Introduction: Listed below are five major categories of learning goals for our degree programs. After the general statements of goals for each category, we list outcomes that could be measured using an appropriate assessment methodology. These goals and outcomes are not separated into undergraduate and graduate categories as many of them will apply to both groups of students. However, the last category of goals pertains primarily to the graduate program.

1. **Mastery of Content:** Students should have a working knowledge of the major branches of physics and the kinds of physical situations each is suited to address. Students should also appreciate the interconnectedness of physics and have begun the process of synthesizing results from different branches of physics to address questions like those encountered in research settings.

**Mastery of Content Outcomes:**

- Students should be able to develop simple mathematical models to describe collected data or observations. Conversely, given a pairing of data set and hypothetical model, students should be able to frame arguments to support or discredit the hypothesized model.

- 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 lab reports that effectively integrate text, data analysis, and graphics into a document that adequately explains the procedures and supports the stated conclusions.

3. **Scientific/Technical Skills:**

- Students should be proficient in the formal mathematical techniques that are central to the practice of physics.

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• Students should appreciate the importance and utility of conceptual representations of abstract ideas in physics.

• Students should be proficient at using computational techniques to visualize and solve physical problems.

• Students should have gained proficiency in basic laboratory techniques and data analysis.

• Finally, students should have the ability to make order of magnitude estimates of more complex calculations and be able to use such information to evaluate the reasonableness of numerical solutions or collected data.

Scientific/Technical Skills Outcomes:

• Students should be able to chart out and successfully execute the solution to complex 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, students should be able to guess appropriate trial solutions when solving initial value problems and be able to effectively use the separation of variables technique when solving boundary value problems.

• Students should be able to use software packages such as Matlab or Mathematica to solve and visualize more advanced problems in physics. Specifically, they should be able to use two and three-dimensional graphics routines, produce simple animations, and use basic numerical algorithms to solve ordinary differential equations or estimate definite integrals.

• Students should be able to execute basic laboratory techniques and estimate the precision of the resulting measurements using the appropriate data analysis techniques. For example, students should be able to measure voltages and currents in a circuit by choosing the appropriate measurement instrument, connections to the circuit, and instrument settings. Students should be able to fit measured data to an appropriate theoretical model, and quantitatively characterize the errors in the data points and goodness of fit to the model.

4. Scientist as Citizen: Students should have developed an appreciation of the connections between science and society. Some examples of such connections are the following: the impact of technology on society and nature, the ethical concerns particular to their work as a scientist, and making science more accessible to traditionally under-represented groups.

Scientist as Citizen Outcomes:

• Students should be able to differentiate between science and pseudo-science and frame supporting arguments for their conclusions about a particular example. The supporting arguments should include text, analysis, and graphics as appropriate.
Students should be able to produce written or oral critiques of articles, films, or political debates related to issues where science impacts society. They should be able to identify the viewpoint of the writer or speaker and discuss to what extent this viewpoint may limit the range of information presented by the writer or speaker.

Students should be able to defend a particular viewpoint or provide an accessible summary of existing viewpoints for the general public of scientific issues that have environmental, social, or ethical implications.

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 begin developing the skills to produce effective oral or written expositions of substantial research projects.

Research Skills Outcomes:

Students working on projects in experimental physics should have mastered key laboratory techniques utilized in their projects and developed the ability to work independently on a research problem.

Students working on projects in computational physics should have mastered key mathematical and numerical techniques utilized in their projects and developed the ability to work independently on a research problem.

Students should be able to develop experimental techniques and numerical algorithms for their projects with limited guidance and be able to troubleshoot these 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.