the fundamental physics knowledge, can synthesize knowledge from different areas, and take the course-based knowledge to the next level, where, with guidance from their mentors and peers, they apply the knowledge to solve problems of practical interest. We therefore aim at an interdisciplinary education and broad course base. In addition to becoming a world expert in the area of their dissertation topics, the candidates will be prepared for a career as a professional scientist/engineer, with all the flexibility that that implies.

Applied physicists must learn how to communicate using written, spoken and presentation skills. The candidates will acquire and improve these skills as part of our course work and exams. For example, Physics 6510, our Advanced Laboratory course has a requirement to write lab reports in standard journal (Physical Review Letters) format as well as make an oral presentation to faculty and peers in a timed format. Our A- and B-exams also require comprehensive skills in written and oral presentation. These formative skills are essential for the practicing Applied physicist.

It is essential that applied physicists are aware of ethical issues pertaining to the conduct and dissemination of research, in collaborative research endeavors as well as instances that may arise concerned with the teaching arena. Opportunities to participate in training concerned with ethical issues will be provided and must be completed by all students before their A-exams. The successful completion of the Responsible Conduct of Research unit online is required of all students.

Proficiencies
A candidate for a Ph.D. in Applied Physics is expected to demonstrate (a) broad knowledge in the fundamental areas of physics and in-depth knowledge at highly advanced level in at least one sub-discipline of Applied Physics, (b) breadth of interdisciplinary training, and (c) the ability to synthesize and create knowledge by making an original and substantial contribution to an area of Applied Physics in a timely fashion.

Proficiencies that are required to be demonstrated by the candidate:

Learning outcome 1: Demonstrate broad knowledge in the fundamental areas of Applied Physics, advanced knowledge in a sub-discipline, and interdisciplinary training
- Proficiency in basic physics
- Advanced knowledge in an area of applied physics
- Breadth of interdisciplinary training

Learning outcome 2: Demonstrate the ability to acquire skills to perform independent advanced research
- Demonstrate ability to identify and seek out resources and information; apply these to guide research plan development
- Demonstrate the ability to master and/or innovate research methodologies, and techniques
- Demonstrate oral and written communication skills

**Learning outcome 3: Make an original and substantial contribution to the discipline**
- Demonstrate independent thinking and creativity
- Develop and execute original research plan(s)
- Generate publishable advances in an area of applied physics

**Learning outcome 4: Demonstrate a commitment to advancing scholarship**
- Maintain familiarity with advances in the field
- Demonstrate commitment to personal professional development through engagement in professional societies, conference participations and publications
- Show commitment to learning, collaborative inquiry, and mentoring

**Learning outcome 5: Demonstrate professional skills**
- Understand and maintain ethical standards in the field
- Listen, give, and receive feedback effectively

**Assessment of Learning Outcomes**

Exams and assessment are part of the learning process. Formal learning in a classroom environment is assessed in exams that are a part of course work, and could be either take-home, timed in-class exams or term-papers combined with presentation of materials. The Q exam is a written exam, and will assess the candidate’s basic knowledge of Physics. Examination of the candidate’s familiarity with all areas of physics and his/her ability to carry out “back of the envelope calculations” are part of the Q exam process. These will help faculty assess the candidate’s readiness in transitioning from a “knowledge-acquirer” to a practicing applied physicist who can synthesize and attack complex problems as well as create new knowledge by carrying out original research.

The second examination is the Admission to Candidacy Examination (ACE), a comprehensive exam that gauges the candidate’s knowledge of the field and readiness for independent research. This is an oral examination, but it is administered by the members of the candidate’s permanent Special Committee. The ‘A’ exam may be preceded by one or more written assignments. At the ‘A’ exam, the candidates should demonstrate broad knowledge in their research area, relate it to the general concept of physics, and demonstrate solid communication and presentation skills. After passing this exam, usually sometime in the candidate’s third year, he/she begins research in earnest.

The third and final exam is the thesis defense, the ‘B exam’. It is an oral exam administered by the candidate’s special committee after his/her completion of the Ph.D. thesis research. The exam covers the thesis topics and related matters. The B exam also is an “open examination” that will permit the faculty (and fellow students) to assess the quality of the research, and highlights the candidate’s written, oral and communication skills.