# PHYSICS (PHYS)

**PHYS 100 Concepts of Physics-GTSC23 Credits**
Introduction to physics. Emphasis on basic conceptual aspects described in everyday language. Elementary mathematics introduced when necessary. Survey of topics such as Newtonian mechanics, heat and energy, electricity and magnetism, light, relativity and quantum theory. The course is designed for majors outside of the sciences.
**Essential Learning Categories:** Natural Sciences
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**PHYS 101 Elementary Astronomy-GTSC23 Credits**
Introduction to astronomy. Survey of topics such as observational astronomy, the solar system, stellar astronomy, galaxies and cosmology. Emphasis on basic conceptual aspects of astronomy. Minimal use of elementary mathematics such as basic arithmetic, fractions, square roots and powers. The course is designed for students in all majors.
**Essential Learning Categories:** Natural Sciences
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**PHYS 111 General Physics-GTSC14 Credits**
Algebra-based introduction to classical mechanics and thermodynamics. Includes mechanics, energy and momentum conservation, thermodynamics and statistical mechanics. Extensive use of high school level algebra and trigonometry, mastery of these subjects required. Four lectures and one two-hour laboratory per week.
**Corequisites:** PHYS 111L.
**Essential Learning Categories:** Natural Science with lab - Both the lab and lecture must be completed
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**PHYS 111L General Physics Laboratory-GTSC11 Credit**
Lab component required for PHYS 111.
**Corequisites:** PHYS 111.
**Essential Learning Categories:** Natural Science with lab - Both the lab and lecture must be completed
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**PHYS 112 General Physics-GTSC14 Credits**
Algebra-based introduction to classical electromagnetism, optics and modern physics. Detailed coverage of electrostatics, electric circuits, magnetism, electromagnetic waves, geometrical optics and wave optics. Topics from modern and atomic physics. Extensive use of algebra and trigonometry.
**Prerequisites:** PHYS 111/PHYS 111L, or PHYS 131/PHYS 131L, with a grade of C or higher.
**Corequisites:** PHYS 112L.
**Essential Learning Categories:** Natural Science with lab - Both the lab and lecture must be completed
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**PHYS 112L General Physics Laboratory-GTSC11 Credit**
Lab component required for PHYS 112.
**Prerequisites:** PHYS 111/PHYS 111L, or PHYS 131/PHYS 131L, with a grade of C or higher.
**Corequisites:** PHYS 112.
**Essential Learning Categories:** Natural Science with lab - Both the lab and lecture must be completed
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**PHYS 131 Fundamental Mechanics-GTSC14 Credits**
Calculus-based introduction to classical mechanics. Detailed coverage of the kinematics and dynamics of linear and rotational motion using Newton's Laws, momentum and energy conservation. The mathematics of calculus and vectors is used throughout. For majors in the sciences and engineering.
**Prerequisites:** MATH 151 or MATH 135 (either may be taken concurrently).
**Corequisites:** PHYS 131L.
**Essential Learning Categories:** Natural Science with lab - Both the lab and lecture must be completed
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**PHYS 131L Fundamental Mechanics Laboratory-GTSC11 Credit**
Lab component required for PHYS 131.
**Prerequisites:** MATH 151 or MATH 135 (either may be taken concurrently).
**Corequisites:** PHYS 131.
**Essential Learning Categories:** Natural Science with lab - Both the lab and lecture must be completed
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**PHYS 132 Electromagnetism and Optics-GTSC14 Credits**
Calculus-based introduction to classical electromagnetism and optics. Detailed coverage of electrostatics, electric circuits, magnetism, electromagnetic waves, geometrical optics and wave optics. The mathematics of calculus and vectors is used throughout. For majors in the sciences and engineering. Requires a mastery of the foundations of classical mechanics as covered in PHYS 131.
**Prerequisites:** PHYS 131/PHYS 131L, and MATH 152 or MATH 136 (either may be taken concurrently). A grade of C or higher in PHYS 131/PHYS 131L is required.
**Corequisites:** PHYS 132L.
**Essential Learning Categories:** Natural Science with lab - Both the lab and lecture must be completed
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**PHYS 132L Electromagnetism and Optics Laboratory-GTSC11 Credit**
Lab component required for PHYS 132.
**Prerequisites:** PHYS 131/PHYS 131L, and MATH 152 or MATH 136 (either may be taken concurrently). A grade of C or higher in PHYS 131/PHYS 131L is required.
**Corequisites:** PHYS 132.
**Essential Learning Categories:** Natural Science with lab - Both the lab and lecture must be completed
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**PHYS 196 Topics1-3 Credits**
Course may be taken multiple times up to maximum of 15 credit hours.

**PHYS 230 Intermediate Dynamics3 Credits**
Intermediate treatment of the dynamics of physical systems not covered in Fundamental Mechanics sequence. Includes fluid dynamics, classical waves and vibrations, thermodynamics, and relativistic kinematics and dynamics.
**Prerequisites:** PHYS 132/PHYS 132L, and MATH 253 (may be taken concurrently).

**PHYS 231 Modern Physics3 Credits**
Quantum theory in the examination of blackbody radiation, the photoelectric effect, and energy quantization of atoms. The Schrodinger wave equation used to analyze simple quantum systems. Applications drawn from atomic and molecular physics, solid-state physics, nuclear and high-energy physics, and astrophysics.
**Prerequisites:** PHYS 132/PHYS 132L, and MATH 253 (may be taken concurrently).

**PHYS 251 Electronics for Scientists3 Credits**
This laboratory-based course is an introduction to electric circuits and electronic instrumentation for scientists. The course will emphasize a practical approach, with students learning about electronic devices and how they work by building working circuits. Topics explored include passive circuits with resistors and capacitors, including applications in electric filtering; diodes; transistors; op-amps; timing circuits; feedback and amplification; and digital circuits.
**Prerequisites:** PHYS 132 or PHYS 112.

**PHYS 252 Intermediate Laboratory3 Credits**
Students will perform experiments in optics, acoustics, and modern physics. Experiments will include measuring the speed of light, measuring the wavelength of atomic discharge lines, X-ray diffraction, and measuring h/e among others. Emphasis will be on experimental design, use of modern instrumentation, preparation of lab reports, and data analysis.
**Prerequisites:** PHYS 231 (may be taken concurrently).

**PHYS 296 Topics1-3 Credits**
Course may be taken multiple times up to maximum of 15 credit hours.

**PHYS 300 New Directions in Science3 Credits**
A survey of recent developments in science. This course is open to qualified students in liberal arts as well as the sciences. Faculty from various disciplines will participate. Topics will be drawn from astronomy, biology, chemistry, geology, physics, engineering, and applied mathematics.
**Prerequisites:** Permission of instructor.

**PHYS 301 Introduction to Space Science3 Credits**
The history and technology of space and space exploration. Designed for all non-science majors, particularly prospective K-12 teachers. Topics include: the solar system, space environments, space travel, satellite communication and design.
**Prerequisites:** Junior or senior status, or permission of instructor.

**PHYS 311 Electromagnetic Theory I3 Credits**
A mature study of electromagnetic fields. Electrostatics and magnetostatics presented. Special techniques, including multipole expansion of fields, analyzed. Electrodynamics introduced leading to Maxwell's equations.
**Prerequisites:** MATH 253; and MATH 260 or MATH 236; and PHYS 230 or PHYS 231.

**PHYS 312 Electromagnetic Theory II3 Credits**
A continuation of PHYS 311. Electromagnetic waves were studied. Wave propagation in conducting and nonconducting media is examined, along with dispersion phenomena. Waveguides are examined. Electromagnetic field radiation is studied, both for point charges and for arbitrary charge distributions. The course concludes with a reformulation of electromagnetism in the language of special relativity.
**Prerequisites:** PHYS 311.

**PHYS 321 Quantum Theory I3 Credits**
Quantum physics foundation. Includes quantum states, measurements, and time evolution using Dirac formalism for discrete and continuous systems. Connection between Dirac formalism and wave mechanics established and Schrodinger equation solved in various context. Includes particles in piecewise square potentials, tunneling, the harmonic oscillator, angular momentum, and the hydrogen atom. Introduces linear algebra for describing quantum physics and uses techniques for solving differential equations.
**Prerequisites:** PHYS 231, and MATH 260 or MATH 236.

**PHYS 331 Advanced Laboratory I3 Credits**
A course in experiment design and technique. Laboratory investigations provide experience in instrumental methods, planning of laboratory experiments, data analysis, preparation of reports according to professional standards, and training in the use of computers for data acquisition and processing. The experiments to be performed are selected from electromagnetism, atomic, nuclear, and solid-state physics.
**Prerequisites:** PHYS 252.

**PHYS 342 Advanced Dynamics3 Credits**
In-depth survey of classical mechanics, includes advanced treatment of Newtonian dynamics, conservation laws, gravitation, and the Lagrangian and Hamiltonian formulations of dynamics. Topics may include central force motion, systems of particles, non-inertial reference frames, rigid bodies, oscillating systems, couple oscillations, and waves on a string.
**Prerequisites:** PHYS 230, and MATH 260 or MATH 236.

**PHYS 352 History and Philosophy of Physics3 Credits**
Material varies from year-to-year. The course addresses problems in the interpretation and development of physics. Case studies of crucial experiments are analyzed. The interaction of physics with other philosophical and cultural pursuits is discussed.
**Prerequisites:** One year of physics or permission of instructor.

**PHYS 362 Statistical and Thermal Physics3 Credits**
Study of the physics of bulk matter. Fundamental principles of quantum mechanics, statistical methods employed to explain macroscopic laws of thermodynamics to make detailed predictions about the large-scale behavior of solids, liquids, and gases. Applications: specific heat of solids, thermal radiation, magnetic susceptibilities, stellar equilibrium, and chemical reactions.
**Prerequisites:** PHYS 230 or CHEM 321; and MATH 236 or MATH 260.

**PHYS 372 General Relativity3 Credits**
Introduction to Einstein's theory of general relativity. Newtonian gravitation and Einstein's theory of special relativity reviewed. Topics may include spherically symmetric stars, static and rotating black holes, FRW cosmologies, gravitational waves, and wormholes.
**Prerequisites:** PHYS 230 and MATH 236 or MATH 260.
**Terms Typically Offered:** Fall, Spring.

**PHYS 395 Independent Study1-3 Credits**
Course may be taken multiple times up to maximum of 6 credit hours.

**PHYS 396 Topics1-3 Credits**
Course may be taken multiple times up to maximum of 15 credit hours.

**PHYS 422 Quantum Theory II3 Credits**
Continuation of PHYS 321. Central forces, complete derivation of hydrogen atom energy levels and eigenstates. Perturbation theory and other approximately techniques. Other selected topics include: multiple quantum systems, scattering, quantum foundations.
**Prerequisites:** PHYS 321.

**PHYS 432 Nuclear and High-Energy Physics3 Credits**
An introduction to the structure and interactions of nuclear and subnuclear particles. Topics include a survey of the intrinsic properties of nuclei, descriptions of various nuclear models, studies of radioactivity and nuclear reactions, and an overview of the technologies of high-energy accelerators and detectors. The course concludes with an introduction to the properties and structures of elementary particles and discussions of current developments in unified theories of force.
**Prerequisites:** PHYS 322.

**PHYS 441 Solid State Physics3 Credits**
The structure and properties of solids. This course is a study of the crystalline state of matter, including crystal classifications, vibrational specific heats, electronic structures and conductivities, cohesive energies, magnetic susceptibility, and optical properties.
**Prerequisites:** PHYS 321.

**PHYS 471 Computational Physics I3 Credits**
Foundation covering application of computational techniques to solving physical problems. Numerical integration, differentiation, and matrix methods covered. Techniques of solving various regular and partial differential equations studied. Application of discretizing numerical solutions for physical problem stressed. Turning analytic problems into solvable computational schemes. Data analysis and visualization covered. Familiarity with any programming language is required. For any Science, Engineering or Mathematics major.
**Prerequisites:** MATH 260 or MATH 236.

**PHYS 472 Computational Physics II3 Credits**
A continuation of PHYS 471. Advanced topics in solving partial differential equations and simulating physical systems using modern parallel computing covered. MPI, Open MP, and their applications to physical phenomenon on Linux workstations covered. Introduction to translating analytical problems to parallel computational problems
**Prerequisites:** PHYS 471.

**PHYS 473 Modern Optics3 Credits**
Modern principles and applications of optics. Optical models including ray and wave optics presented. Laws of reflection and refraction studied within the context of both ray and wave optics. Reflectivity and transmissivity analyzed. Superposition and wave interference discussed. Diffraction theory used in a number of applications. Concludes with an introduction to lasers and quantum optics.
**Prerequisites:** PHYS 311.

**PHYS 482 Senior Research1 Credit**
An individual research project, supervised by a faculty advisor. The project may be selected from experimental or theoretical topics. The research concludes with a formal report written in accordance with The American Institute of Physics Style Manual. This course is normally taken twice in the senior year.
Course may be taken 2 times for credit.

**PHYS 487 Structured Research1-3 Credits**
Physics research under the direct guidance of a faculty member. Designed for advanced junior and senior level students.
**Prerequisites:** Permission of instructor.

**PHYS 494 Physics Seminar1 Credit**
A forum for topical physics. In this seminar, faculty and students of physics participate in both informal discussions and formal oral presentations of selected topics of scientific interest, including significant current advances and crucial historical developments.
**Prerequisites:** Upper division standing and permission of instructor.
Course may be taken 4 times for credit.

**PHYS 495 Independent Study1-3 Credits**
Course may be taken multiple times up to maximum of 6 credit hours.

**PHYS 496 Topics1-3 Credits**
Course may be taken multiple times up to maximum of 15 credit hours.

**PHYS 596 Topics:1-3 Credits**
Course may be taken multiple times up to maximum of 15 credit hours.