PHYSICS

The Department of Physics offers several majors. The course structure allows students to tailor their programs to their main interests.

ABOUT THE PROGRAM

Opportunities for research participation are available to all students at all class levels during both the academic year and the summer. Students are presently engaged in:

- Nuclear physics experiments on the Hope accelerator
- Theoretical astrophysics investigations
- Material analysis with scanning electron microscopy (SEM) and atomic force microscopy (AFM)
- Heavy ion physics experiments at national laboratories
- Surface analysis using alpha particle beams from the Hope accelerator
- Chemical analysis using proton beams from the Hope accelerator
- Superconductivity
- Plasma physics
- Microwave science
- Electrochemistry
- Nanoscale science

Laboratories provide students with opportunities to test fundamental concepts and apply theory in practical applications. In addition, research programs and internships enable students to work alongside faculty members and working professionals.

In the department, the primary physics research laboratories are a:

- 1.7 million volt Van de Graaff pelletron tandem accelerator
- Scanning electron microscope
- Atomic force microscope
- Nuclear physics laboratory
- Superconductivity/microwave laboratory
- Electrochemistry/nanoscale laboratory
- Extensive computer support.
Students and faculty are also involved in research programs at national laboratories and NASA Goddard Space Flight Center. Students are strongly encouraged, as early as possible, to become involved in one of the research programs of the faculty members. Summer stipends for such activity are often available.

Honors Designation

In order to encourage students to go beyond the minimum requirements for graduation, students completing additional requirements will have an Honors Designation added to their transcripts. Students must fulfill the requirements for a B.S. in physics and take an additional 6 credits of physics. PHYS 342, 361, 362, and 372 must all be taken.

In addition, one summer and two semesters (for one credit each term) of research work must be done with a Hope faculty member, and the research work must be documented in written form and submitted to the Journal of Undergraduate Research in Physics or another appropriate peer-reviewed journal. An additional semester of a laboratory based science majors course outside of physics is required, and a mathematics course beyond the required calculus sequence is required. The minimum GPA in physics courses is 3.6.

DUAL MAJORS

In case of a dual major, the physics courses required are those listed in the major/minor tab above. The additional mathematics and science requirements shall be established by agreement between the student and the department. Recent dual majors have included physics-mathematics, physics-computer science, physics-geology, physics-chemistry and physics-philosophy.

ENGINEERING

The fields of physics and engineering are closely related. Similar principles and science concepts are found in both. One is more focused on application and one tends more to the abstract. Students unsure of their specific career goals are encouraged to speak with the chairpersons of each department.

HEALTH PROFESSIONS

Medicine, Dentistry, Physical Therapy, Veterinary Medicine

Students considering one of the health professions may enroll either in PHYS 105, 106, 107, 108 or PHYS 121, 122, 141, 142. Consultation with your advisor about the appropriate course is strongly advised. Students who may pursue graduate work in the sciences should take PHYS 121, 122, 141, 142.

PREREQUISITE POLICY

Many courses in the department have prerequisites listed. A grade of C- or better is required in these prerequisite courses. If this is not the case, then it is the view of the department that the
prerequisite has not been fulfilled and the course may not be taken without written permission of
the instructor and the department chairperson.

MAJORS

The department offers several majors designed to meet a variety of students' needs. Students with
a possible interest in engineering should also see that section.

Program for students interested in post-graduate professional work in physics, astronomy,
medicine, biophysics, chemical physics, materials physics, radiation physics, environmental
physics, medical physics, please see the major/minor tab.

Bachelor of Arts Degree

A minimum of 27 credits in physics courses numbered 121 and higher including 122, 141, 142,
270, 280, 281 and 382. In addition, 6 credits from courses numbered 340 or higher are required.
Two semesters of PHYS 080 (Seminar) are required. In addition, MATH 232 and an additional
laboratory science course, designated for science majors, in chemistry, biology, or geology are
required. Computer programming competence is expected by the beginning of the junior year.
This requirement may be satisfied by CSCI 225, 245 or by demonstrating competence on a
problem chosen by the department.

Bachelor of Science Degree

A minimum of 36 credits in physics and including 121 and 122, 141, 142, 270, 280, 281 and
two semesters of 382. In addition, three courses selected from PHYS 342, 361, 362, 372 are
required. Two semesters of PHYS 080 (Seminar) are required. In addition, 24 credits of courses in
mathematics, computer science, and science are required, including MATH 232 and a laboratory
science course, designated for science majors in chemistry, biology, or geology.

Computer programming competence is expected by the beginning of the junior year. This
requirement may be satisfied by CSCI 225, 245 or by demonstrating competence on a problem
chosen by the department. For those planning graduate work, MATH 334, 361 or 370, as well
as other physics courses and research are recommended.

Physics Education

In partnership with the Hope College Department of Education, the Department of Physics offers
a teaching major for certification through the State of Michigan. This includes a 30-credit major
leading to a Bachelor of Arts degree. A listing of the requirements can be found on the education
website. Students interested in teaching physics at the secondary level should begin working with
the Department of Education as early as possible.
**MINORS**

**Physics**

A minor in physics consists of 20 credits. PHYS 121, 122, 141, 142, 270 and at least one 300-level course are required. The remaining courses are to be chosen by the student in consultation with the department chairperson. The exact courses will depend upon the intended major program of the student. Approval of the courses by the department chairperson is required.

**Physics Education**

In partnership with the Hope College Department of Education, the Department of Physics offers a teaching minor for certification through the State of Michigan. This includes a 20-credit minor leading to a Bachelor of Arts degree. A listing of the requirements can be found on the education website. Students interested in teaching physics at the secondary level should begin working with the Department of Education as early as possible.
PHYSICS

PHYS 080 - Seminar
All students interested in physics and engineering are encouraged to attend departmental seminars. Registered students are required to attend at least 80% of the seminars presented. The purpose of the seminars is twofold. One is the presentation of fields of current interest and questions of concern for researchers so that students can learn the content of and approaches to research. The other is to provide students contemplating further study at the graduate level with opportunities to discuss with speakers the programs at their institutions. In this manner, students can make better informed decisions on the course of their further education.

Credits Awarded: 0  
Terms Offered: Fall, Spring  
Prerequisites: Junior standing

PHYS 104 - Matter and Energy
One of a two-semester sequence of courses, along with Biol 104. The combined courses will satisfy the natural science laboratory general education requirements only for elementary education teacher candidates. Cross-listed with Chem 104. A full description may be found there.

Credits Awarded: 4  
Terms Offered: Fall, Spring  
Attribute: Natural Science I with lab (NSL)

PHYS 105 - College Physics I
This is an algebra-based course which provides a rigorous examination of the following physical phenomena and systems: 1) mechanics (forces, kinematics of motion, conservation of energy and momentum, collisions, and rotational systems), 2) oscillating systems and springs and 3) selected topics from molecular physics and heat (physics of solids and fluids, thermal physics and thermodynamics).

Credits Awarded: 3  
Terms Offered: Fall  
Prerequisites: Math 123 or equivalent  
Corequisites: Phys 107 or Phys 141  
Attribute: Natural Science I with lab (NSL)

PHYS 106 - College Physics II
A continuation of Phys 105. This course is algebra-based with an accompanying laboratory. It provides a rigorous examination of the following physical phenomena and systems: 1) electricity and magnetism, 2) geometric optics, 3) physical optics and waves and 4) atomic and nuclear physics.

Credits Awarded: 3  
Terms Offered: Spring  
Prerequisites: Phys 105  
Corequisites: Phys 108 or Phys 142  
Attribute: Natural Science I with lab (NSL)
**PHYS 107 - College Physics Laboratory I**
The laboratory is designed to accompany Phys 105. Basic laboratory skills are developed. Students use modern instrumentation methods to explore and analyze scientific measurements. This laboratory is a great introduction to the use of computers in the collection and analysis of data. Students will be able to study quantitatively, and in detail, many of the mechanical systems which are presented in Phys 105.

Credit Awarded: 1  
Terms Offered: Fall  
Corequisites: Phys 105

**PHYS 108 - College Physics Laboratory II**  
A continuation of Phys 107. The laboratory accompanies Phys 106. The topics of electricity and magnetism, electrical circuits, optics, radiation and quantum effects are explored. Physical phenomena are studied and measured at a more advanced level, including techniques currently employed in modern physics. A major goal of the course is to develop skills in the measurement of physical phenomena.

Credit Awarded: 1  
Terms Offered: Spring  
Prerequisites: Phys 107  
Corequisites: Phys 106  
Attribute: Natural Science I with lab (NSL)

**PHYS 111 - Introduction to Physics**  
This course is an introduction to the field and practice of physics for those intending or considering a major in physics. It focuses on the topic of spectroscopy in atomic spectra, stellar astrophysics, molecular spectroscopy, and proton induced x-ray emission. Students will also learn laboratory skills, writing skills, problem-solving skills, and presentation skills. Students may take Math 125 or Math 131 either prior to enrollment in or concurrently with the class.

Credit Awarded: 2  
Terms Offered: Fall  
Prerequisites: Math 125 or Math 131  
Corequisites: Math 125 or Math 131  
Attribute: Natural Science II (NS2)

**PHYS 112 - Introduction to Modern Physics**  
This course is an introduction to modern physics for the student who enters Hope College with advanced placement but weaknesses in the area of modern physics. The material covered includes interference and diffraction, wave nature of light, particle nature of light, wave nature of matter, introduction to quantum mechanics, and atomic and nuclear structure. Students may take Math 132 either prior to enrollment in or concurrently with the class.

Credit Awarded: 2  
Terms Offered: Fall  
Prerequisites: AP credit for Phys 122, Math 132  
Corequisites: Math 132  
Attribute: Natural Science II (NS2)
**PHYS 121 - General Physics I**
The course is calculus-based and designed for students desiring professional science careers. It provides a rigorous examination of the following physical phenomena and systems: forces, conservation of momentum, energy (kinetic, potential, chemical, and thermal), fields, thermodynamics, and statistical mechanics. Students may take Math 126 or Math 131 either prior to enrollment in or concurrently with the class.

**Credits Awarded:** 3  
**Terms Offered:** Fall, Spring  
**Prerequisites:** Math 126 or Math 131  
**Corequisites:** Math 126 or Math 131, Phys 141  
**Attribute:** Natural Science I with lab (NSL)

**PHYS 122 - General Physics II**  
A continuation of Phys 121. The course is calculus-based with an accompanying laboratory. It is designed for students desiring professional careers in science. The course provides a rigorous introduction to the following topics: 1) electricity and magnetism, 2) geometric optics, 3) physical optics and waves, 4) atomic and nuclear physics. Students may take Math 132 either prior to enrollment in or concurrently with the class.

**Credits Awarded:** 3  
**Terms Offered:** Fall, Spring  
**Prerequisites:** Phys 121 with a grade of C- or better, Math 132  
**Corequisites:** Math 132, Phys 142  
**Attribute:** Natural Science I with lab (NSL)

**PHYS 141 - Physics Laboratory I**  
The laboratory is designed to accompany Phys 105 and Phys 121. Basic laboratory skills are developed. The use of modern instrumentation in physical measurements is explored. Students gain experience in using computers to analyze scientific measurements. Topics covered include forces, conservation of momentum, conservation of energy, oscillation systems, and rotational motion.

**Credit Awarded:** 1  
**Terms Offered:** Fall, Spring  
**Corequisites:** Phys 105 or Phys 121  
**Attribute:** Natural Science I with lab (NSL)

**PHYS 142 - Physics Laboratory II**  
A continuation of Phys 141. This laboratory accompanies Phys 106 and Phys 122. Physical phenomena are studied and measured on a more advanced level. Topics in electrostatics, radioactivity, modern physics, optics, electricity and magnetism, resonance, and electrical circuits are explored. A major goal of the course is to develop skills in the measurements of physical phenomena.

**Credit Awarded:** 1  
**Terms Offered:** Fall, Spring  
**Corequisites:** Phys 106 or Phys 122  
**Attribute:** Natural Science I with lab (NSL)

**PHYS 195 - Topics in Physics**  
A course offered in response to student and instructor interest. Topics are not generally covered in the regular course listings. Course may be taken multiple times if topics are different. Permission of instructor is required.

**Credits Awarded:** 1-4  
**Terms Offered:** As Needed  
**Prerequisites:** Permission of instructor
**PHYS 270 - Modern Physics**

A first course in the quantum physics of atoms, molecules, solids, nuclei, and particles. Topics include special relativity, the structure of the nucleus, the Schroedinger wave equation, one electron atoms, angular momentum, spectra, transition rates, and quantum statistics. Applications to atoms, molecules, nuclei, conductors, semiconductors, superconductors, and elementary particles will be discussed. Experiments as well as theory will be examined.  

Credits Awarded: 4  
Terms Offered: Fall  
Prerequisites: Phys 122, Math 132

**PHYS 280 - Introduction to Mathematical Physics and Engineering**

Mathematical methods applicable to physical systems are studied. These include effective use of MAPLE, modeling with ordinary differential equations, vector calculus, Fourier Analysis, and common differential equations. Special attention is given to physical examples from multiple areas to show the generality of the techniques. Students may take Math 232 either prior to enrollment in or concurrently with the class.  

Credits Awarded: 2  
Terms Offered: Spring  
Prerequisites: Math 232  
Corequisites: Math 232

**PHYS 281 - Intermediate Laboratory**

This course focuses on developing experimental skills. These include experiment planning, research, analysis, error propagation, writing, and presenting. A series of short exercises are done first to develop the background in these areas and then experiments are done where these skills must be correctly applied. Typical laboratory experiments will include the Cavendish experiment, index of refraction of a gas with an interferometer, and determining the ellipticity of a large outdoor courtyard.  

Credits Awarded: 2  
Terms Offered: Spring  
Prerequisites: Phys 270

**PHYS 290 - Independent Studies**

With departmental approval freshmen or sophomores may engage in independent studies at a level appropriate to their ability and class standing, in order to enhance their understanding of physics. Students may enroll each semester.  

Credits Awarded: 1-2  
Terms Offered: Fall, Spring  
Prerequisites: Permission of instructor

**PHYS 295 - Studies in Physics**

A lecture and/or laboratory course in a physics area of current interest.  

Credits Awarded: 2-4  
Terms Offered: As Needed  
Prerequisites: Permission of instructor
PHYS 330 - Marine Biology and Biophysics
An interdisciplinary course focusing on the biology of marine organisms and the physicochemical and geological factors that govern their distribution, abundance, and characteristics. Cross-listed with Biol 330. A full description may be found there.
Credits Awarded: 4
Terms Offered: Spring

PHYS 342 - Electricity and Magnetism
A course in classical electromagnetism with the development and application of Maxwell's equations as the central focus. Topics include electromagnetic fields, boundary value problems, dielectric and magnetic materials, radiation, and energy and momentum of the electromagnetic field.
Credits Awarded: 4
Terms Offered: Spring, Even years
Prerequisites: Phys 122, Phys 280

PHYS 352 - Optics
Topics covered concern both geometrical and physical optics. The approach involves matrix formulation, computer formulation, Fourier analysis as it relates to Fresnel and Fraunhofer diffraction, interference, polarization matrices and holography. The relevance of these topics to modern day optical information processing and physical devices is considered. Cross-listed with Engs 352.
Credits Awarded: 3
Terms Offered: As Needed
Prerequisites: Phys 122, Phys 280

PHYS 361 - Analytical Mechanics
This course covers Newtonian mechanics, linear and nonlinear oscillations, calculus of variations, Lagrangian and Hamiltonian dynamics, and motion in noninertial frames of reference. The course builds upon the topics covered in general physics and makes extensive use of the methods learned in Phys 280. The course acquaints students with mathematical and computer techniques in solving complex problems. These more formal methods empower students with skills necessary to make the transition from introductory to advanced physics and engineering. Cross-listed with Engs 361.
Credits Awarded: 4
Terms Offered: Fall
Prerequisites: Phys 121, Phys 280

PHYS 362 - Thermodynamics and Statistical Mechanics
The prominent states of matter are examined from classical and quantum mechanical points of view. A thorough overview of thermodynamics and statistical mechanics is given. Nonidealities in gases are treated in order to examine cooling and phase transitions. Effects of Bose-Einstein and Fermi-Dirac statistics are detailed for gases, liquids and solids. Slightly degenerate perfect gases, electrons in metals and Bose-condensation, viewed as a first order phase transition, are discussed. Students may take Phys 280 either prior to enrollment in or concurrently with the class.
Credits Awarded: 4
Terms Offered: Spring, Odd Years
Prerequisites: Phys 270, Phys 280
Corequisites: Phys 280
PHYS 372 - Quantum Theory
A detailed study of the mathematical and physical foundations of quantum mechanics. Topics include the Schroedinger wave equation, one-dimensional potentials, operator methods in quantum mechanics, the Heisenberg representation of operators, the three-dimensional Schroedinger equation, angular momentum, the hydrogen and helium atoms, matrix methods in quantum mechanics, time independent and time dependent perturbation theory, radiation of atoms, and scattering theory.

Credits Awarded: 4
Terms Offered: Fall, Even Years
Prerequisites: Phys 270, Phys 280

PHYS 380 - Mathematical Physics and Engineering II
This is a continuation of Phys 280. Additional mathematical methods, primarily for physics, are considered, including complex analysis, numerical methods, probability and statistics, additional special functions, and more partial differential equations.

Credits Awarded: 2
Terms Offered: Fall, Odd Years
Prerequisites: Phys 280

PHYS 382 - Advanced Laboratory
This laboratory builds on the skills learned in Phys 281 and combines experiments from both classical and modern physics. Extensive use of the computer is made in the analysis of data from experiments. Detailed error analysis of each experiment is required. In any given semester the selected topics are drawn from experiments such as gamma detection, Millikan oil drop, alpha spectroscopy, accelerator operation, Cavendish, Rutherford scattering, semiconductors, saturated absorption, spectroscopy, and neutron activation. Two hours of lecture and seven hours of laboratory. Required for Physics majors and may be taken more than once for credit.

Credits Awarded: 2
Terms Offered: Fall
Prerequisites: Phys 270, Phys 281, Math 232

PHYS 395 - Studies in Physics
A course offered in response to student and instructor interest. Topics are not generally covered in the regular course listings. Course may be taken multiple times if topics are different.

Credits Awarded: 1-4
Terms Offered: As Needed
Prerequisites: Permission of instructor

PHYS 490 - Research
With departmental approval students may engage in independent studies at a level appropriate to their ability and class standing, in order to enhance their understanding of physics. Students may enroll in each semester.

Credits Awarded: 0-3
Terms Offered: Fall, Spring
Prerequisites: Permission of Instructor
**PHYS 495 - Advanced Studies in Physics**
A lecture or seminar in an area of special interest or experience. Department chairperson's approval required.

**Credits Awarded:** 2-4  
**Terms Offered:** Fall, Spring  
**Prerequisites:** Permission of department chairperson

**PHYS 499 - Internship**
The internship program provides an opportunity to gain practical experience in the work place, typically off campus. The student will have a qualified supervisor at the site of this experience as well as a faculty advisor. It provides physics training and skill development for the student. Written reports appropriate to the internship experience are required. Consultation and a formal application with permission of the physics faculty advisor are required. Once an internship host is secured, complete the “Academic Internship Registration” form (https://hope.edu/offices/boerigter-center/prepare/internships/index.html).

**Credits Awarded:** 1-3  
**Terms Offered:** As Needed  
**Prerequisites:** Permission of instructor

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**FACULTY & STAFF**

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*The Kenneth G. Herrick Professor of Physics (1985)*  
Ph.D., University of Notre Dame, 1982  
B.A., Hope College, 1977

**Gonthier, Dr. Peter**  
*Professor of Physics (1983)*  
Ph.D., Texas A&M Univ College Sta*, 1980  
B.A., Texas A&M Univ College Sta*, 1975

**Hampton, Dr. Jennifer**  
*Associate Professor of Physics (2007)*  
Ph.D., Cornell University, 2002  
MPHI, Cambridge University, 1996  
B.A., Oberlin College, 1995

**Heinz, Lynette**  
*Lecturer/Physics (2000)*

**Hildore, Amanda**  
*Lecturer in Computer Science (2001)*  
M.S., University of Illinois Urbana, 1989  
B.S., Hope College, 2004

**Knoll, Amanda**  
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*Professor of Physics (1993)*  
Ph.D., Michigan State University, 1993  
M.S., Colorado School Mines, 1989  
B.S., Colorado School Mines, 1987

**Remillard, Dr. Stephen**  
*Associate Professor of Physics and Department Chair (2007)*  
Ph.D., Coll William And Mary, 1993  
M.S., Coll William And Mary, 1990  
B.S., Calvin College, 1988

**Shank, Dr. Benjamin**  
*Lecturer/Physics (2014)*  
Ph.D., Stanford University, 2014  
B.S., Case Western Reserve Univ, 2007