

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 Melanie Lott, Chair

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

Melanie Lott, Steven Olmschenk; Visiting Assistant Professor Sandra Doty

Technician/Instrument Maker

Michael Thomas

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	Physics I: Quarks to Cosmos
or ASTR 125	Physics I: Quarks to Cosmos
PHYS 126	Physics II: Mechanics, Fluids, and Heat
PHYS 127	Physics III: Electricity, Magnetism, Waves, and Optics
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	Physics I: Quarks to Cosmos
or ASTR 125	Physics I: Quarks to Cosmos
PHYS 126	Physics II: Mechanics, Fluids, and Heat
PHYS 127	Physics III: Electricity, Magnetism, Waves, and Optics

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	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 - Multivariable Calculus.
- The B.S. degree requires MATH 135 - Single Variable Calculus and MATH 145 - Multivariable 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	Physics I: Quarks to Cosmos
or ASTR 125	Physics I: Quarks to Cosmos
PHYS 126	Physics II: Mechanics, Fluids, and Heat
PHYS 127	Physics III: Electricity, Magnetism, Waves, and Optics
MATH 135	Single Variable Calculus
MATH 145	Multivariable 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 - Special Introductory Topics in Physics (4 Credit Hours)

An introductory, general education science course. The topical focus of each iteration of this course is determined by the instructor. No previous training in physics is expected; mathematical preparation is assumed to include high school algebra and trigonometry.

PHYS 121 - General Physics I (4 Credit Hours)

A calculus-based course providing quantitative coverage of the foundations and concepts of physics and its approach toward understanding natural phenomena. Topics include Newtonian mechanics and dynamics, fluids, and thermal physics. Three lectures and one three-hour laboratory each week.

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

PHYS 122 - General Physics II (4 Credit Hours)

A calculus-based course providing quantitative coverage of the foundations and concepts of physics and its approach toward understanding natural phenomena. Topics include electricity, magnetism, waves, and optics. Three lectures and one three-hour laboratory each week.

Prerequisite(s): PHYS 121.

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

A course that introduces students to topics that are at the current frontiers of physics and astronomy, and helps students develop quantitative reasoning and analytical skills necessary for further study in these fields. Topics typically include special relativity, waves and interference, quantization of light and energy, the hydrogen atom, nuclear structure, radioactivity, and cosmology. This 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 - Physics II: Mechanics, Fluids, and Heat (4 Credit Hours)

The second course in a calculus-based sequence primarily designed for those interested in physics, astronomy, and engineering. This course quantitatively explores the principles of physics and its approach toward investigating natural phenomena and the universe around us. Topics include Newtonian mechanics and dynamics, vibrations, fluids, and thermal physics. Three lectures and one three-hour laboratory each week.

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

PHYS 127 - Physics III: Electricity, Magnetism, Waves, and Optics (4 Credit Hours)

The third course in a calculus-based sequence primarily designed for those interested in physics, astronomy, and engineering. This course quantitatively explores the principles of physics and its approach toward investigating natural phenomena and the universe around us. Topics include electricity, magnetism, waves, and optics. Three lectures and one three-hour laboratory each week.

Prerequisite(s): PHYS 126, 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, quantum mechanics, and atomic physics. Analytical techniques are emphasized throughout.

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

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

An 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. Students will develop both analytical and computational techniques.

Prerequisite(s): PHYS 122 or PHYS 127, MATH 145.

PHYS 220 - Optics, Photonics, and Lasers (4 Credit Hours)

A course on the physics of controlling and generating light. Topics typically include geometric optics, optical instruments, polarization, interference and diffraction, optical fibers, optical cavities, and lasers. Three class hours and one laboratory per week.

Prerequisite(s): PHYS 122 or PHYS 127.

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

A course exploring a topic in physics at the intermediate level. The topical focus of each iteration of this course is determined by the instructor. In some cases, the course may be repeated for credit.

Prerequisite(s): PHYS 121 or PHYS 126.

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 mechanics with a focus on analytical techniques. Topics include an in-depth exploration of Newton's laws, oscillations, rotations, the calculus of variations, central forces, non-inertial frames, the Lagrangian-Hamiltonian formulation of mechanics, and modern-day applications.

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

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 122 or PHYS 127, PHYS 201, PHYS 305.

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, AC circuits, transistors, op-amps, and interfacing with scientific instruments.

Prerequisite(s): PHYS 122 or PHYS 127.

PHYS 312 - Experimental Physics (4 Credit Hours)

An advanced lab course focused on experimental design and techniques, applying statistical principles to analyze and interpret data, and communicating scientific results through writing. May be repeated once for credit as either PHYS 312 or ASTR 312.

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

Crosslisting: ASTR 312.

PHYS 320 - Statistical and Thermal Physics (4 Credit Hours)

A course in statistical mechanics and thermodynamics. Concepts such as free energy, entropy, chemical potential, and statistical ensembles are introduced and applied to a variety of both classical and quantum systems.

Prerequisite(s): PHYS 200, PHYS 201.

PHYS 330 - Quantum Mechanics (4 Credit Hours)

A course in quantum mechanics focusing on solutions of the Schrödinger equation for elementary systems, the mathematical formalism of quantum theory, the hydrogen atom, angular momentum, and perturbation theory.

Prerequisite(s): PHYS 200, PHYS 201, PHYS 305.

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

A course exploring a topic in physics at the advanced level. The topical focus of each iteration of this course is determined by the instructor. In some cases, the course may be repeated for credit.

Prerequisite(s): PHYS 122 or PHYS 127.

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

A student in good standing may work intensively in areas of special interest under the Directed Study plan. A Directed Study is appropriate when, under the guidance of a faculty member, a student wants to explore a subject more fully than is possible in a regular course or to study a subject not covered in the regular curriculum. A Directed Study should not normally duplicate a course that is regularly offered. Directed Studies are normally taken for 3 or 4 credits. A one-semester Directed Study is limited to a maximum of 4 credit hours. Note: Directed Studies may not be used to fulfill General Education requirements.

Prerequisite(s): Consent of chairperson.

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

A student in good standing may work intensively in areas of special interest under the Directed Study plan. A Directed Study is appropriate when, under the guidance of a faculty member, a student wants to explore a subject more fully than is possible in a regular course or to study a subject not covered in the regular curriculum. A Directed Study should not normally duplicate a course that is regularly offered. Directed Studies are normally taken for 3 or 4 credits. A one-semester Directed Study is limited to a maximum of 4 credit hours. Note: Directed Studies may not be used to fulfill General Education requirements.

Prerequisite(s): Consent of chairperson.

PHYS 363 - Independent Study (1-4 Credit Hours)

Independent Study engages a student in the pursuit of clearly defined goals. In this effort, a student may employ skills and information developed in previous course experiences or may develop some mastery of new knowledge or skills. A proposal for an Independent Study project must be approved in advance by the faculty member who agrees to serve as the project advisor. Note: Independent Studies may not be used to fulfill General Education requirements.

PHYS 364 - Independent Study (1-4 Credit Hours)

Independent Study engages a student in the pursuit of clearly defined goals. In this effort, a student may employ skills and information developed in previous course experiences or may develop some mastery of new knowledge or skills. A proposal for an Independent Study project must be approved in advance by the faculty member who agrees to serve as the project advisor. Note: Independent Studies may not be used to fulfill General Education requirements.

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.

Prerequisite(s): PHYS 125 or ASTR 125 or above or concurrent.

PHYS 451 - Senior Research (4 Credit Hours)

Research under faculty supervision for qualified senior students. Prior consent of the instructor (faculty member advising the research) and the Department Chair required for registration.

PHYS 452 - Senior Research (4 Credit Hours)

Research under faculty supervision for qualified senior students. Prior consent of the instructor (faculty member advising the research) and the Department Chair required for registration.

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

In this course students will develop an understanding of methods and techniques used to teach physics.

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