

DEPARTMENT OF PHYSICS AND ASTRONOMY

Department Objectives

- To provide the background necessary for understanding the highly scientific age in which we live;
- To prepare students for careers and for graduate work in physics and other closely allied fields;
- To prepare teachers in subject matter and in methods for the teaching of Physics, Astronomy and related fields;
- To furnish pre-professional work for those preparing for a career in science and related fields.

Department of Physics and Astronomy

Seven options are available:

1. Physics (<http://catalog.unk.edu/undergraduate/departments-programs/physics-astronomy/physics-ba/>) - Bachelor of Arts Degree or Physics (<http://catalog.unk.edu/undergraduate/departments-programs/physics-astronomy/physics-bs/>) - Bachelor of Science Degree
2. Physics Comprehensive (<http://catalog.unk.edu/undergraduate/departments-programs/physics-astronomy/physics-comprehensive-bs/>) - Bachelor of Science Degree
3. Physics Comprehensive Engineering Emphasis (<http://catalog.unk.edu/undergraduate/departments-programs/physics-astronomy/physics-comprehensive-engineering-emphasis-bs/>) - Bachelor of Science Degree
4. Physical Science (<http://catalog.unk.edu/undergraduate/departments-programs/physics-astronomy/physical-science-ba/>) - Bachelor of Arts Degree or Physical Science (<http://catalog.unk.edu/undergraduate/departments-programs/physics-astronomy/physical-science-bs/>) - Bachelor of Science Degree
5. Astronomy (<http://catalog.unk.edu/undergraduate/departments-programs/physics-astronomy/astronomy-bs/>) - Bachelor of Science Degree
6. Astrophysics Comprehensive (<http://catalog.unk.edu/undergraduate/departments-programs/physics-astronomy/astrophysics-comprehensive-bs/>) - Bachelor of Science Degree
7. Physics 7-12 Teaching Subject Endorsement (<http://catalog.unk.edu/undergraduate/departments-programs/physics-astronomy/physics-7-12-teaching-subject-endorsement-bse/>) - Bachelor of Science in Education Degree

A minor in Physics (<http://catalog.unk.edu/undergraduate/departments-programs/physics-astronomy/physics-minor/>) is available for students pursuing majors in other disciplines. An Engineering Minor (<http://catalog.unk.edu/undergraduate/departments-programs/physics-astronomy/engineering-minor/>) is available. A Science Minor (<http://catalog.unk.edu/undergraduate/departments-programs/physics-astronomy/science-elementary-education-minor/>) is available for Elementary Education majors.

A Pre-professional Program is available in Engineering Foundations 2+2 (for UNL) (<http://catalog.unk.edu/undergraduate/departments-programs/physics-astronomy/engineering-foundations/>).

Engineering (ENGR)

ENGR 10 – Freshman Engineering Seminar 0 credit hours

Overview of the engineering field as well as major specific information. Information will be provided to help with transitional needs to UNL and the college of engineering (time management, study skills, and resources), involvement opportunities (student organizations, research, and study abroad), tours of engineering facilities for experiential learning, and interactive learning to increase business knowledge and skills.

ENGR 101 – Introduction to Engineering 3 credit hours

Students will examine relevant and practical industrial and commercial engineering applications to gain necessary engineering skills that will help them succeed as a student as well as a professional engineer. A variety of engineering disciplines will be highlighted and discussed, as well as topics in the underlying physical, chemical, and biological scientific principles and processes related to each topic. The class will use a specified focus area that involves real world applications to aid in the conceptualization and learning of the course material.

Corequisite: MATH 103 or MATH 115 or MATH 202.

ENGR 130 – Computer Aided Drafting for Mechanical Engineering 3 credit hours

Principles and accepted practices of geometric design in mechanical engineering. Computer generation of 2D and 3D models for mechanical systems. Introduction to engineering design practices such as specifications, dimensioning, and tolerance.

Prerequisite: ENGR 101

ENGR 155 – Engineering Problem Solving: MATLAB 3 credit hours

This course is divided into three modules. During the first module of this course, we will focus on the basics of computing and at the same time learn the basic programming constructs. The second module of this course explores engineering design process and computing with a focus on representing engineering systems using matrices and solving them in MATLAB. The third module will focus on using MATLAB for advanced computation optimization and data fitting.

Prerequisite: MATH 103 or higher

ENGR 200 – Engineering Thermodynamics 3 credit hours

Introduce students to the Thermodynamics properties, open and closed systems, equations of state, heat and work, first law of thermodynamics, second law of thermodynamics, Carnot Cycle, Otto Cycle, Diesel Cycle and heat engine, Exergy balance, Rankine Cycle, refrigeration cycles, Brayton cycle, Heat pump, psychrometrics, Steady-flow, Entropy.

Prerequisite: PHYS 275 and PHYS 275L.

Corequisite: ENGR 223 and MATH 202.

ENGR 215 – Engineering Circuits I 4 credit hours

Introduction to electrical engineering circuit theory. Kirchoff's laws and circuit analysis theorems applied to steady state DC resistive circuits. Analysis of transient RLC and sinusoidal steady-state circuits.

Corequisite: PHYS 276 and MATH 202.

ENGR 216 – Engineering Circuits II 4 credit hours

Steady state power calculations for sinusoidal single-phase and balanced three-phase circuits. Analysis of circuits containing mutual inductance. Advanced analysis of active and passive circuits in both the time and frequency domain. Introduction to fundamentals of semiconductor theory and their application to p-n junction devices. Kirchoff's laws and circuit analysis theorems applied to steady state diode and transistor circuits.

Applications of operational amplifiers. Lecture 3 hours, lab 1 hour.

Prerequisite: ENGR 215

ENGR 223 – Engineering Statics 3 credit hours

Analysis of forces, using vector algebra, acting on particles and rigid bodies in static equilibrium; equivalent systems of forces; friction; centroids and moments of inertia; introduction to energy methods.

Prerequisite: PHYS 275 and ENGR 101.

Corequisite: MATH 202.

ENGR 325 – Mechanics of Materials 3 credit hours

Stresses and strain in solids, uniaxial loading, linear elasticity, material behavior, stresses in beams, pressure vessels, Torsion of circular shafts, bending of beams of symmetrical section, column buckling and elastic instability.

Prerequisite: ENGR 223.

Corequisite: MATH 260.

Additional Course Fee Required

ENGR 373 – Engineering Dynamics 3 credit hours

Basic theory of engineering mechanics, using calculus, involving the displacement, velocity, and acceleration of particles, rigid bodies, and systems of particles. Newton's Laws, work and energy relationships, principles of impulse and momentum are applied to the solution of kinematic engineering problems.

Prerequisite: ENGR 223.

Corequisite: MATH 260.

Physics (PHYS)

PHYS 100 – Physical Science 3 credit hours

An introduction to the natural laws governing the physical world, with emphasis upon the development of these laws and their effect upon man. The course should instill a basic understanding of physical science; the scientific methods of physics, chemistry, geology, and astronomy. With this understanding, the student should be able to solve simple problems dealing in these areas. The student should realize how these areas are used in modern technology. Finally, the student should be able to make informed choices in their daily lives regarding issues of science and technology.

Prerequisite: ACT Math Score of 17 or above or completion of MATH 101 or above with a grade of C or above.

Corequisite: PHYS 100L.

PHYS 100L – Physical Science Laboratory 1 credit hour

A laboratory experience in physical science (mechanics, thermodynamics, chemistry, electricity, magnetism, optics, and astronomy) to accompany PHYS100

Corequisite: PHYS 100.

Additional Course Fee Required

PHYS 107 – Physical Science for Elementary Teachers 4 credit hours

An introduction to physics and chemistry designed for Elementary Education majors where basic concepts will be emphasized. The laboratory will focus on experiments that can be used to illustrate the essentials of the disciplines. Laboratory safety, scientific methodology, and problem solving will also be emphasized.

Prerequisite: MATH ACT score of 17 or greater or MATH 101 with a grade of C or above.

PHYS 123 – Freshman Physics Seminar 3 credit hours

Introductory course in physics, offering the students an overview of careers in physics and the research of the faculty in the Department of Physics and Astronomy. The course will help students succeed in physics by helping them develop problem solving and mathematics skill. An experimental approach will be taken to a broad range of exciting contemporary ideas. The topics covered range from simple geometric optics, the speed of light, and analysis of motion, to the photoelectric effect. This is a studio course, a blend of laboratory and lecture format, with a focus on a hands-on approach to the topics

Corequisite: MATH 103 or MATH 115 or MATH 202.

PHYS 126 – First Year Seminar 1 credit hour

The First-Year Seminar provides students with a multidisciplinary experience in which they approach an issue or problem from the perspective of three different academic differences. The First-Year Seminar will consist of three 1-credit hour courses taken as co-requisites in a single semester. The successful completion of all three courses satisfies the General Studies LOPER 1 course requirement. Students may take the First-Year Seminar in any discipline, irrespective of their major or minor. Students admitted as readmit students or transfer students who transfer 18 or more hours of General Studies credit to UNK are exempt from taking a LOPER 1 course.

PHYS 131H – Newton's Universe 4 credit hours

This course is designed to provide students with an understanding and appreciation of science as a human activity, its historical role in shaping our self and world views, its impact on the human condition, and its philosophical implications for their ultimate destiny. An associated laboratory, using inquiry-oriented activities, allows students to experience the process of science.

PHYS 155 – Science of Sound and Music 3 credit hours

This course will address the how and why aspects of sound and music. It is intended to be a journey from the starting point where a sound is produced in an instrument, to the overtones produced by the instrument, and ultimately through its reception and enjoyment in the mind. We will discuss the mathematical and physical basis for common musical scales and how musical instruments are designed to produce musical notes for these scales. This course is designed for students majoring in Music, Speech and Hearing, Audio Technology, and Telecommunications, as well as other students having a general interest in the physics of sound and music

Prerequisite: MATH 102 or higher.

Corequisite: PHYS 155L.

PHYS 155L – Science of Sound and Music Laboratory 1 credit hour

A laboratory experience into the physical science of sound and music to accompany PHYS155.

Corequisite: PHYS 155.

Additional Course Fee Required

PHYS 201 – Earth Science 4 credit hours

Inquiry activities are used to teach basic concepts of meteorology, geology, and astronomy. Emphasis is placed on process and critical thinking skills as well as on environmental issues.

Additional Course Fee Required

PHYS 203 – General Physics for Allied Health 4 credit hours

A one semester survey of general physics for students in the allied health program. Students will study Newton's laws, torque, energy, and momentum, electrostatics and magnetism, mechanical and electromagnetic waves, nuclear reactions, and some of the physics of medical devices. We will develop the concepts and formalism in these areas so that students will be able to solve simple problems. Also, students should realize how these topics are used in modern technology and connected to their discipline. Students who have not completed MATH 102 are strongly encouraged to take PHYS 203 and MATH 102 in the same semester. Please see the Physics department for further information.

Prerequisite: MATH 102

PHYS 205 – General Physics I 4 credit hours

Students will study the fundamental laws of mechanics, thermodynamics, and waves at a level suitable for those with knowledge of algebra. We will develop concepts and formalism in these areas. With this understanding, the student will be able to solve simple problems. Also, the student should realize how these areas are used in modern technology and connected to other disciplines. The primary audience for this class are those not specifically interested in advanced work in physics or chemistry.

Prerequisite: MATH 102 with a grade of B+ or above or MATH 103 with a grade of B+ or above or MATH 115 or Math ACT score of 20 or above.

Corequisite: PHYS 205L.

PHYS 205L – Physics I Laboratory 1 credit hour

A laboratory experience in mechanics, thermodynamics, and waves to accompany PHYS 205

Corequisite: PHYS 205.

Additional Course Fee Required

PHYS 206 – General Physics II 4 credit hours

A continuation of PHYS205. The course will present an elementary understanding of electricity and magnetism, geometric and wave optics, and atomic and nuclear physics.

Prerequisite: PHYS 205 and PHYS 205L.

Corequisite: PHYS 206L.

PHYS 206L – Physics Laboratory II 1 credit hour

A laboratory experience in electricity, magnetism, and optics to accompany PHYS206.

Corequisite: PHYS 206.

Additional Course Fee Required

PHYS 209 – Meteorology 3 credit hours

Basic principles of the science associated with the atmosphere including atmospheric structure, dynamics, and processes. Topics include atmospheric energy balance, cloud and precipitation process, dynamical stability, local and global wind dynamics, weather forecasting, meteorological instruments, storm development, climate change, and applications of meteorology to agriculture, aviation, and environmental issues.

Prerequisite: Math 102 or permission of instructor Enrollment not allowed in PHYS 209 if GEOG 209 has been completed

PHYS 210 – Astronomy 3 credit hours

The goal of this course is to introduce students to the growth of knowledge about our universe. Topics include: the Earth, Moon, planets, Sun, stars, galaxies and cosmology. The course uses the resources of the UNK planetarium and observatory.

Prerequisite: MATH 102 or higher

PHYS 210L – General Astronomy Laboratory 1 credit hour

The laboratory course will explore – through a mixture of hands-on and simulation-based experiments – the size and scope of the Universe along with the basic principles of modern astronomy. Involves quantitative analysis.

Prerequisite: Concurrent enrollment or completion of PHYS 210.

Additional Course Fee Required

PHYS 275 – General Physics I (Calculus) 4 credit hours

Students will study the fundamental laws of mechanics, thermodynamics, and waves at a level suitable for those with knowledge of calculus, and prepares the student for advanced courses in physics.

The primary audience for this class consists of those planning advanced work in physics, engineering, or a related area. Lecture 4 hours.

Prerequisite: Concurrent enrollment or completion of MATH 115.

Corequisite: PHYS 275L.

PHYS 275L – General Physics I (Calculus) Laboratory 1 credit hour

A laboratory experience in mechanics, thermodynamics, and waves to accompany PHYS275.

Corequisite: PHYS 275.

Additional Course Fee Required

PHYS 276 – General Physics II (Calculus) 4 credit hours

Students will study the fundamental laws of electrostatics, magnetism, and optics at a level suitable for those with knowledge of calculus and prepares the student for advanced courses in physics. The primary audience for this class consists of those planning advanced work in physics, engineering, or a related area. Lecture 4 hours.

Prerequisite: Grade of C or above in both PHYS 275 and PHYS 275L.

Corequisite: PHYS 276L.

PHYS 276L – General Physics II (Calculus) Laboratory 1 credit hour

A laboratory experience in electricity, magnetism, and optics to accompany PHYS 276.

Corequisite: PHYS 276.

Additional Course Fee Required

PHYS 299 – Freshman Seminar in Physics: History, State of the Art and Perspectives 1 credit hour

This seminar is a non-mathematical discussion of 21st century physics (potentially including topics such as relativity, chaos, elementary particles, etc.)

PHYS 301 – Advanced Physical Science 4 credit hours

Fundamental study of mechanics, light, electricity, magnetism, astronomy and earth science. Emphasis is placed on the development of process and critical thinking skills. Offered spring of even years.

Additional Course Fee Required

PHYS 346 – Modern Physics I 4 credit hours

An introduction to wave optics, relativity, and atomic and nuclear physics. The primary audience for this class consists of those planning advanced work in physics, engineering, or a related area.

Prerequisite: Grade of C or above in both PHYS 276 and PHYS 276L

Additional Course Fee Required

PHYS 350 – Astrophysics I 3 credit hours

This course addresses how the principles of physics can be used to understand a variety of astrophysical objects and phenomena.

Topics include the physics of photon emission and absorption, stellar evolution of stars from birth to death including stellar end-states such as blackholes and supernovae, clusters of stars, and the structure of the Milky Way.

Prerequisite: PHYS 346 or permission of instructor

PHYS 351 – Astrophysics II 3 credit hours

This course continues the study of astrophysical objects and phenomena. Topics include galactic astronomy, large scale structure of the Universe, and cosmology.

Prerequisite: PHYS 350

PHYS 360 – Computational Methods in Physics and Astronomy 3 credit hours

This course addresses the computational methods used in physics and astronomy with an integrated lab and lecture. Physics contains many problems that can only be solved numerically and large quantities of data must often be reduced and examined to draw meaningful results. Modern astronomy has moved beyond observations made locally at telescopes. Handling large datasets, using scripts to mine data, and computational modeling methods are all important tools for modern physicists and astronomers. Topics addressed in this course will include computer usage techniques, writing scripts, modeling data, presentation of data, mining data from large surveys, and computational analysis methods. The lab will focus on the use of computational tools. Lecture 2 credit hours, Laboratory 1 credit hour.

Prerequisite: PHYS 346 or permission of instructor

PHYS 361 – Astronomy Methods II 3 credit hours

This course addresses the observational methods used in astronomy. Topics addressed will include photon statistics, imaging, photometry, spectroscopy, and telescope design. An emphasis will be placed on practical applications of these topics. The lab will focus on the use of the UNK telescope to make observations to measure stellar properties.

Prerequisite: PHYS 360

PHYS 370 – Introduction to Biophysics 3 credit hours

This course will introduce the student to how concepts and techniques in physics are applied to living systems. The course covers scale in biological systems, models of thermodynamics and fluid mechanics relevant at the cellular level, then molecular machines and nerve impulses. Diffusion, low Reynolds number fluids, and the entropy/free energy of cells are key concepts. Relevant concepts from chemistry, biochemistry, and physiology will be reviewed.

Prerequisite: PHYS 206 or PHYS 276 and MATH 115 or higher

PHYS 372 – Physics of the Body I 3 credit hours

This course uses the knowledge gained in the general physics and expands upon them by applying them to the human body. Physics of the Body I studies biomechanics (the statics and motions of the body; forces, torques, and levers), thermodynamics and heat transfer, sounds and hearing, and light and vision. These are from the 'macrophysics' of the body, and this course leaves most of the 'microphysics' to other courses.

Prerequisite: PHYS 206 or PHYS 276 and MATH 115 or higher

PHYS 399 – Internship 1-4 credit hours

This course emphasizes the professional development of the student in the area of the student's interest. Students should contact a department faculty member who would agree to supervise the work for the semester. A written work plan must be approved by the department chair.

Total Credits Allowed: 4.00

PHYS 402 – Analytic Mechanics 4 credit hours

Advanced applications of classical nonrelativistic mechanics. Topics include dynamics of a system of particles, motion in noninertial reference frames, properties of three-dimensional rotations and tensors, dynamics of rigid bodies, and coupled oscillations. The course ends with an introduction to the mechanics of continuous media and applications to fluid dynamics and elasticity.

Prerequisite: PHYS 410 and MATH 305 or permission of Instructor

PHYS 407 – Electricity & Magnetism 4 credit hours

Review of Maxwell's equations, electromagnetic fields, and vector calculus. Physical and mathematical properties of static electric and magnetic fields. Topics include electrostatics, electric potential, energy of the electrostatic field, conductors, Laplace's and Poisson's equations, boundary value problems, multipole expansions, dielectric media, magnetostatics, the vector potential, electromagnetic waves (in a vacuum, in infinite linear media, and in bounded regions), optical dispersion in material media, and electromagnetic radiation.

Prerequisite: PHYS 410 and MATH 305 or permission of Instructor

PHYS 410 – Mathematical Techniques in Physics I 3 credit hours

A formal development of selected topics from infinite series, determinants and matrices, partial differentiation, vector analysis, Fourier series, functions of a complex variable, and coordinate transformations.

Prerequisite: MATH 260 or permission of instructor

PHYS 411 – Mathematical Techniques in Physics II 3 credit hours

A development of series solution of differential equations, partial differential equations, tensor analysis, asymptotic series, integral transforms, and operators.

Prerequisite: PHYS 410

PHYS 419 – Quantum Mechanics 4 credit hours

A formal development of the principles of quantum mechanics. The mathematics of Hamiltonian Mechanics are presented as a bridge from Classical Physics to Quantum Physics. Topics include time-dependent quantum mechanics and spectroscopy, perturbation theory, two-level systems, light-matter interactions, relaxation in quantum systems, correlation functions and linear response theory, applications to atomic and molecular physics.

Prerequisite: PHYS 410

PHYS 420 – Advanced Physics Laboratory 3 credit hours

An application and investigation of advanced physical topics in the laboratory. Techniques of experimental physics, such as computerized instrumentation, vacuum technology, optics, and electron optics will be applied to investigate various areas of advanced physics. Proper data reduction and analysis will be used to yield meaningful measurements. Intended as laboratory course to prepare the student for more advanced, independent experimental lab work. Laboratory 3 hours.

Prerequisite: PHYS 410

PHYS 430 – Optics 3 credit hours

Geometric and wave optics including optical instruments. Prior completion of MATH 305 is recommended.

Prerequisite: PHYS 276 and PHYS 276L and PHYS 410

PHYS 435 – Solid State Physics 3 credit hours

An introduction to the physics governing the crystalline state of matter. Modern theories describing lattice vibrations, energy bands, crystal binding, and optical properties are presented. These ideas are then applied to the understanding of technologically important areas such as superconductivity, doped semiconductors, ferroelectric materials, and photorefractivity.

Prerequisite: PHYS 410

PHYS 440 – Thermodynamics and Statistical Mechanics 3 credit hours

The study of temperature, heat and work, the laws of thermodynamics, heat engines, including the Carnot Cycle, Maxwell relations, and an introduction to statistical thermodynamics.

Prerequisite: Concurrent enrollment or completion of PHYS 410

PHYS 456 – Regional Field Studies 1-4 credit hours

Includes visits to specialized research or scientific centers, or expeditions to observe or study special events such as solar eclipses.

Total Credits Allowed: 4.00

PHYS 471 – Methods in Secondary Science Teaching 3 credit hours

This course focuses on the latest trends in science teaching. Emphasis is placed on designing demonstrations, laboratory investigations, test items and other components that promote process and critical thinking skills.

Computers are utilized extensively in these activities.

Prerequisite: Admission to Teacher Education Enrollment in PHYS 471 is not allowed if BIOL 471 has been completed.

PHYS 472 – Science Curricula 1-3 credit hours

History of science curricula, introduction to the specifics of selected science curricula, experience working with science curricula materials in junior high or senior high school as well as exposure to several teaching strategies.

Total Credits Allowed: 3.00

PHYS 490 – Special Topics 1-4 credit hours

Topics are studied which are not covered in other courses offered by the department. The format will vary depending upon the nature of the topic and the instructor but will typically be a lecture/demonstration format with laboratory work included as appropriate.

Department Consent Required

Total Credits Allowed: 9.00

PHYS 495 – Research in Physics 1-3 credit hours

Students work on an undergraduate research project under the guidance of a faculty member.

Department Consent Required

Total Credits Allowed: 6.00

PHYS 496 – Practicum in Physics Education 1-3 credit hours

For each credit hour the student will spend approximately three hours per week working as a classroom assistant in an activity-based class and/or doing physics education research.

Total Credits Allowed: 3.00

Prerequisite: PHYS 205 and PHYS 205L and PHYS 206 and PHYS 206L and PHYS 275 and PHYS 275L and PHYS 276 and PHYS 276L or permission of instructor.

PHYS 498 – Senior Seminar in Physics 3 credit hours

A senior capstone class for physics majors, completing research started in previous semesters of PHYS495. Students will write a senior paper and make a presentation at the end of the semester based on their undergraduate research experiences.

Prerequisite: 3 hours of PHYS 495

PHYS 499 – Problems in Physical Science 1-3 credit hours

Independent investigation of physical science problems. Three hours of laboratory work each week for each hour of credit.

Department Consent Required

Total Credits Allowed: 3.00