PHYSICS

The Physics Department at UNO is a vibrant program well-known for offering quality education, diverse research activities, and broad community outreach programs.

The variety of options students have in the physics program makes our graduates well prepared to thrive in modern industries. Additionally, about a third of physics graduates are accepted into top graduate degree programs where they can pursue a master's or doctoral degree in physics, physics education, engineering, chemistry, astrophysics, biophysics and medical physics. Our curriculum is flexible and provides students with a number of options to better prepare them for the career of their choice.

In addition to our Bachelors of Science program we offer concentrations in Biomedical Physics and Physics Education. The Physics Department emphasizes involving its physics majors in undergraduate research as well as the education process. Working closely with the faculty provides students a valuable experience. Beyond-the-classroom learning opportunities engage students and create a sense of community. Research projects are available in the following areas: astrophysics, biophysics, medical physics, computational physics, quantum computing, materials for energy applications, solid-state physics, and physics education.

Other Information

All coursework taken for the Physics major or minor must be completed with a grade of "C-" or better.

Physics majors must also take the two assessment tests (Major Field Test and Local Test) and complete the exit interview.

Apart from PHYS 1154, PHYS 1164, and PHYS 1950, no 1000-level courses may count toward the major requirements in physics. However, they do count as electives for various other college degrees.

Physics majors should strive to take as many of the courses in modern physics (PHYS 4210, PHYS 4220, PHYS 4230) and electronics (PHYS 3500) as their program will permit.

The **senior project** must be approved and the department chair notified at least eight months prior to graduation as a Physics major and the student must register for either PHYS 4950 or PHYS 4960.

Upper division courses (3000-level or higher) will assume that students have at least some experience with, and ability to use, computers for solving physics problems.

Physics is also offered as a concentration in the Division of Continuing Studies.

Contact

129 DSC
402.554.2511

Website (http://www.physics.unomaha.edu/)

Degrees Offered

- Physics, Bachelor of Arts (http://catalog.unomaha.edu/undergraduate/college-arts-sciences/physics/physics-ba/)
- Physics, Bachelor of Science (http://catalog.unomaha.edu/undergraduate/college-arts-sciences/physics/physics-bs/)
- Physics, Bachelor of Science with a Concentration in Biomedical Physics (http://catalog.unomaha.edu/undergraduate/college-arts-sciences/physics/concentration-biomedical-physics/)
- Physics, Bachelor of Science with a Concentration in Physics Education (http://catalog.unomaha.edu/undergraduate/college-arts-sciences/physics/concentration-education/)

Writing in the Discipline

All students are required to take a writing in the discipline course within their major. For the Physics major this is: ENGL 3980.

Minors Offered

- Physics Minor (http://catalog.unomaha.edu/undergraduate/college-arts-sciences/physics/physics-minor/)

Physics is one of the broadest scientific disciplines. Most students develop expertise with a great variety of hands-on experiences with instrumentation, fabrication, analytical techniques and computer modeling. These practical skills make physicists attractive to employers in physics, engineering, financial and computer science fields.

Particular skills include: research and problem solving, fluency in using scientific equipment, refined mathematical skills, programming, modeling and simulation, and quality control protocol.

"Soft skills" are also vital to successful career. Soft skills you would be trained in at the university include: cultivating strategic written and oral communication skills, learning to work well on a team, and being a good listener.

Some common jobs for those who have a bachelor's degree in physics include:

- Design or process engineer
- Software engineer
- Applications engineer
- Inside sales engineer
- Research analyst
- Lab technician
- IT developer (administrator, consultant)
- Programmer
- High school science teacher
- Accelerator operator
- Data analyst
- Systems analyst
- Technical specialist.

If students choose to continue and receive a graduate degree the 10 most common jobs are

- Research scientist (at tech companies, national laboratories or universities)
- Professor, physics teacher
- Data scientist
- Lab manager
- Medical physicist
- Aerospace engineer
- Astronomer
- Environmental scientist
- Geophysicist.

PHYS 1030 PHYSICS OF EVERYDAY LIFE (3 credits)
A conceptual course in the principles of physics and their relationship to man and his environment. Topics included relate the basic laws of physics and recent developments in science to their effects on man. This course is intended for students not majoring in the sciences and may be used in partial fulfillment of the natural science requirement.
Prerequisite(s): High School algebra or equivalent.
Distribution: Natural/Physical Sci General Education lecture

PHYS 1034 PHYSICS OF EVERYDAY LIFE LABORATORY (1 credit)
A physics laboratory consisting of a series of concise experiments which relate man directly to his physical environment.
Prerequisite(s): High school algebra or equivalent; PHYS 1030, prior or concurrent.
Distribution: Natural/Physical Sci General Education lab course

PHYS 1050 INTRODUCTION TO PHYSICS (4 credits)
A terminal one-semester course covering major topics in mechanics, heat, sound, electricity, magnetism, light and modern physics. Designed particularly for non-science liberal arts majors or others for whom such a one-semester coverage might be deemed adequate. (Does not count towards physics requirement for chemistry, physics and engineering majors.)
Prerequisite(s): High school algebra or equivalent.
Distribution: Natural/Physical Sci General Education lecture

PHYS 1054 INTRODUCTION TO PHYSICS LABORATORY (1 credit)
A series of concise experiments on varied topics in physics, such as scientific sampling, optics, elasticity, motion, sound, light and electricity are covered in this one-semester course. Emphasis is placed on data collection and graphing, and error reduction.
Prerequisite(s): High school algebra or equivalent; PHYS 1050, prior or concurrent, or permission of the instructor
Distribution: Natural/Physical Sci General Education lab course

PHYS 1110 GENERAL PHYSICS I WITH ALGEBRA (4 credits)
First part of a two-semester continuing course designed for students with no prior background in physics. Mechanics, heat and sound are covered in this semester.
Prerequisite(s): MATH 1310 or MATH 1220 or equivalent, or MPE score above 2 or permission of instructor
Distribution: Natural/Physical Sci General Education lecture

PHYS 1120 GENERAL PHYSICS (4 credits)
Second part of a two-semester continuing course designed for students with no prior background in physics. Electricity and magnetism, light, and a little modern physics are covered.
Prerequisite(s): PHYS 1110 or permission.

PHYS 1154 GENERAL PHYSICS LABORATORY I (1 credit)
One-semester laboratory course for students enrolled in PHYS 1110 or PHYS 2110. Covers experiments in mechanics, wave motion and heat.
Prerequisite(s): PHYS 1110 or PHYS 2110, prior or concurrent.
Distribution: Natural/Physical Sci General Education lab course

PHYS 1164 GENERAL PHYSICS LABORATORY II (1 credit)
One-semester laboratory course for students enrolled in PHYS 1120 or PHYS 2120. Second semester covers experiments in electricity and magnetism, optics, and modern physics.
Prerequisite(s): PHYS 1120 or PHYS 2120, prior or concurrent.

PHYS 1350 PRINCIPLES OF ASTRONOMY (3 credits)
An introductory course that satisfies divisional requirements in natural science. Topics discussed include the night sky, gravity, telescopes, atoms and radiation, the solar system, the sun and stars; and cosmology.
Prerequisite(s): High school algebra or equivalent.
Distribution: Natural/Physical Sci General Education lecture

PHYS 1354 INTRODUCTORY ASTRONOMY LAB (1 credit)
Laboratory sessions acquaint students with basic phenomena, methods and data acquisition in astronomy. By use of the experiments, students will be able to explore and add to what has been discussed in lecture. Several night observing sessions will also be available for students to use telescopes.
Prerequisite(s): PHYS 1350 prior or concurrent.
Distribution: Natural/Physical Sci General Education lab course

PHYS 1750 FUNDAMENTAL PHYSICS OF SOUND (4 credits)
A course designed for music and communication majors. It covers transmission of sound, wave motion, pitch, quality, sound synthesis, acoustics, resonance, interference, musical scales, string and wind instruments, recording and reproduction of sound. Three lectures and one discussion per week.
Prerequisite(s): High school algebra or equivalent.

PHYS 1754 FUNDAMENTAL PHYSICS OF SOUND LABORATORY (1 credit)
A laboratory that accompanies PHYS 1750. The experiments are coordinated with the music-related portions of lecture course. The laboratory is designed for music majors.
Prerequisite(s): PHYS 1750 prior or concurrent and music major or permission of instructor.

PHYS 1950 PHYSICS GATEWAY COURSE (1 credit)
Designed for first year physics majors, a one-semester introduction to concepts and tools to be encountered and used in earning a physics degree.
Prerequisite(s): High school algebra or equivalent.

PHYS 2030 ENERGY AND FUELS (3 credits)
This one semester course focuses on energy from a macroscopic perspective. Viewpoints based on the law of physics are distinguished from unsupported opinion. Topics include: electricity production and consumption; mineral and fossil fuel resources; nuclear, solar, fossil fuel and biomass energies; pollution, conservation and recycling; extrapolation and interconnections.
Prerequisite(s): MATH 1310 or MATH 1220

PHYS 2040 RADIATION FUNDAMENTALS (3 credits)
This one-semester course examines the ways radiation affects our daily lives. Topics include: structure of matter and types of radiation, half-life and activity, biological effects of radiation, radiation standards and protection, uses of isotopes and radiation, nuclear wastes life-cycle, nature of risk versus benefit, dose calculations and shielding fundamentals.
Prerequisite(s): MATH 1310 or MATH 1220, minimum of PHYS 1050.

PHYS 2110 GENERAL PHYSICS I - CALCULUS LEVEL (4 credits)
First part of a two-semester continuing course for students majoring in some area of science, mathematics or engineering. Mechanics, molecular properties of matter and heat are covered in the first semester.
Prerequisite(s): MATH 1950 (MATH 1930 for Geology majors) or permission of the instructor. High school physics or PHYS 1050 is recommended.
Distribution: Natural/Physical Sci General Education lecture

PHYS 2120 GENERAL PHYSICS-CALCULUS LEVEL (4 credits)
Second part of a two-semester continuing course for students majoring in some area of science, mathematics or engineering. Wave motion, electricity, magnetism and light are considered during the second semester.
Prerequisite(s): PHYS 2110 and MATH 1960 (MATH 1930 for Geology majors) or permission of the instructor.

PHYS 2130 MODERN PHYSICS (4 credits)
The course is composed of introductions to relativity theory and quantum theory with applications to atomic and nuclear structure. Topics include: Planck radiation law; Compton Effect; photoelectric effect; the Rutherford experiments and Bohr model of the atom; the Schroedinger electronic structure of atoms; nuclear reactions, nuclear models, radioactive decay, fission, fusion and elementary particles.
Prerequisite(s): PHYS 2110, PHYS 2120, MATH 1950, & MATH 1960; or permission.

PHYS 2350 SPECIAL TOPICS IN ASTRONOMY: OBSERVATIONAL ASTRONOMY (2-3 credits)
This one semester course emphasizes personal study of the sky, including observing, measuring and recording celestial positions. Students will be shown how to observe and measure the Sun, the Moon, visible planets, and stars, and how to document astronomical observations. Students will be required to study outdoors on their own and will also use the department's observing facilities.
Prerequisite(s): PHYS 1350 or instructor permission.

PHYS 3250 MATHEMATICAL METHODS OF PHYSICS (3 credits)
Training in the use of mathematical techniques applicable to physics problems encountered in upper-level physics courses. Vector operators, Fourier analysis, frequently used differential equations (ordinary and partial), orthogonal functions, and matrix methods of coordinate transformation are included. Emphasis is given to solving problems from mechanics such as vectoral mechanics, oscillatory systems, wave motion, potential theory, etc.
Prerequisite(s): MATH 1950, MATH 1960, MATH 1970 and PHYS 2160 or 2120 or permission.

PHYS 3260 COMPUTER TOOLS FOR PHYSICISTS (2 credits)
This course will introduce a wide selection of computer-powered mathematical tools for doing physics or any upper level science courses. It will introduce software packages in real and complex algebra, trigonometry, calculus I & II, linear algebra, statistics, differential equations, special functions, graphics, document preparation, and programming in the manner of a research scientist.
Prerequisite(s): PHYS 1120 or PHYS 2120 and MATH 1960.

PHYS 3300 INTRODUCTION TO BIOMEDICAL PHYSICS (3 credits)
This course is designed primarily for students desiring to specialize in Biomedical Physics. The course emphasizes an understanding of the fundamental principles of physics and the use of these principles in a variety of biological and medical applications with the major goal to merge physics, biology, and medicine in a unified perspective. PHYS 3300 covers various topics relating basic physics to living systems, including mechanics, fluid mechanics, thermodynamics, sound, electricity, optics, atomic physics, nuclear physics, and nanotechnology. It also describes various technologies widely used in modern medicine such as laser surgery, ultrasound imaging, X-ray, computed tomography, and magnetic resonance imaging. Each topic briefly introduces related background of physics principles as well as comprehensive overview of biological/medical application, thus (although highly recommended) very little background in physics or biology is required. This course will benefit students with interests in medicine, biology, biophysics, or medical physics.
Prerequisite(s): PHYS1110 is required. PHYS2110 and PHYS1120 or PHYS2120 are recommended.

PHYS 3450 CLASSICAL MECHANICS (3 credits)
Statics and dynamics of particles and rigid bodies including the equations of Lagrange and Hamilton.
Prerequisite(s): MATH 1970, PHYS 3250 or permission.

PHYS 3500 ELEMENTS OF ELECTRONICS (3 credits)
The topics covered will include basic circuit theory, principles and operation of electronic devices such as diodes, transistors and integrated circuits. Application of these devices in various electronic circuits. Both analog and digital circuitry will be studied. (Cross-listed with PHYS 8505)
Prerequisite(s): PHYS 1120 or PHYS 2120 and MATH 1970

PHYS 3504 EXPERIMENTAL PHYSICS I (1 credit)
A set of experiments designed to complement PHYS 3750 and PHYS 4200.
Prerequisite(s): PHYS 2120

PHYS 3524 EXPERIMENTAL PHYSICS II (1 credit)
A set of experiments designed to complement PHYS 3760 and PHYS 4210.
Prerequisite(s): PHYS 2120

PHYS 3544 EXPERIMENTAL PHYSICS III (1 credit)
A set of experiments designed to complement PHYS 3450, PHYS 3850, and PHYS 4200.
Prerequisite(s): PHYS 2120

PHYS 3564 EXPERIMENTAL PHYSICS IV (1 credit)
A set of experiments designed to complement PHYS 3020 and PHYS 4220.
Prerequisite(s): PHYS 2120

PHYS 3600 THERMODYNAMICS AND STATISTICAL PHYSICS (3 credits)
Topics include: empirical and absolute temperature, equations of state, work, heat, entropy, the four laws of thermodynamics, phase changes, thermodynamic potentials, classical and quantum statistics of an ideal gas. Applications to be included: Einstein theory of a solid, paramagnetism, blackbody radiation, and conduction electrons. (Cross-listed with PHYS 8605)
Prerequisite(s): PHYS 2120 and MATH 1970.

PHYS 3750 ELECTRICITY AND MAGNETISM I (3 credits)
An advanced study of electrostatics and magnetostatics, including Coulomb's law, Gauss' law, the scalar potential, conductors and dielectrics, electrostatic energy, special methods, electric current, Ampere's law, the magnetic induction, Faraday's law, and the electromagnetic wave equation as obtained from Maxwell's equations, with simple examples such as transmission lines and antennas. (Cross-listed with PHYS 8755)
Prerequisite(s): MATH 1950, MATH 1960, MATH 1970, PHYS 3250, or permission.

PHYS 3760 ELECTRICITY AND MAGNETISM II (3 credits)
A selection of more advanced topics from electromagnetic theory, including a deeper treatment of the electromagnetic wave equations derived from Maxwell's equations, extending to propagation, reflection and refraction of plane waves, waves in wave guides, and radiation. Other topics covered might be magnetism and magnetic energy, plasmas and special relativity. (Cross-listed with PHYS 8765)
Prerequisite(s): PHYS 3750

PHYS 3800 OPTICS (3 credits)
The behavior of electromagnetic radiation as formulated in the ray, wave, and quantum models. Topics will include: reflection and refraction, vergence, matrix method, optical instruments, scalar waves, electromagnetic waves, blackbody radiation, interference, diffraction, and lasers; if time permits, fiber optics and holography will also be included. (Cross-listed with PHYS 8805)
Prerequisite(s): PHYS 1120 or PHYS 2120 and MATH 1970

PHYS 4200 INTRODUCTION TO QUANTUM MECHANICS (3 credits)
This course provides an introduction to the historical development of modern physics and to the Schroedinger formulation of quantum mechanics. Specific topics will include square wells potential barriers, the simple harmonic oscillator potential and the hydrogen atom. Characteristics of multi-electron atoms, including angular momentum coupling schemes, spectra and transition rules will also be included. (Cross-listed with PHYS 8206)
Prerequisite(s): PHYS 3250 or permission.

PHYS 4210 QUANTUM THEORY (3 credits)
The matrix operator formalism is covered along with philosophical implications of this approach. The methods developed will be applied to simple harmonic oscillator and hydrogen atom potentials. Raising and lowering operators, creation-annihilation operators, and first and second order perturbation theory will be discussed. (Cross-listed with PHYS 8216)
Prerequisite(s): PHYS 4200 or permission.

PHYS 4220 PHYSICS OF MOLECULES AND SOLIDS (3 credits)
This course covers the various types of atomic bonding found in molecules and solids. Electronic energy levels and spectra of molecules will be discussed. Topics in solid state physics will include mechanics and thermodynamics of crystals, the scattering of waves, including x-ray and neutron scattering, electron scattering and phonon and photon interactions. (Cross-listed with PHYS 8226)
Prerequisite(s): PHYS 4200 or permission.

PHYS 4230 SPECIAL RELATIVITY AND NUCLEAR PHYSICS (3 credits)
This course includes a brief historical background of the development of relativity theory and the importance of the experiments performed in conjunction with it. Lorentz transformations and covariant formalism will be developed and applied to certain problems in mechanics and electricity and magnetism. The nuclear physics portion of the course will include the historical development of the concept of the nuclear atom. Theoretical models of nuclear structure will be discussed, along with the theory of alpha, beta and gamma decay. Fission and fusion discussed as time permits. (Cross-listed with PHYS 8236)
Prerequisite(s): PHYS 4200 or permission.

PHYS 4300 GENERAL RELATIVITY (3 credits)
A study of general relativity theory and its leading applications. Physical motivations and conceptual foundations will be explored. Students will be guided step-by-step to mastery of the tensor analysis required by this theory. Topics covered will include the equivalence principle, recap of special relativity, tensors, curvature and geodesics, Einstein field equations, black holes, cosmology, and gravitational waves. (Cross-listed with PHYS 8306)
Prerequisite(s): PHYS 3750 and PHYS 4230, or permission of instructor.

PHYS 4350 ASTROPHYSICS (3 credits)
This course introduces the fundamentals of astrophysics to students with a prior knowledge of physics and mathematics. A review will be given of light and telescopes, classical and quantum mechanics and special relativity. Basic laws of physics will be applied to various topics such as: the sun, nuclear fusion and particle physics, evolution and end state of stars, interstellar medium, galaxies and cosmology. (Cross-listed with PHYS 8356)
Prerequisite(s): PHYS 2130 or 4200 and MATH 1970. Recommended: PHYS 1350.

PHYS 4400 GEOPHYSICS (3 credits)
A study of geophysical techniques used to understand the earth, study environmental problems, and in resource exploration. Seismic, gravity, heat flow, magnetic and other methods will be presented. The insights from these methods into earthquake events, stress distributions, rock rheology and plate tectonics will also be addressed. Interpretive skills will be emphasized. (Cross-listed with GEOL 4400).
Prerequisite(s): GEOL 1170, PHYS 1110 or higher, or permission of instructor

PHYS 4500 BIOLOGICAL PHYSICS (3 credits)
This course is designed primarily for students specializing in Biomedical Physics. As a part of Biomedical Physics program at the Department of Physics, the course introduces the fundamental principles of physics and the use of these principles for various biological applications. PHYS 4500/8506 covers various topics including cells, polymers, polyelectrolytes, membranes, mesoscopic forces, self-assembly, photonics, fluid mechanics, motility, chemical kinetics, enzyme kinetics, modern experimental techniques of biophysics. Each topic connects biomolecules with their functions and relevant biological phenomena from a physics perspective. This course will benefit students with interests in biological and medical physics, as well as chemistry, biology. (Cross-listed with PHYS 8506).
Prerequisite(s): PHYS 2110 is required. PHYS 2120 and PHYS 3300 are recommended.

PHYS 4550 PHYSICS IN MEDICINE (3 credits)
This course is designed primarily for students desiring to specialize in Biomedical Physics. The course introduces principles and applications of various medical imaging modalities and medical physics based therapies. Topics include such imaging techniques as ultrasound, X-ray imaging, Computed Tomography (CT), MRI imaging, and positron emission tomography. The course discusses physical principles behind medical imaging and therapeutic applications and covers interaction of different kinds of radiation with biological matter. (Cross-listed with PHYS 8556).
Prerequisite(s): PHYS 2110; PHYS 2120, and PHYS 2130 for Physics majors or permission of the instructor. PHYS 3300 and PHYS 4500 are recommended.

PHYS 4800 INTERNSHIP (1-6 credits)
Internship with agencies or corporations enabling students to gain knowledge and experience in practical applications of physics and/or environmental principles.
Prerequisite(s): Junior or senior standing. Permission.

PHYS 4950 PROBLEMS IN PHYSICS (1-3 credits)
Individual laboratory and/or library work, or reading course in some field of physics. (Cross-listed with PHYS 4960, PHYS 8956, PHYS 8966)
Prerequisite(s): PHYS 2120 and permission of instructor.

PHYS 4960 PROBLEMS IN PHYSICS (1-3 credits)
Individual laboratory and/or library work, or reading course in some field of physics. (Cross-listed with PHYS 4950, PHYS 8956, PHYS 8966)
Prerequisite(s): PHYS 2120 and permission of instructor.