Department of Physics and Astronomy
Goals and Learning Outcomes

1. Students know basic physics principles [BS, BA, MS]

1.1 Students can demonstrate an understanding of Newton's laws
1.2 Students can demonstrate an understanding of Maxwell's equations
1.3 Students can demonstrate an understanding of the Schrödinger equation
1.4 Students can answer qualitative and quantitative problems in classical mechanics
1.5 Students can answer qualitative and quantitative problems in electricity and magnetism
1.6 Students can answer qualitative and quantitative problems in quantum mechanics
1.7 Students can demonstrate an understanding of the thermodynamics and statistical mechanics
1.8 Students can represent physical systems using mathematics and manipulate mathematical expressions relating to physical systems

2. Students can apply their knowledge to practical, theoretical and experimental problems [BS, BA only]

2.1 Students can analyze experimental results and draw reasonable conclusions from them
2.2 Students can interpret experimental data to draw meaningful conclusions from properly conducted experiments

3. Students can effectively communicate with the physics community through scientific journals, poster presentations and scientific talks. [MS only]

3.1 Students can locate research results by searching electronic and traditional databases
3.2 Students can present research in a form consistent with the AIP style manual

4. Students are prepared for careers in science, industry and education. [BS, BA, MS]

4.1 Students can identify and use standard laboratory equipment and instrumentation
4.2 Students have developed critical thinking skills (and can apply these skills to solving problems in physics)
4.3 Students are proficient using standard software tools (such as Mathematica, Excel and Word) for modeling, data analysis and report writing

Assessment Plan for Learning Outcomes for BA/BS in Physics

Assessment of Basic Level Outcomes (BS, BA)

Solve applications in Physics-

(1.1, 1.4) In an assignment or exam taken by the end of their sophomore year, physics majors can correctly draw free-body diagrams and write the associated equations of motion. [50]

(1.5) In an assignment or exam taken by the middle of their junior year, physics majors can correctly determine the electric field due to a symmetric charge distribution. [51]

(1.5) In an assignment or exam taken by the middle of their junior year, physics majors can correctly determine the magnetic field due to a symmetric current distribution. [51]

In an assignment or exam taken by the end of their junior year, physics majors can correctly relate the image distance, object distance, magnification, and focal length for a thin lens. [52]

(1.7) In an assignment or exam taken by the end of their junior year, physics majors can correctly relate the parameters of the kinetic model of an ideal gas. [52]

(2.1) In a laboratory class by the end of their sophomore year, physics majors can analyze results of a physics experiment and draw reasonable conclusions from them [50,51,52]

(2.2) In a laboratory class by the end of their sophomore year, physics majors can correctly interpret experimental data to quantitatively compare experimental results to theoretical values, taking into account experimental uncertainty. [50,51,52]

(2.2) In a laboratory class by the end of their sophomore year, physics majors can quantitatively describe in a reasonable fashion the amount of uncertainty in measured quantities. [50,51,52]

(4.1) In a laboratory class by the end of their sophomore year, physics majors can demonstrate proper use of Vernier calipers for linear measurements. [50,51,52]

(4.1) In a laboratory class by the end of their junior year, physics majors can use an oscilloscope to measure the frequency and amplitude of a periodic signal. [51,120A]

(1.4) In an assignment or exam by the end of their Sophomore year, students can correctly analyze simple harmonic motion of an object. [50]

(1.8) In an assignment or exam by the end of their Sophomore year students can transform vectors between Cartesian coordinate system. [50]

(4.3) By the completion of their sophomore year, students have analyzed scientific data using software tools.

(4.3) By the completion of their sophomore year, students have produced scientific writing using a computer.

Assessment of Intermediate Level Outcomes (BS, BA)

(1.5) In an assignment or exam taken by the middle of their junior year, physics majors can calculate the currents in various branches of a circuit involving batteries and resistors using Kirchhoff's rules. [51]

(1.5) In an assignment or exam taken by the middle of their junior year, physics majors can correctly determine the induced electromotive force due to a time-varying magnetic field.[51]

In an assignment or exam taken by the end of their junior year, physics majors can calculate the diffraction from a circular aperture and relate to two point resolution using Rayleigh's criterion. [52,158]

(4.1) In a laboratory class by the end of their junior year, physics majors can use a multimeter to measure the resistance, voltage and current in a given circuit. [51,120A]

(2.2) In a laboratory course by the end of their Junior year, physics majors can determine the experimental uncertainty of calculated parameters based on experimental uncertainty in measured data. [50,51,52]

(1.4) In an assignment or exam by the end of their Junior year, students can correctly analyze oscillatory motion of an object, including damped and driven harmonic oscillations. [105]

(1.8) In an assignment or exam by the end of their Junior year students can express vector quantities in cartesian, cylindrical or spherical coordinates. [105, 110]

(1.5) In an assignment or exam by the end of their Senior year students can use multiple methods to find the electric fields produced by a given charge distribution. [110]

(1.5) In an assignment or exam by the end of their Senior year students can use multiple methods to find the magnetic fields produced by a given current distribution. [110]

Assessment of Advanced Level Outcomes (BS, BA)

(1.5) In an assignment or exam taken by the middle of their junior year, physics majors can calculate the voltage across and current through various devices of a circuit involving capacitors, inductors, resistors and power sources. [51]

(4.2) In a laboratory class by the end of their junior year, physics majors can develop a physics experiment to decisively test a hypothesis [52]

(1.4) In an assignment or exam by the end of their senior year physics majors can determine the Lagrangian for a physical system and obtain from it the equation of motion [105]

(1.4) In an assignment or exam by the end of their senior year can derive and use the equation of motion in a rotating coordinate frame [105]

(1.4) In an assignment or exam by the end of their senior year, students can correctly analyze coupled harmonic oscillators. [105, 163]

(1.6) In an assignment or exam by the end of their senior year, students can demonstrate an understanding of how quantum mechanics allows in-principle-absolutely-secure cryptographic communication.[163]

(1.2, 1.5) In an assignment or exam by the end of their senior year, students can use Maxwell's equations to derive electromagnetic wave equations. [110]

(1.8) In an assignment or exam by the end of their Senior year students can demonstrate the ability to transform vectors between Cartesian, cylindrical and spherical coordinate systems. [105, 110]

(1.8) In an assignment or exam by the end of their senior year students can transform lengths and durations into different reference frames, and can utilize the invariant spacetime interval to relate events in different reference frames. [122]

(1.3, 1.6) In an assignment or exam by the end of their senior year students can compute wavelengths of photons emitted by electron transitions in the Hydrogen atom and the infinite square well. [122]

In an assignment or exam by the end of their senior year students can use conservation laws to determine validity of particular particle-scattering or particle-decay processes. [122]

(4.2) In a programming assignment by the end of their Senior year, physics students can solve differential equations using numerical methods [140]

(1.3, 1.6) In an assignment or exam by the end of their senior year students are able to calculate expectation values for measurements on arbitrary states of a simple harmonic oscillator. [122]

(1.3, 1.6) In an assignment or exam by the end of their senior year students are able to calculate angular momentum outcomes and associated probabilities for arbitrary state of the Hydrogen atom [122]

(1.7) In an assignment or exam by the end of their senior year, physics students can use Boltzman statistics to describe parameters of a system in thermal equilibrium [160]

Assessment of Learning Outcomes for MS in Physics

Assessment of Basic Level Outcomes (MS)

(1.4) In an assignment or exam, physics masters students can demonstrate the ability to use the methods of Lagrange to generate equations of motion. [205]

(1.8) In an assignment or exam, physics masters students can calculate the Fourier transform of a function. [205]

(1.2) In an assignment or exam, students can recognize Maxwell's equations in differential and integral form. [210]

(1.3, 1.6) In an assignment or exam, students can find the quantized energy levels for a simple harmonic oscillator. [263]

(1.8) In an assignment or exam, students can correctly recognize when a mathematical function can be well approximated by a linear relation and correctly determine the linear approximation. [240]

(3.1) Students can locate research results by searching electronic databases

(1.2) In an assignment or exam, physics masters students can demonstrate an understanding of the generation and propagation of electromagnetic radiation. [210]

Assessment of Intermediate Level Outcomes (MS)

(1,4) In an assignment or exam, physics masters students are able to derive Hamilton's equations from Hamilton's principle and by using a Legendre transformation [205]

(1.1, 1.4) In an assignment or exam, physics masters students are able to solve a simple problem (such as the harmonic oscillator) using the Hamilton Jacobi equation. [205]

(1.2) In an assignment or exam, physics masters students can write Maxwell's equations in integral or differential form and use them to solve problems in electricity and magnetism. [210]

(1.3) In an assignment or exam, students can use the Schrödinger equation to find the wave-function and energy states for a particle in a variety of potential wells. [263]

(1.3, 1.6) In an assignment or exam, students are able to find low-order energy corrections caused by small perturbations to the Hamiltonian. [263]

(1.3, 1.6) In an assignment or exam, students are able to find transition probabilities induced by sinusoidally varying potentials. [263]

(1.8) In an assignment or exam, physics masters students are able to use Green's functions to solve potential problems involving Dirichlet and Neumann boundary conditions. [210]

(1.8) In an assignment or exam, physics masters students demonstrate an understanding of the solution of the Poisson equation in spherical and cylindrical coordinates, thus showing a familiarity with spherical harmonics and Bessel functions. [210]

(3.2) In a class presentation or a research presentation present research in a form consistent with the AIP style manual [Culminating Exerpeince]

(4.3) By the completion of their degree, students have produced scientific writing using LaTeX. [Culminating Exerpeince]

Assessment of Advanced Level Outcomes (MS)

(1.6, 4.2) In an oral exam, physics masters students can describe quantitatively real-world consequences of quantum mechanics. [Culminating Experience]

(1.2) In an oral exam, physics masters students demonstrate an in-depth understanding of Maxwell's equations [Culminating Experience]

(4.2) In an oral exam or presentation students physics masters students can demonstrate critical thinking skills and can apply these skills to solving problems in physics [Culminating Experience]

(4.2) In an oral presentation physics masters students can describe the physical significance and the theory behind a recent experiment, project, or work in Physics [Culminating Experience]