PHYSICS

Departmental Guidelines

The study of physics is a challenging and intellectually rewarding activity selected by those who seek to sharpen and broaden their appreciation and understanding of the physical world and their relationship to it. To this end, courses offered by the Department of Physics and Astronomy are designed to bring the student to an increasingly independent level of investigation in experimental and theoretical physics, and to a level of sophistication commensurate with an individual’s motivation, goals, and abilities.

A major in Physics is an excellent preparation for careers in engineering, medicine, business, computer science, law, industrial management, and teaching. Sufficient flexibility exists in the major program to suit the needs and goals of the individual.

Faculty

Associate Professor Riina Tehver, Chair

Professors Steven D. Doty, N. Daniel Gibson, Daniel C. Homan, C. Wesley Walter; Associate Professors Kimberly A. Coplin, Steven M. Olmschenk, Riina Tehver; Assistant Professor Melanie Lott; Visiting Assistant Professor Carl Pfendner; Technician/Machinist David Burdick; Academic Administrative Assistant, Cathy Geho

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

Physics Major

A student who wants to major or minor in Physics, or minor in Astronomy, should consult with a member of the Department as soon as possible. The requirements for the major in Physics include Physics courses, Math courses, and the comprehensive experience, as discussed below. (Students who have taken PHYS 121 - General Physics I and PHYS 122 - General Physics II should consult with the chair about Physics course requirements.)

1. Physics courses
   a. The B.A. degree requires:
      | Code  | Title                                      |
      |-------|--------------------------------------------|
      | PHYS 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 211 | Electronics                                |
      | PHYS 305 | Classical Mechanics                        |
      | PHYS 312 | Experimental Physics                       |

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

   b. The B.S. degree requires:
      | Code  | Title                                      |
      |-------|--------------------------------------------|
      | PHYS 125 | Principles of Physics I: Quarks to Cosmos |
      | PHYS 126 | Principles of Physics II                   |

2. Math courses
   a. The B.A. degree requires MATH 135 - Single Variable Calculus and MATH 145 - Multi-variable Calculus.
   b. 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. Comprehensive experience -

   The B.A. and B.S. degree both require the successful completion of an independent project. The project must be approved in advance by the department. As a result, the student is required to discuss potential project ideas with the chair and other department faculty before beginning work on a project.

   The B.S. degree also requires passing the physics comprehensive examination, normally administered during the senior year.

Students preparing for graduate work in Physics, Astronomy, or related fields are advised to elect the B.S. degree in Physics. Additional courses taken in other science departments (Biology, Chemistry, Computer Science, Geosciences, Math) are desirable.

Physics Minor

A minor program in Physics is designed to be flexible and complement the student’s major program. The student, in consultation with the Physics and Astronomy Department, will develop a minor program that will broaden and enhance both the liberal arts experience and the student’s major program. The minor shall include:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 125</td>
<td>Principles of Physics I: Quarks to Cosmos</td>
</tr>
<tr>
<td>PHYS 126</td>
<td>Principles of Physics II</td>
</tr>
<tr>
<td>PHYS 127</td>
<td>Principles of Physics III</td>
</tr>
<tr>
<td>MATH 135</td>
<td>Single Variable Calculus</td>
</tr>
<tr>
<td>MATH 145</td>
<td>Multi-variable Calculus</td>
</tr>
</tbody>
</table>

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

In addition, three courses at the advanced level (200 and above) in Physics are required for the minor. One of the three courses must include a significant laboratory component. These courses will be selected to provide a perspective on the discipline with the specific needs of the student in mind.
In addition to these requirements, a final culminating experience will be designed by the Department and the student. One possibility includes interdisciplinary research that bridges the major and minor areas.

**Additional Points of Interest**

**Engineering**

Denison offers the opportunity to study engineering via three, two dual-degree programs undertaken in cooperation with leading schools of engineering. Students interested in these programs should consult early with the Physics Department chair. 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)**

This course is designed for first-year students who intend to major in physics or pre-engineering. The goal of Physics 125 is to stimulate interest in physics by exposing students to topics that are at the current frontiers of physics and to help students develop quantitative reasoning and analytical skills that are necessary for further study in physics. Topics possibly covered include relativity, particle physics, cosmology, QED, and basic quantum mechanics. The course satisfies the quantitative reasoning requirement and is intended to help students make a smooth transition from high school math and physics courses to our Principles of Physics course (126-127). Three lectures and one three-hour laboratory per week.

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

**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 electricity and magnetism, waves, and optics. Four lectures and one three-hour laboratory each week.

**Prerequisite(s):** PHYS 125, MATH 135 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. Four 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 211 - Electronics (4 Credit Hours)**

A course in digital and analog electronics with an emphasis on circuit design and lab work. Topics 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 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 126 and MATH 145, or consent.
PHYS 299 - Intermediate Topics in Physics (1-4 Credit Hours)
A general category used only in the evaluation of transfer credit.

PHYS 300 - Physics Math Seminar (1 Credit Hour)

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 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 211 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 Schrödinger 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 chairman.
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.