

PHYSICS

Mission Statement

The Department of Physics & Astronomy at Denison University seeks to foster an understanding and deep appreciation of the physical world and our relationship to it. Our mission is centered on an engaging curriculum that balances breadth and depth, empowering students to explore, comprehend, and apply the fundamental principles of the universe.

Our faculty prioritize undergraduate education, combining effective teaching practices with the latest scholarly insights. We invite students to become active partners in the pursuit of original investigations, nurturing a culture of inquiry and discovery. Through our comprehensive program, students achieve increasing levels of autonomy in both experimental and theoretical physics.

The key objectives of our program are for students to:

1. understand the principal laws which govern the physical world;
2. master the fundamental reasoning process used in solving problems;
3. learn mathematical techniques and computational tools to solve physics problems;
4. develop an understanding of electronics, technical measurements, and data analysis;
5. identify, organize, and conduct independent investigations and communicate the results.

Departmental Guidelines

The physics curriculum at Denison University begins with an exploration of modern physics and astronomy in the very first class, titled "Quarks to Cosmos" (Physics / Astronomy 125). In this course, students examine how time and space transform near the speed of light, the structure of atoms and nuclei, elementary particles, and the evolution of the universe.

The following courses in the introductory sequence investigate motion, fluids, heat, electricity, magnetism, waves, and optics. Advanced courses dive deeper into classical mechanics, electrodynamics, quantum physics, and thermodynamics, as well as electronics and data analysis. Many of our students are also involved in research during their time at Denison, contributing to the generation of new knowledge.

A physics degree is a strong foundation for a wide range of careers, from engineering and medicine to finance and industrial management.

Physics majors develop problem-solving, effective communication, quantitative reasoning, and technical skills that are highly valued by employers. They are also well-prepared for graduate study in physics, astronomy, and related fields.

All students interested in the physics major or in engineering should enroll in Physics 125 and calculus during the fall of their first year.

Students can also complete a major in physics by beginning in the sophomore year, although they may have fewer course options. Students who have taken Physics 121 and Physics 122, and those that have transferred to Denison, should consult with the Department Chair about degree requirements.

Faculty

Associate Professor Steven Olmschenk, Chair

Professors Steven D. Doty, N. Daniel Gibson, Daniel C. Homan, C. Wesley Walter; Associate Professors Kimberly A. Coplin, Melanie Lott, Steven

Olmschenk, Riina Tehver; Visiting Assistant Professor Sandra Doty; Technician/Machinist David Burdick

Academic Administrative Assistant
Cathy Geho

View faculty profiles and contact information (<https://denison.edu/academics/physics/contacts/>)

Physics Major

The Department offers a Bachelor of Arts (B.A.) and a Bachelor of Science (B.S.) degree in Physics, as well as a minor in Physics and a minor in Astronomy. Both the B.A. and the B.S. are excellent preparation for a wide range of careers. The B.S. degree is highly recommended for students planning to pursue advanced study in Physics, Astronomy, or related fields.

The requirements for the B.A. and B.S. degrees in Physics, as well as the minor in Physics, are described below. Requirements for the B.A., B.S., and minor include courses in both Physics and Math; the B.S. also requires completion of an approved independent project. (Requirements for the minor in Astronomy appear under the Astronomy (<https://catalog.denison.edu/catalog/courses-of-study/astronomy/>) section of this catalog.) Students who have taken PHYS 121 - General Physics I and PHYS 122 - General Physics II should consult with the Department Chair about course requirements. All students interested in a major or minor in Physics, or a minor in Astronomy, should consult with a faculty member in the Department as soon as possible.

1. Physics courses

a. The B.A. degree requires:

Code	Title
PHYS 125	Principles of Physics I: Quarks to Cosmos
or ASTR 125	Principles of Physics I: Quarks to Cosmos
PHYS 126	Principles of Physics II
PHYS 127	Principles of Physics III
PHYS 200	Modern Physics
PHYS 201	Applied Mathematics for Physical Systems
PHYS 305	Classical Mechanics
PHYS 311	Electronics
PHYS 312	Experimental Physics

And two semesters of PHYS 400 (1 credit each), plus one additional Physics or Astronomy course at the 200-level or above.

Any courses used to satisfy the upper-level elective requirement for the Physics major (B.A. or B.S.) or for the Physics minor may not also be used to satisfy the Astronomy minor.

b. The B.S. degree requires:

Code	Title
PHYS 125	Principles of Physics I: Quarks to Cosmos
or ASTR 125	Principles of Physics I: Quarks to Cosmos
PHYS 126	Principles of Physics II
PHYS 127	Principles of Physics III
PHYS 200	Modern Physics
PHYS 201	Applied Mathematics for Physical Systems
PHYS 305	Classical Mechanics
PHYS 311	Electronics

PHYS 306	Electricity and Magnetism
PHYS 312	Experimental Physics
PHYS 330	Introductory Quantum Mechanics

And two semesters of PHYS 400 (1 credit each), plus one additional Physics or Astronomy course at the 200-level or above.

Any courses used to satisfy the upper-level elective requirement for the Physics major (B.A. or B.S.) or for the Physics minor may not also be used to satisfy the Astronomy minor.

2. Math courses

- The B.A. degree requires MATH 135 - Single Variable Calculus and MATH 145 - Multi-variable Calculus.
- The B.S. degree requires MATH 135 - Single Variable Calculus and MATH 145 - Multi-variable Calculus, as well as one additional Math class (200-level or above) or a course in Computer Science.

3. Independent project

The B.S. degree requires the successful completion of an independent project. The project must be approved in advance by the department.

Physics Minor

The requirements for a minor in Physics are:

Code	Title
PHYS 125	Principles of Physics I: Quarks to Cosmos
or ASTR 125	Principles of Physics I: Quarks to Cosmos
PHYS 126	Principles of Physics II
PHYS 127	Principles of Physics III
MATH 135	Single Variable Calculus
MATH 145	Multi-variable Calculus

Plus three Physics courses at the 200-level or above; at least one of these courses must include a significant laboratory component.

(Students who have taken PHYS 121 - General Physics I and PHYS 122 - General Physics II should consult with the Department Chair about requirements.)

Additional Points of Interest

Engineering

Denison offers the opportunity to study engineering via dual-degree programs undertaken in cooperation with leading schools of engineering. Students interested in these programs should consult early with the Pre-Engineering Director, Steven Doty. Additional details can be found in this catalog under Pre-Professional Programs.

Courses

PHYS 100 - Current Topics in Physics (4 Credit Hours)

Designed principally for students not contemplating a major in the sciences, but who nevertheless wish to develop their ability to figure things out about the physical world for themselves. Recently, the course has focused on the physics of societal concerns such as energy and the environment. The laboratory, an integral part of the course, will serve to introduce the student to the observation, measurement, and analysis of phenomena directly related to topics studied in the course. Open to seniors by consent only. Mathematical preparation is assumed to include high school algebra and geometry.

PHYS 121 - General Physics I (4 Credit Hours)

This calculus-based course is designed to provide a thorough quantitative coverage of the foundations and concepts of physics and its approach toward an understanding of natural phenomena. Newtonian mechanics and dynamics, fluids, and thermal physics are covered. Three lectures and one three-hour laboratory each week.

Prerequisite(s): MATH 130 or MATH 135 or MATH 145 or concurrent.

PHYS 122 - General Physics II (4 Credit Hours)

This calculus-based course is designed to provide a thorough quantitative coverage of the foundations and concepts of physics and its approach toward an understanding of natural phenomena. The course includes electricity and magnetism, optics and waves. Three lectures and one three-hour laboratory each week.

Prerequisite(s): PHYS 121.

PHYS 125 - Principles of Physics I: Quarks to Cosmos (4 Credit Hours)

Physics/Astronomy 125 will introduce students to topics that are at the current frontiers of physics and astronomy, and help students develop quantitative reasoning and analytical skills necessary for further study in these fields. Topics possibly covered include special relativity, waves and interference, quantization of light and energy, the hydrogen atom, nuclear structure, radioactivity, and cosmology. The course satisfies the quantitative reasoning requirement. Three lectures and one three-hour laboratory per week.

Prerequisite(s): MATH 130 or MATH 135 or MATH 145 or concurrent.

Crosslisting: ASTR 125.

PHYS 126 - Principles of Physics II (4 Credit Hours)

This course is designed to provide a thorough quantitative understanding of the principles of physics and its approach toward investigating natural phenomena and the universe around us. This calculus-based sequence is primarily designed for those interested in physics, astronomy and pre-engineering. This course satisfies the quantitative reasoning requirement and is also appropriate for those majoring in other physical sciences (see also Physics 121-122). Topics include Newtonian mechanics, vibrations, fluids, and thermal physics. Three lectures and one three-hour laboratory each week.

Prerequisite(s): PHYS 125, MATH 135 or MATH 145 or concurrent.

PHYS 127 - Principles of Physics III (4 Credit Hours)

This course is designed to provide a thorough quantitative understanding of the principles of physics and its approach toward investigating natural phenomena and the universe around us. This calculus-based sequence is primarily designed for those interested in physics, astronomy, and pre-engineering. This course is also appropriate for those majoring in other physical sciences. (also see Physics 121-122). Topics include electricity and magnetism, waves and optics. Three lectures and one three-hour laboratory each week.

Prerequisite(s): PHYS 126 and MATH 145 or concurrent.

PHYS 199 - Introductory Topics in Physics (1-4 Credit Hours)

A general category used only in the evaluation of transfer credit.

PHYS 200 - Modern Physics (4 Credit Hours)

A quantitative study of topics in modern physics including relativistic kinematics and dynamics, interactions between light and matter, an introduction to the principles of quantum mechanics, and atomic physics. Additional topics may include solid-state physics, nuclear physics, or other contemporary topics. Analytical techniques are emphasized throughout.

Prerequisite(s): PHYS 122 or PHYS 127, PHYS 201 or concurrent, or consent.

PHYS 201 - Applied Mathematics for Physical Systems (4 Credit Hours)

A one-semester overview of mathematics applied to physical systems, with extensive use of examples from introductory and intermediate physics. Topics covered will include operators, functions, vectors, complex numbers, integration, differentiation, geometry, differential equations, and linear algebra. The unity of linear systems will be emphasized, though non-linearity will also be discussed. Both hand- and computer-aided computation will be required.

Prerequisite(s): PHYS 121 or PHYS 126, and MATH 145, or consent.

PHYS 220 - Geometrical and Physical Optics (4 Credit Hours)

A study of the laws of reflection and refraction and their applications to lenses and mirrors; and a study of diffraction, interference, polarization, and related phenomena. The course includes a laboratory.

Prerequisite(s): PHYS 122 or PHYS 127.

PHYS 245 - Special Intermediate Topics in Physics (4 Credit Hours)

This course provides a venue in which to explore chosen topics in physics at the intermediate level. Topics vary according to the interests of students and faculty. In some cases, the course may be repeated for credit.

Prerequisite(s): PHYS 121 or PHYS 126 or consent.

PHYS 299 - Intermediate Topics in Physics (1-4 Credit Hours)

A general category used only in the evaluation of transfer credit.

PHYS 305 - Classical Mechanics (4 Credit Hours)

A course in classical mathematical physics designed to provide the student with a basic understanding of the methods and procedures of physical analysis.

Prerequisite(s): PHYS 127, PHYS 201 or MATH 213, or consent.

PHYS 306 - Electricity and Magnetism (4 Credit Hours)

A course in the theory of electromagnetic interactions, including the sources and descriptions of electric and magnetic fields, Maxwell's equations, and electromagnetic radiation.

Prerequisite(s): PHYS 305 or consent.

PHYS 311 - Electronics (4 Credit Hours)

A course in digital and analog electronics with an emphasis on circuit design and lab work. Topics typically include binary encoding, combinational and sequential logic, microcontrollers and FPGAs, AC circuits, transistors, op-amps, and interfacing with scientific instruments.

Prerequisite(s): PHYS 122 or PHYS 127 or consent.

PHYS 312 - Experimental Physics (4 Credit Hours)

A course in the theory and practice of physical research with emphasis on the understanding and use of present-day research instrumentation. May be repeated once for credit as either PHYS 312 or ASTR 312.

Prerequisite(s): PHYS 122 or PHYS 127, PHYS 200 recommended.

PHYS 320 - Thermodynamics (4 Credit Hours)

Selected topics from thermodynamics, kinetic theory, and statistical methods. This course normally will be offered in alternate years. The course may include a laboratory.

Prerequisite(s): PHYS 200 or consent.

PHYS 330 - Introductory Quantum Mechanics (4 Credit Hours)

A first course including solutions of the Schrodinger equation for some elementary systems, followed by an introduction to the more abstract methods of quantum mechanics.

Prerequisite(s): PHYS 305, PHYS 201 or MATH 213, or consent.

PHYS 340 - Advanced Topics (1-2 Credit Hours)

Independent work on selected topics at the advanced level under the guidance of individual staff members. May be taken for a maximum of four semester hours of credit.

Prerequisite(s): Junior standing and consent of chairperson.

PHYS 345 - Special Topics in Physics (4 Credit Hours)

Topics will be chosen according to the interests of the staff member offering the course from such areas as energy, the solid state, laser physics, nuclear physics, biophysics, astrophysics, geophysics and medical physics. The course normally will be offered on demand. May be repeated with consent of chairperson.

Prerequisite(s): PHYS 122 or PHYS 127, or consent.

PHYS 361 - Directed Study (1-4 Credit Hours)

Prerequisite: Consent of chairperson.

PHYS 362 - Directed Study (1-4 Credit Hours)

Prerequisite: Consent of chairperson.

PHYS 363 - Independent Study (1-4 Credit Hours)**PHYS 364 - Independent Study (1-4 Credit Hours)****PHYS 399 - Advanced Topics in Physics (1-4 Credit Hours)**

A general category used only in the evaluation of transfer credit.

PHYS 400 - Physics Seminar (1 Credit Hour)

Current topics in physics. May be repeated.

PHYS 405 - Advanced Dynamics (3 Credit Hours)

A course extending the work of PHYS 305 to include the more general formulations of classical dynamics and to relate these to modern theoretical physics.

Prerequisite(s): PHYS 305 or consent.

PHYS 406 - Electromagnetic Theory (3 Credit Hours)

A course extending the work of PHYS 306 to include more general boundary value problems, additional implications of Maxwell's equations, and the wave aspects of electromagnetic radiation, including topics in modern physical optics.

Prerequisite(s): PHYS 306 or consent.

PHYS 451 - Senior Research (4 Credit Hours)

Prerequisite: PHYS 312 or consent of chairperson.

PHYS 452 - Senior Research (4 Credit Hours)

Prerequisite: PHYS 312 or Consent of Chairperson.

PHYS 470 - Teaching Methods in Physics (1 Credit Hour)

This course is designed to provide an understanding of the basic methods used to teach physics. This course is primarily for those majoring in physics, astronomy, and pre-engineering. One-hour laboratory each week.

Prerequisite(s): PHYS 121 and PHYS 122, or PHYS 126.