Nebraska Wesleyan University

Physics

Catalog

2023-2024

About the Program

The Bachelor of Arts degree in Physics is designed for those students who want a solid physics education with a broad liberal arts background and will be pursuing further education or employment in fields other than physics or engineering. The Bachelor of Science degree in Physics is designed for those students pursuing employment or further education in physics or engineering.

Department Learning Outcomes
Majors will be able to:

1. Explain fundamental concepts, theories, and models of classical and modern physics.
2. Apply physics principles and models to real-world problem.
3. Solve real-world problems by applying appropriate mathematical and computer analysis.
4. Exhibit experimental skills:
    - conduct semi-independent research under the direction of a faculty mentor;
    - make careful physical measurements using a range of laboratory tools and record them appropriately;
    - analyze experimental data and meaningfully interpret results;
    - identify uncertainties in measured quantities, and quantify and interpret the uncertainty of derived results;
    - apply appropriate computer software for organization, analysis, and visualization of experimental data.
5. Exhibit scientific literacy and communication skills:
    - critically review a published scientific report;
    - effectively communicate physical arguments, in written, oral, and dialogic formats, incorporating clear purpose and appropriate context, organized structure, and supported conclusions.

Dual-Degree Engineering Program

The Dual-Degree Program is a cooperative academic program between Nebraska Wesleyan University and the School of Engineering and Applied Science at Washington University in St. Louis; and the College of Engineering and Technology at the University of Nebraska. The Dual-Degree Program enables a student to devote three years to the study of sciences and liberal arts at Nebraska Wesleyan before transferring to one of these schools for two years of engineering studies. This program leads to a Bachelor of Science degree from Nebraska Wesleyan and the appropriate engineering bachelor's degree from Washington University or the University of Nebraska.

The Dual-Degree Program is designed to give the student the best of both liberal arts and engineering and to provide the practicing engineer with a background in the humanities and social sciences. The program encourages engineers to be aware of the changing values and priorities of society, and to be concerned about the effects of science and technology upon the environment and the quality of life.

Engineering fields of study include the following:

Washington University

- Biomedical Engineering
- Chemical Engineering
- Computer Engineering
- Computer Science
- Electrical Engineering
- Mechanical Engineering
- System Science and Engineering

University of Nebraska

- Agricultural Engineering
- Architectural Engineering
- Biological Systems Engineering
- Chemical Engineering
- Civil Engineering
- Computer Engineering
- Construction Engineering
- Construction Management
- Electrical Engineering
- Electronics Engineering
- Mechanical Engineering
- Software Engineering

Other information

In addition to the regular course offerings, the department provides opportunities to participate in research projects on an individual basis. These projects may be of a theoretical or experimental nature. The department is especially well equipped in digital electronics, x-ray fluorescence and nuclear spectroscopy, astrophysics and planetary science, and radiation protection.

Courses numbered below 1600 are suitable for students who are not natural science majors. They may not be counted toward a major or minor in physics.

Majors, Minors & Degrees

Majors

1. Physics (B.A.)
2. Physics (B.S.)

Minors

1. Physics

Courses

PHYS 1100 Introduction to Geology

4 hours

A survey of geology and geophysics. Topics include characteristics of minerals and rocks, plate tectonics, Earth's interior, Earth history and time scales, surface processes, and ocean processes.
Three lectures per week.
One laboratory per week.
Prerequisite(s): One year of high school algebra or permission of instructor.
(Normally offered alternate fall semesters.)

Archway Curriculum: Essential Connections: Diversity Instructive: Global
Archway Curriculum: Essential Connections: Diversity Instructive: U.S.
Archway Curriculum: Integrative Core: Humans in the Natural Environment Thread
Archway Curriculum: Foundational Literacies: Mathematical Problem Solving
Archway Curriculum: Integrative Core: Science and Religion Thread
Archway Curriculum: Foundational Literacies: Scientific Investigations: Natural Science Laboratory

PHYS 1200 Energy and the Global Environment

4 hours

A course covering some of the most critical problems facing the world today - those relating to the production, distribution, and use of energy. The basic concepts of heat, work, electricity and energy as they apply to energy use around the world will be studied. The major source of energy, their value and importance, the historical and future demand for energy and the specific environmental problems and benefits encountered will be identified.
Three lectures and one laboratory per week.
Prerequisite(s): One year of high school algebra or permission of instructor.
(Normally offered alternate fall semesters.)

Archway Curriculum: Integrative Core: Humans in the Natural Environment Thread
Archway Curriculum: Foundational Literacies: Scientific Investigations: Natural Science Laboratory

PHYS 1300 Astronomy

4 hours

An introductory course on the solar system, stars and galaxies.
Three lectures per week.
One laboratory/observation per week.
Prerequisite(s): One year of high school algebra or permission of instructor.
(Normally offered alternate spring semesters.)

Archway Curriculum: Foundational Literacies: Scientific Investigations: Natural Science Laboratory
Archway Curriculum: Integrative Core: Science and Religion Thread

PHYS 1400 Introduction to Meteorology

4 hours

A survey of and explanation of weather and climate phenomena in terms of the physical characteristics and processes of the atmosphere.
Three lectures per week.
One laboratory per week.
Prerequisite(s): One year of high school algebra or permission of instructor.
(Normally offered alternate spring semesters.)

Archway Curriculum: Foundational Literacies: Scientific Investigations: Natural Science Laboratory

PHYS 1600 Principles of Physics I

4 hours

The principles of classical mechanics, energy and motion designed for majors in the natural and health sciences. Algebra and trigonometry will be used in descriptions and problems.Three two-hour workshop sessions per week.Students may not receive credit for both PHYS 1600 and PHYS 2000 General Physics I.
Prerequisite(s): A grade of "C" or better in MATH 1470 Trigonometry or MATH 1400 Pre-Calculus or MATH 1600 Calculus I or a MATH ACT score of 27 or permission of the instructor.

(Normally offered each fall semester.)

Archway Curriculum: Foundational Literacies: Scientific Investigations: Natural Science Laboratory

PHYS 1700 Principles of Physics II

4 hours

A continuation of PHYS 1600 with emphasis on waves, sound, electricity, magnetism, and electronics.
Three two-hour workshop sessions per week.
Students may not receive credit for both PHYS 1700 and PHYS 2100 General Physics II.
Prerequisite(s): PHYS 1600 Principles of Physics I.
(Normally offered each spring semester.)

Archway Curriculum: Foundational Literacies: Scientific Investigations: Natural Science Laboratory

PHYS 1900 Selected Topics

1-4 hours

A course designed to treat subject matter not covered in other departmental courses. The title, content, and credit hours will be determined by current mutual interests of faculty and students.
Prerequisite(s): Permission of the instructor and approval of the department chair.

PHYS 1950 Independent Study

1-4 hours

This is a research course. The student initially meets with the department chair to select a study topic and review research methods. At this time the student will be assigned a faculty resource person to guide his or her work and assist in an advisory capacity. A copy of the student's work is filed in the archives for the department. Independent study may not duplicate courses described in the catalog.
Prerequisite(s): Permission of the department chair.

PHYS 1960 Special Projects

1-15 hours

Supervised individual projects for students on topics selected by the student in consultation with the instructor. Special Projects may not duplicate courses described in the catalog.
Prerequisite(s): Permission of the instructor.

PHYS 1970 Internship

1-8 hours

On-the-job training for physics majors in situations that satisfy the mutual interests of the student, the supervisor, and the instructor. The student will arrange for the position in accordance with the guidelines established by the department.
Pass/Fail only.
Prerequisite(s): Permission of the instructor and approval of the department chair.

PHYS 2000 General Physics I

4 hours

An introduction to classical mechanics, energy and motion designed for majors in physics, mathematics, and closely related sciences. Elements of calculus will be used in descriptions and problems.
Three two-hour workshop sessions per week.
Students may not receive credit for both PHYS 1600 Principles of Physics I and PHYS 2000.
Pre or Corequisite(s): MATH 1500 Calculus for Management, Biological, and Social Sciences or MATH 1600 Calculus I or permission of the instructor.
(Normally offered each fall semester.)

Archway Curriculum: Foundational Literacies: Scientific Investigations: Natural Science Laboratory

PHYS 2100 General Physics II

4 hours

A continuation of PHYS 2000 with emphasis on waves, sound, electricity, magnetism, and electronics.
Three two-hour workshop sessions per week.
Students may not receive credit for both PHYS 1700 Principles of Physics II and PHYS 2100.
Prerequisite(s): PHYS 2000 General Physics I.
(Normally offered each spring semester.)

Archway Curriculum: Foundational Literacies: Scientific Investigations: Natural Science Laboratory

PHYS 2200 Electronic Measurements

4 hours

An integrated treatment of analog and digital circuits and measurements using the techniques of solid state electronics and integrated circuits. Emphasis is placed on laboratory techniques.
Three lectures per week.
One laboratory per week.
Prerequisite(s): PHYS 1700 Principles of Physics II or PHYS 2100 General Physics II, and MATH 1600 Calculus I or permission of instructor.
(Normally offered each fall semester.)

PHYS 2400 Introduction to Modern Physics

4 hours

An introduction to modern physics: the post-Newtonian developments of quantum mechanics and Einsteinian relativity, with focus on special relativity, the atomic and nuclear structure of matter, and the foundations of quantum physics. Principles of modern physics will be approached through the contexts of the historical developments and classic experiments that brought them to light. The laboratory experience incorporates experiments and computer-based investigations, with emphasis on the development of laboratory skills including detectors and measurement techniques, laboratory journaling, data analysis, and reporting of results. Practical aspects of nuclear radiation detection and safety will also be covered.
Three lectures per week.
One laboratory per week.
Prerequisite(s): PHYS 1700 Principles of Physics II or PHYS 2100 General Physics II, and MATH 1610 Calculus II or permission of the instructor.
(Normally offered each spring semester.)

Archway Curriculum: Integrative Core: Innovation Thread

PHYS 2500 Introduction to Health Physics

4 hours

An introduction to radiation protection, also known as health physics, with emphasis on the practical aspects of radiation detection, protection, and regulation. Topics include the basic interaction of radiation with the human body, its beneficial and harmful biological effects, how to quantify radiation dose, and the use of radiation protection regulations to prevent harm to humans. Laboratory experience includes hands-on exercises in spectroscopy, dosimetry, and environmental monitoring of radiation. This course is particularly useful for those who will work with radiation in medical, radiology, energy production, or research settings.
Three lectures per week.
One laboratory per week.
Prerequisite(s): PHYS 1700 Principles of Physics II or PHYS 2100 General Physics II or permission of the instructor.
(Normally offered alternate spring semesters.)

Archway Curriculum: Foundational Literacies: Scientific Investigations: Natural Science Laboratory

PHYS 2600 Computer Architecture and Interfacing

4 hours

A first course in the levels of architecture of a modern computer, from digital logic, through circuits and register level components, to programming. Topics include data representation, memory organization, input/output control, interfacing, and communication.
Three lectures per week. One laboratory per week.
Cross listed with CMPSC 2600.
Prerequisite(s): PHYS 2200 Electronic Measurements or CMPSC 1100 Python Programming I or permission of the instructor.
(Normally offered alternate spring semesters.)

PHYS 2700 Introduction to Astrophysics

4 hours

A quantitative treatment of topics in planetary science, stellar physics and cosmology, with emphasis on the interaction of matter and radiation.
Three lectures per week.
One laboratory per week.
Prerequisite(s): PHYS 1700 Principles of Physics II or PHYS 2100 General Physics II or permission of the instructor.

PHYS 2800 Tutoring Experience

0 hour

A tutoring experience comprised of at least 20 hours of physics tutoring. Tutoring will occur in department-sponsored tutoring sessions. Regular journaling and a reflection paper are required. Regular meetings with the tutoring supervisor are also required.
P/F only.
Prerequisite(s): Permission of the department chair.

Archway Curriculum: Essential Connections: Experiential Learning: Exploratory

PHYS 2900 Selected Topics

1-4 hours

A course designed to treat subject matter not covered in other departmental courses. The title, content, and credit hours will be determined by current mutual interests of faculty and students.
Prerequisite(s): Permission of the instructor and approval of the department chair.

PHYS 2950 Independent Study

1-4 hours

This is a research course. The student initially meets with the department chair to select a study topic and review research methods. At this time the student will be assigned a faculty resource person to guide his or her work and assist in an advisory capacity. A copy of the student's work is filed in the archives for the department. Independent study may not duplicate courses described in the catalog.
Prerequisite(s): Permission of the department chair.

PHYS 2960 Special Projects

1-15 hours

Supervised individual projects for students on topics selected by the student in consultation with the instructor. Special Projects may not duplicate courses described in the catalog.
Prerequisite(s): Permission of the instructor.

PHYS 2970 Internship

1-8 hours

On-the-job training for physics majors in situations that satisfy the mutual interests of the student, the supervisor, and the instructor. The student will arrange for the position in accordance with the guidelines established by the department.
Pass/Fail only.
Prerequisite(s): Permission of the instructor and approval of the department chair.

PHYS 3000 Mechanics

4 hours

An advanced study of the mechanics of particles, systems of particles, and rigid bodies, with an emphasis on Newton's laws, conservation of energy, and conservation of linear and angular momentum. The behavior of moving, rotating, and oscillating systems will be studied, using both analytical and numerical approaches. Lagrangian and Hamiltonian formalisms will be introduced as complementary to Newtonian mechanics. Vector calculus will be developed and used as needed.

Three lectures per week.
One recitation per week.
Prerequisite(s): PHYS 1700 Principles of Physics II or PHYS 2100 General Physics II; MATH 1610 Calculus II and computer programming skills or permission of the instructor.
Corequisite(s): MATH 2600 Calculus III or MATH 3100 Differential Equations.
(Normally offered alternate fall semesters.)

PHYS 3100 Electromagnetism and Optics

4 hours

This course builds upon the foundation of electromagnetism and optics developed in introductory physics, and the quantum nature of photons introduced in modern physics. Topics include electrostatic forces, fields, and potentials; magnetic forces on charges and currents; magnetic fields produced by steady currents; light as an oscillating electromagnetic field; polarization of light; ray tracing of optical systems; optical interference; and electric, magnetic, and optical properties of matter. Vector calculus will be developed and heavily used.
Three lectures per week.
One recitation per week.
Prerequisite(s): PHYS 1700 Principles of Physics II or PHYS 2100 General Physics II, MATH 1610 Calculus II, and computer programming skills or permission of the instructor.
Corequisite(s): MATH 2600 Calculus III or MATH 3100 Differential Equations.
(Normally offered alternate fall semesters.)

PHYS 3800 Advanced Laboratory

1-4 hours

An advanced laboratory in which students extend and amplify the work of other courses. Work may be chosen in electrical measurements, physical optics, modern physics, or other areas of mutual interest.
Prerequisite(s): Permission of the instructor and approval of the department chair.
(Normally offered each semester.)

Archway Curriculum: Essential Connections: Writing Instructive
Archway Curriculum: Essential Connections: Speaking Instructive

PHYS 3900 Selected Topics

1-4 hours

A course designed to treat subject matter not covered in other departmental courses. The title, content, and credit hours will be determined by current mutual interests of faculty and students.
Prerequisite(s): Permission of the instructor and approval of the department chair.

PHYS 3950 Independent Study

1-4 hours

Individual research projects of a creative nature for qualified physics students. Projects may be of a theoretical or experimental nature. Independent Study may not duplicate courses described in the catalog.
Prerequisite(s): Permission of the instructor and approval of the department chair.

PHYS 3960 Special Projects

1-15 hours

Supervised individual projects for students on topics selected by the student in consultation with the instructor. Special Projects may not duplicate courses described in the catalog.
Prerequisite(s): Permission of the instructor.

PHYS 3970 Internship

1-8 hours

On-the-job training for physics majors in situations that satisfy the mutual interests of the student, the supervisor, and the instructor. The student will arrange for the position in accordance with the guidelines established by the department.
Pass/Fail only.
Prerequisite(s): Permission of the instructor and approval of the department chair.

PHYS 4000 Quantum Mechanics

4 hours

An introduction to fundamental concepts and topics in quantum mechanics. Topics include the Schrödinger equation, wave functions, probability, the uncertainty principle, stationary states, one-dimensional potentials, Hilbert space and formal operator methods, the hydrogen atom, spin and angular momentum, and identical particles and entanglement. Analytical and computational solutions to the Schrödinger equation will be developed. Quantum information science and its applications will also be explored. mechanics. Topics include the Schrödinger equation, wave functions, probability, the uncertainty principle, stationary states, one-dimensional potentials, Hilbert space and formal operator methods, the hydrogen atom, spin and angular momentum, and identical particles and entanglement. Analytical and computational solutions to the Schrödinger equation will be developed. Quantum information science and its applications will also be explored.

Prerequisite(s): PHYS 2400 Introduction to Modern Physics, CMPSC 1100 Python Programming I and MATH 2600 Calculus III or MATH 3100 Differential Equations.
(Normally offered even spring semesters.)

PHYS 4100 Thermal and Statistical Physics

4 hours

An introduction to classical and statistical thermodynamics. Topics include the ideal gas equation of state, the First and Second Laws of Thermodynamics, the thermodynamic identity, engines and refrigerators, the thermodynamic potentials, and classical and quantum distribution functions. Vector calculus will be developed and heavily used.
Three lectures per week.
One recitation per week.
Prerequisite(s): PHYS 2400 Introduction to Modern Physics and MATH 2600 Calculus III or MATH 3100 Differential Equations and computer programming skills or permission of the instructor.
(Normally offered alternate spring semesters.)

PHYS 4900 Selected Topics

1-4 hours

A course designed to treat subject matter not covered in other departmental courses. The title, content, and credit hours will be determined by current mutual interests of faculty and students.
Prerequisite(s): Permission of the instructor and approval of the department chair.

PHYS 4950 Independent Study

1-12 hours

Individual research projects of a creative nature for qualified physics students. Projects may be of a theoretical or experimental nature. Independent study may not duplicate courses described in the catalog.
Prerequisite(s): Permission of the instructor and approval of the department chair.

Archway Curriculum: Essential Connections: Experiential Learning: Intensive
Archway Curriculum: Essential Connections: Speaking Instructive
Archway Curriculum: Essential Connections: Writing Instructive

PHYS 4960 Special Projects

1-15 hours

Supervised individual projects for students on topics selected by the student in consultation with the instructor. Special Projects may not duplicate courses described in the catalog. P/F Oriented.
Prerequisite(s): Permission of the instructor and approval of the department chair.

PHYS 4970 Physics Internship

1-8 hours

On-the-job training for physics majors in situations that satisfy the mutual interests of the student, the supervisor, and the instructor. The student will arrange for the position in accordance with the guidelines established by the department.
Pass/Fail only.
Prerequisite(s): Permission of the instructor and approval of the department chair.

Archway Curriculum: Essential Connections: Experiential Learning: Intensive

PHYS 5200 Energy and the Global Environment

3 hours

A course covering some of the most critical problems facing the world today - those relating to the production, distribution, and use of energy. The basic concepts of heat, work, electricity and energy as they apply to energy use around the world will be studied. The major source of energy, their value and importance, the historical and future demand for energy and the specific environmental problems and benefits encountered will be identified.
Three lectures per week.
One laboratory per week.

PHYS 5200L Energy and the Global Environment Lab

1 hour

Energy and the Global Environment Lab is the laboratory for PHYS 5200 Energy and the Global Environment.

PHYS 5900 Selected Topics: Physics

3 hours

This graduate-level course is designed to give students the opportunity for in-depth study of a physics-based concept. Topics will consist of a highly specialized area of study or revolve around issues or recent trends and innovations related to the field of physics.