**Department of Physics and Astronomy**

**Learning Outcomes Assessment Plan**

**B.S. in Physics**

**Program Purpose**

The B.S. program in Physics and Astronomy is an undergraduate program for students seeking to develop a quantitative, mathematical understanding of the universe and it's constitute matter, forces, and phenomena. training for research in all areas of physics and astronomy. The program prepares the student for the professional practice in academia, research or industry the fields of Physics or Astronomy. The program also prepares the student for graduate degree programs in physics, astronomy, chemistry, medicine, law, business, and engineering.

**Learning Outcomes**

1. The nature of physics and its concepts

1. Understanding the role of observation and the interplay between experiment and theory in scientific progress.
2. Understanding the self-correcting nature of science.
3. Familiarity with the major historical threads and key players in the development of physics.
4. Basic understanding of the major threads of physics concepts: conservation laws, forces (gravity, E&M), fields, Newton's laws, work and energy, optics, thermodynamics, relativity, quantum mechanics, condensed matter physics, particle physics, cosmology.
5. Ability to integrate physics concepts with concepts from other branches of science.
6. Understanding the place of humans in the Universe.

2. The role of physics and science in society

1. Understanding scientific ethics.
2. Understanding political issues in the relationship between science and society. Public perceptions of scientists. Ethical uses of scientific results.
3. Understanding the physical basis of some major contemporary societal problems, such as energy production, nuclear power, and human impacts on the global climate.

3. Mathematical skills, modeling skills, and problem solving skills

1. Ability to organize problems by identifying physical principles, identifying relevant vs. irrelevant quantities, and making appropriate diagrams.
2. Ability to use the language of mathematics to solve physical problems.
3. Ability to build physical models by abstracting the most important concepts.
4. Ability to use and interpret graphical representations of data.
5. Ability to estimate results.

4. Fundamental laboratory skills

1. Understanding how to collect, organize, and present data and connect it to physical principles.
2. Ability to carry out error analysis, understanding what errors mean.
3. Estimating and understanding the statistical significance of experimental results using concepts such as confidence levels and chance probabilities.
4. Understanding the basics of experimental design, and the tradeoffs between statistical and systematic uncertainties.
5. Understanding of and commitment to laboratory safety.

5. Scientific communication

1. Basic writing ability: Ability to use correct grammar, punctuation, clear sentence structure, and coherent paragraph construction.
2. Scientific writing ability: Ability to use technical terms correctly, introduce notation properly, and use displayed equations, tables, figures, and citations properly.
3. Presentation skills: Ability to give effective, persuasive presentations to peers, both formal and informal.
4. Teamwork: Ability to work in groups to solve scientific problems.
5. Proper attribution of sources. Honesty in reporting results.

6. Computational literacy

1. Ability to write simple code in a modern, high-level   
   computing language.
2. Ability to use scientific subroutine packages.
3. Ability to solve problems using symbolic math systems.
4. Knowledge of basic numerical analysis, such as the solution of linear systems, the determination of eigenvalues, Fourier analysis, and the numerical integration of differential equations.
5. Understanding of computer modeling of physical systems.

7. Research experience (honors only)

1. Ability to apply physics competencies semi-independently in a research context.
2. Ability to synthesize physics principles and applications
3. Ability to present research motivations, findings, and significance

**Learning Outcomes Assessment**

Learning Outcomes are assessed in required major classes in exams, homework, laboratory work, presentations, and group work.

| **Course** | **LO1** | **LO2** | **LO3** | **LO4** | **LO5** | **LO6** |
| --- | --- | --- | --- | --- | --- | --- |
| **P1970 - UG Seminar I** | X | X |  |  | X |  |
| **P1980 - UG Seminar II** | X | X |  |  | X |  |
| **P2215 - Phys Lab S & E I** | X |  | X | X | X |  |
| **P2225 - Phys Lab S & E II** | X |  | X | X | X |  |
| **P3210 - Phys Scientists I** | X |  | X |  |  |  |
| **P3220 - Phys Scientists II** | X |  | X |  |  |  |
| **P3719 - Advanced UG Lab** | X |  | X | X | X |  |
| **P3730 - Intro Comp Phys** | X |  | X |  | X | X |
| **P3740 - Intro Quantum and Rel** | X |  | X |  |  |  |
| **P3760 - Thermo & Stat Mech** | X |  | X |  |  |  |
| **P4410 - Classical Phys I (Mech)** | X |  | X |  |  |  |
| **P4420 - Classical Phys II (EM)** | X |  | X |  |  |  |
| **P5110 - Intro Nuc & Part Phys** | X | X | X |  |  |  |
| **P5450 - Intro Quantum Mech** | X |  | X |  |  |  |
| **P5460 - Quantum and Stat Mech** | X |  | X |  |  |  |
| **M1210/1250 - Calculus I** | X |  | X |  |  |  |
| **M1220/1260 - Calculus II** | X |  | X |  |  |  |
| **M2210 - Calculus III** | X |  | X |  |  |  |
| **M2250 - Diff Eq and Lin Alg** | X |  | X |  |  |  |
| **M3150 - PDE’s for Engineers** | X |  | X |  |  |  |
| **M3160 - Appl Complex Var** | X |  | X |  |  |  |
| **C1210 - Gen Chem I** | X |  | X |  |  |  |
| **C1215 - Gen Chem I Lab** | X |  | X | X |  |  |
| **C1220 - Gen Chem II** | X |  | X |  |  |  |
| **C1225 - Gen Chem II Lab** | X |  | X | X |  |  |