M.S. in Physics

Learning Outcomes

Listed below are learning goals for our graduate (Masters) program in Physics. After the general statements of goals for each category, we list outcomes that could be measured using an appropriate assessment methodology.

1. Mastery of Content: Students should have a working knowledge of the core branches of an advanced physics curriculum, namely, Classical Mechanics, Quantum Mechanics, and Electrodynamics. Students should also appreciate the interconnectedness of physics and continue the process of synthesizing results from different branches of physics (that they should have been exposed to as undergraduates) to address questions like those encountered in research settings.

Mastery of Content Outcomes:

• Students should be able to solve a selected set of standard problems in Classical Mechanics, Quantum Mechanics, and Electrodynamics.
• Students should be able to apply general principles, such as conservation of energy and momentum, to complex systems that require the use of more than one branch of physics.

2. Articulate Communication: Students should be able to express scientific and technical ideas in a manner accessible to their peers in oral presentations and in writing. Students should have the ability to effectively synthesize mathematical analysis, graphics, and text to communicate scientific and technical material.

Articulate Communication Outcomes:

• Students should be able to give oral presentations of problem solutions or research projects that combine formal mathematical material with computer generated graphics and verbal explanations in a manner that makes the topic accessible to their peers.
• Students should be able to write research reports that effectively integrate text, data analysis, and graphics into a document that adequately explains the procedures and supports the stated conclusions.
3. Scientific Skills: Students should be proficient in the formal mathematical techniques that are central to the practice of physics. Students should appreciate the importance and utility of conceptual representations of abstract ideas in physics.

Scientific Skills Outcomes:
• Students should be able to chart out and successfully execute the solution to complex (graduate-level) problems that require a multi-step process to solve.
• Students should be able to choose and utilize appropriate formal mathematical techniques in solving problems in physics. For example, they should be able to use Poisson brackets to examine the time evolution of a dynamical variable and identify constants of motion based on the commutation with the Hamiltonian of a system.

4. Technical Skills: Students should be proficient at using theoretical and/or computational techniques to visualize and solve physical problems, or be proficient in advanced laboratory techniques and data analysis (or combinations of the above, depending on their chosen thesis topic).

Technical Skills Outcomes:
• Students working in an area of experimental physics for their thesis should be able to execute advanced laboratory techniques that are standard in their area of research and estimate the accuracy and precision of their resulting measurements using appropriate data analysis techniques.
• Students working in an area of observational astronomy for their thesis should be able to handle telescope data (in their wavelength of study), including applying advanced computational techniques to analyze and interpret those data.
• Students working in an area of theoretical/computational physics should be able to apply the defined norms for their areas of research to an understanding of the implications, accuracy, and precision of their results.

5. Research Skills: Students should understand how the provisional nature of science requires one to revisit old problems as new techniques and theories emerge, in addition to working on the frontiers of phenomena/systems that are not well understood. Students should appreciate the importance of advanced theoretical, computational, and experimental techniques for addressing research topics. Students should understand the importance of clear technical communication and continue developing the skills (that they should have begun to develop as undergraduates) to produce effective oral or written expositions of substantial research projects.

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Research Skills Outcomes:

- Students should be able to develop experimental techniques and numerical algorithms for their projects (depending on the area of their chosen thesis topic) with limited guidance and be able to troubleshoot these techniques and algorithms when problems arise.
- Students should produce a written thesis that effectively integrates formal mathematical analysis, graphics, and text into a document that is accessible to their peers. The document should introduce the topic, set the context, and explain the significance of the work as well as describe the particulars of the project.
- Students should be able to give an oral presentation that explains and summarizes the major aspects of their research project to an audience of peers. The presentation should make effective use of computer graphics, text, and verbal explanations and be well organized.