PHYSICS

Overview

Physics is the science that studies the laws that govern the universe at its most fundamental level. These laws are expressed through mathematics and are uncovered through study, experiment, modeling, and contemplation. Physicists seek to understand matter and its interactions at every scale - from the smallest subatomic particles to galactic superclusters. Physics lies at the heart of technologies like lasers, the MRI and other medical imaging devices, computers and cell phones, solar panels and other methods of alternative energy generation, and many more. Majoring in physics at Lewis University will not only provide students a solid grounding in Physics but will also help them to hone their mathematical skills, cultivate powerful, broadly applicable problem-solving abilities, and develop their computational and experimental skills. Undergraduates also have the opportunity to conduct research with Lewis faculty in fields like lasers and optics, materials characterization, and high energy physics. Career opportunities are available to physics graduates in a variety of fields, including industry, academia, consulting, medicine, law, teaching, biotechnology, engineering and business. Physics graduates may also go to graduate school in physics, engineering, materials science, or a related field. In view of the diversity of goals that students bring to the study of physics, the Lewis University Physics Department has made a concerted effort to develop a variety of program options. This allows students, in consultation with their faculty advisors, the flexibility to select a curriculum that would be most advantageous in advancing them toward their individual goals.

The Physics Department offers a B.S. with concentrations in Applied Physics and Engineering Physics, a B.A., a B.A. for future high school Physics teachers, minors in Physics and Mechanical Engineering, a pre-engineering program, and two partnership programs. One partnership program in conjunction with Northern Illinois University awards a dual degree in Physics from Lewis (B.S. in Physics) and a second B.S. in Mechanical Engineering from NIU. A second partnership program in conjunction with Purdue University Northwest provides a pathway from the B.S. Physics to a M.S. Mechanical Engineering degree.

In order to be considered for entry into any majors (B.A. and B.S.) in Physics, transfer students must have earned a 2.75 cumulative GPA or better, and students currently attending Lewis University must have an overall GPA of 2.75 or better. Facility in mathematics and laboratory sciences is essential.

All Physics majors must earn a grade of "C-" or better in a prerequisite Physics course in order to advance to the next course in a sequence. In addition, in order to complete the degree, majors must maintain a minimum GPA of 2.0, both in the major and overall.

Programs

Partnership Program

- Bachelor of Arts or Science in Physics to Master of Arts in Secondary Education / Fast Track Program (https://catalog.lewisu.edu/undergraduate/aviation-science-technology/physics/bachelor-arts-science-physics-master-secondary-education-fast-track-program/)
- Bachelor of Science to Master of Science in Physics / Fast Track Program (https://catalog.lewisu.edu/undergraduate/aviation-science-technology/physics/physics-bachelor-science-master-4-1-program/)
- Physics Major in Applied Science: Bachelor of Science / Mechanical Engineering Major: Bachelor of Science (Dual Degree) (https://catalog.lewisu.edu/undergraduate/aviation-science-technology/physics/physics-major-applied-science-bachelor-mechanical-engineering-dual-degree/)
- Physics Major in Engineering Physics to M.S. Mechanical Engineering (https://catalog.lewisu.edu/undergraduate/aviation-science-technology/physics/physics-major-engineering-ms-mechanical/)

Bachelor

- Physics / Bachelor of Arts (https://catalog.lewisu.edu/undergraduate/aviation-science-technology/physics/physics-bachelor-arts/)
- Physics / Bachelor of Science (https://catalog.lewisu.edu/undergraduate/aviation-science-technology/physics/physics-bachelor-science/)
- Physics Major for the High School Teaching License (9-12) / Bachelor of Arts (https://catalog.lewisu.edu/undergraduate/aviation-science-technology/physics/physics-major-high-school-teaching-license-9-12-bachelor-arts/)

Minor

- Mechanical Engineering / Minor (https://catalog.lewisu.edu/undergraduate/aviation-science-technology/physics/mechanical-engineering-minor/)
- Physics / Minor (https://catalog.lewisu.edu/undergraduate/aviation-science-technology/physics/physics-minor/)

Non-Degree

- Pre-Engineering (https://catalog.lewisu.edu/undergraduate/aviation-science-technology/physics/pre-engineering/)

Courses

Mechanical & Materials Engineering

MMEG 21000 - Engineering Mechanics: Statics (3)
Statics is the study of particles and rigid bodies in equilibrium, meaning they have no unbalanced forces or torques acting on them. This course covers force and moment vectors, distributed loads, centroids, moments of inertia, friction, virtual work, particle equilibrium, and rigid body equilibrium in two and three dimensions. These concepts are applied toward the analysis of trusses, frames, machines, and beams.
Prerequisite: PHYS 21000 and MATH 23500 (may be taken concurrently)

MMEG 21100 - Engineering Mechanics: Dynamics (3)
Dynamics is the study of an object or system in motion under the influence forces. This course covers kinematics of particles and rigid bodies in two and three dimensions; the relationship between force, mass, and acceleration; work and energy; impulse, and momentum.
Prerequisite: MATH 23500 and MMEG 21000

MMEG 21200 - Mechanics of Materials (3)
This course covers the mechanics of deformable elastic and inelastic bodies with emphasis on analyzing stresses, strains, and deflection and deformation in machine and structural elements (axial, shear, torsion and bending loads). Combined loading, buckling, failure criteria, and design concepts will also be discussed.
Prerequisite: MMEG 21000

MMEG 33000 - Materials Science (3)
This course covers the scientific principles determining the structure of metallic, polymeric, ceramic, semiconductor and composite materials; electronic structure, atomic bonding, atomic structure, microstructure and macrostructure. The basic principles of structure-property relationships are covered in the context of chemical, mechanical, and physical properties of materials. This course includes several laboratory sessions.
Prerequisite: CHEM 11000 and PHYS 21800

MMEG 34000 - Fluid Mechanics (3)
This course provides an introduction to fundamentals of fluid statics, integral form and control volume analysis, Bernoulli's Theorem, differential analysis and potential flow, incompressible viscous internal and external flow, application of Navier-Stokes equations, and compressible flow. Applications include flow in pipes and air foils. This course includes several laboratory sessions. MATH 30000 and either MMEG 21100 or PHYS 30000 are recommended prerequisites.
Prerequisite: MATH 25000 and PHYS 21800

MMEG 35000 - Engineering Thermodynamics (3)
This course covers principles of thermal energy conversion; properties of pure substance; work and heat; zeroth law of thermodynamics, first law of thermodynamics, control volume, steady state and steady flow process, uniform state and uniform flow process; second law of thermodynamics, entropy, power and refrigeration cycles.
Prerequisite: MATH 25000 and PHYS 21800

MMEG 35500 - Heat and Mass Transfer (3)
This course covers the fundamentals of heat transfer by conduction, convection, and radiation and mass transfer by convection. Topics include steady and transient heat conduction in solids, forced and free convection in fluids, properties of thermal radiation, radiation heat transfer between solids, and applications like heat exchangers.
Prerequisite: MMEG 35000

Physics

PHYS 10000 - Elementary Laboratory Physics (3)
This course provides an introduction to physics concepts and applications from areas such as mechanics, heat, sound, electricity, magnetism, light, and/or modern physics. Specific topics and applications covered are at the discretion of the instructor. This is a hands-on, laboratory/activity-based course in which the scientific method will be used to explore physics principles and application in our everyday world. Laboratory fee applies.
Attributes: Science General Education

PHYS 10500 - Introduction to Astronomy (3)
This one-semester course gives a general overview of astronomy. It will cover four main areas. There will be an introduction to the sky, the physics principles needed for the course, and a history of astronomy. The solar system and planetary structures and processes will be examined using a comparative planetology approach. The structure and evolution of stars will be discussed beginning with our sun, the only star in our system. Finally, large scale structures - galaxies, clusters, and the universe itself - will be discussed.
Attributes: Science General Education

PHYS 10600 - Topics in Physical Science (3)
This course is a physical science option for students in the humanities, social sciences, or communication arts It develops and explains some of the important findings of classical and modern physical science Topics will vary.

PHYS 10800 - Energy and Society (3)
Energy production and use has shaped many aspects of society and the world in which we live. This course will discuss what energy is, its production and consumption, and ways it impacts society. The physics and technology of energy generation, transmission/transport, storage, and use, including limitations and issues involved with these, will be covered both qualitatively and quantitatively. Various types of energy sources, including fossil fuels, water, nuclear, solar, and wind, will be considered. Impacts of energy production, consumption, and waste on society, climate, and the environment will be discussed.
Attributes: Science General Education

PHYS 11000 - Weather and Climate (3)
Students are introduced to physical principles and their application to students' everyday experience with weather.

PHYS 12000 - Integrated Science 1 (3)
This course is designed for students requiring a general science class that integrates physics, chemistry, biology and environmental science This is the first semester of a two-semester sequence Topics covered include the practice of science, measurement, experimentation, forces and motion, optics, heat, energy, wave motions, atomic structure, chemical reactions, and an introduction to astronomy including the evolution of stars and an understanding of the solar system Emphasis is placed on the integration of these concepts across the physical, chemical and biological disciplines.
Corequisite: PHYS 12100
Attributes: Science/Lab Gen Ed

PHYS 12100 - Integrated Science 1 Lab (1)
This course is the laboratory companion to PHYS 12000 Integrated Science 1. Laboratory fee applies.
Corequisite: PHYS 12000
Attributes: Science/Lab Component Gen Ed

PHYS 12400 - Foundations of Physical Science (3)
This course is designed to equip students with essential skills and professional practices necessary for success in the physical sciences in college and beyond. Students will strengthen their mathematical foundation, develop critical thinking skills essential for scientific inquiry, and cultivate an appreciation for the culture and community of the physical sciences. Through hands-on activities, real-world applications, and critical analysis of popular science communication, students will gain a deeper understanding of core physical science principles and learn to apply them in diverse contexts.

PHYS 13000 - Applied Physics for Aviation (3)
This course covers units and measurement, vectors, forces and motion, drag and lift, equilibrium of forces during flight, energy, momentum, and gravitation. Selected topics related to aviation and avionics from rotational and oscillatory motion, fluid mechanics and thermodynamics; electricity; electrical energy; magnetism; electromagnetic induction; linear and wave optics; atmospheric optics; and chemical and material properties. This is an integrated lecture/lab course. Laboratory fee applies

PHYS 14000 - Fundamentals of Space Science (1)
The purpose of this course is to provide secondary education teachers with an introductory overview of the solar system, stars, galaxies, and the universe as a whole. The formation, evolution, and properties of each are discussed.

PHYS 20000 - College Physics 1 (4)
This course offers a study of the fundamental laws of mechanics, forces and motions, energy, material properties, fluids, and heat.
Corequisite: PHYS 20100
Attributes: Science General Education
Illinois Articulation Initiative (IAI): P1900.

PHYS 20100 - College Physics 1 Lab (1)
This laboratory reinforces the concepts discussed in PHYS 20000 and develops experimental skills. Laboratory fee applies.
Corequisite: PHYS 20000
Illinois Articulation Initiative (IAI): P1900L.

PHYS 20500 - College Physics 2 (4)
This course is a study of waves and sound, electricity, magnetism, light, and topics in modern physics.
Prerequisite: PHYS 20000
Corequisite: PHYS 20600

PHYS 20600 - College Physics 2 Lab (1)
This laboratory reinforces the concepts discussed in PHYS 20500 and develops experimental skills. Laboratory fee applies.
Corequisite: PHYS 20500

PHYS 20900 - Applied College Physics (3)
This course focuses on the application of specific fundamental principles of physics and chemical physics to contemporary industrial requirements and products Information and skills treated in this course will vary according to the needs of the company and/or student.
Prerequisite: MATH 12000 (may be taken concurrently)

PHYS 21000 - General Physics 1 (3)
This course is the first of three introductory calculus-based Physics courses and provides the foundation for the other two Translational, rotational, and oscillatory motions of objects and the forces and torques acting on them are covered. Newton's Laws and the laws of conservation of energy, momentum, and angular momentum are emphasized.
Prerequisite: MATH 20900 (may be taken concurrently)
Corequisite: PHYS 21100
Attributes: Science/Lab Gen Ed

PHYS 21100 - General Physics 1 Lab (1)
This is the laboratory component to PHYS 21000 Experiments reinforcing topics in mechanics are conducted, and measurement techniques and data analysis are emphasized. Laboratory fee applies.
Corequisite: PHYS 21000
Attributes: Science/Lab Component Gen Ed

PHYS 21500 - General Physics 2 (3)
This course is a calculus-based introduction to electricity and magnetism. Properties and sources of electric and magnetic fields are investigated. Electric and magnetic forces and torques; induction; DC and, time permitting, AC circuits; and the physics of various circuit components are covered. Maxwell's equations are introduced. Courses PHYS 21500 and PHYS 21800 may be taken in any order.
Prerequisite: PHYS 21000 and MATH 23500 (may be taken concurrently)
Corequisite: PHYS 21600

PHYS 21600 - General Physics 2 Lab (1)
This is the laboratory companion to PHYS 21500 Experiments reinforcing topics in electricity and magnetism are conducted, and electric circuits are a primary focus of this laboratory Measurement techniques and data analysis will be emphasized. Laboratory fee applies.
Corequisite: PHYS 21500

PHYS 21800 - General Physics 3 (3)
This course is a calculus-based introduction to waves, light, thermodynamics, and modern physics. Wave properties, electromagnetic radiation, geometric and wave optics, heat and thermodynamics, special relativity, and an introduction to modern physics will be covered. Courses PHYS 21500 andPHYS 21800 may be taken in any order.
Prerequisite: PHYS 21000 and MATH 23500 (may be taken concurrently)
Corequisite: PHYS 21900

PHYS 21900 - General Physics 3 Lab (1)
This is the laboratory companion to PHYS 21800. The primary focus of this laboratory is on waves and optics though other pertinent experiments may also be conducted. Students also conduct a multi-week project in this lab. Measurement techniques and data analysis are emphasized. Laboratory fee applies.
Corequisite: PHYS 21800

PHYS 24200 - Introduction to Materials Physics (3)
This course explores the central principles underlying the array of structural, thermodynamic, electronic, magnetic, and optical properties found in large collections of atoms (i.e., materials).
Prerequisite: CHEM 22700

PHYS 29600 - Research Methods Seminar (1)
This course is intended to give an overview of the research process and focuses strongly on scientific communication Topics covered include research ethics, scientific method and the experimental process, literature searches and literature reviews, scientific writing (journals, proposals, abstracts), and presentation skills This course partially fulfills the advanced writing requirement for the Physics major.

PHYS 30000 - Mechanics (4)
Following an introduction to vector analysis this course develops the Newtonian, Lagrangian and Hamiltonian formulations of mechanics. The power of each of these formulation is examined through their application to the solution of a broad range of problems in particle and rigid body dynamics and oscillation theory.
Prerequisite: PHYS 21000 and MATH 25000

PHYS 30600 - Mathematical Methods for the Physical Sciences (2)
This course will provide an overview of mathematical concepts and techniques frequently encountered in Physics, Engineering, and Chemical Physics (and Physical Chemistry). Topics are drawn from linear algebra, matrix algebra, complex variables, Fourier analysis, series expansion, and vector calculus.
Prerequisite: PHYS 21000 (may be taken concurrently) and MATH 25000 (may be taken concurrently)

PHYS 31000 - Electricity and Magnetism (4)
This course develops Maxwell's Equations through a survey of electrostatics, conductors and dielectrics, magnetostatics, magnetic materials, and induction The vector calculus used in this course is also reviewed Time permitting, electromagnetic radiation and waves will be introduced.
Prerequisite: PHYS 21500 and MATH 25000

PHYS 31100 - Analog and Digital Electronics (4)
This course presents the fundamentals of both analog and digital electronic circuits Analog electronics topics include DC and AC circuit analysis using circuit elements including diodes, op amps, and transistors. Digital electronics topics include basic digital logic and digital circuits including gates, flip-flops, and counters Other topics may include non-linear circuits, converters, data acquisition, filtering, or transducers This course includes lecture and laboratory components and meets for 6 hours each week Laboratory fee applies.
Prerequisite: PHYS 21600

PHYS 31800 - Optics (4)
This course builds on the Physical and Geometrical Optics covered in PHYS 21800 and PHYS 21900. Topics include wave optics and beam propagation, Fourier optics, Gaussian beams, optical properties of atoms and laser gain media, laser design, light detection, and applications of lasers Other topics such as nonlinear optics or quantum optics may also be discussed at the instructor discretion. This course has lecture and laboratory components and meets for 6 hours each week. Laboratory fee applies.
Prerequisite: PHYS 21900 and PHYS 21800

PHYS 33100 - Thermodynamics (3)
This course provides a comprehensive introduction to the thermodynamics of the gaseous, liquid and solid states of matter and solutions.
Prerequisite: PHYS 21800 and MATH 25000

PHYS 34100 - Modern Physics (3)
This course builds on PHYS 21800 It covers special relativity, foundations of quantum mechanics, wave-particle duality, the uncertainty principle, the Schrodinger Equation in 1D, an introduction to the hydrogen atom, and spin The Pauli exclusion principle and application to atomic electron shell filling and periodic table properties will also be discussed.
Prerequisite: PHYS 21800 and MATH 25000

PHYS 34200 - Applied Modern Physics: Atoms, Molecules, and Condensed Matter (2)
This course will cover atomic structure and properties, spectroscopy, molecular bonding, and the structure and properties of matter Applications may include lasers, semiconductor devices, nanostructures, phase transitions, superconductors, and/or Bose-Einstein condensates.
Prerequisite: CHEM 30500 or PHYS 34100

PHYS 34300 - Applied Modern Physics: Nuclear and Particle Physics (2)
This course covers simple nuclear models and properties of nuclei, radiation types, nuclear reactions, the Standard Model of Physics, fundamental particles, fundamental particle interactions and interaction mediators, and conservation lawsOther topics that may be introduced include techniques of nuclear and particle physics experiments, medical applications, and physics beyond the Standard Model.
Prerequisite: PHYS 34100

PHYS 36000 - An Introduction to Dynamic Meteorology (3)
Students explore the physics of the atmosphere, including the thermodynamics of dry and moist air, the equations of motion on a rotating Earth, atmospheric motions under balanced forces, variations in wind and pressure fields and their relation to weather
Prerequisite: PHYS 21800

PHYS 36500 - Intermediate Physics Laboratory (3)
This lab course emphasizes experimental techniques and data analysis through various experiments from a range of Physics topics. Statistical methods and scientific writing are taught in the lecture portion of this class Students will write formal lab reports, reviews of outside lectures and/or scientific literature and other papers on topics such as classic experiments, laboratory techniques, and laboratory apparatus. This course has lecture and lab components and meets for 5 hours each week. This course partially fulfills the advanced writing requirement for the Physics Major. Laboratory fee applies.
Prerequisite: PHYS 21600 and PHYS 21900
Attributes: Experiential Learning Gen Ed

PHYS 37100 - Workshop in Physics (1-2)
This course provides the student with concepts, methods, and hands-on experience covering a wide range of topics of current interest in Physics.
Attributes: Workshop/Seminar

PHYS 40100 - Computational Mechanics (3)
This course builds on PHYS 30000. Computational techniques will be used to study various topics in mechanics selected at the discretion of the instructor. Topics may include Hamiltonian and Lagrangian formulations of mechanics and their applications, coupled oscillators, fluids, non-linear systems, and/or chaos.
Prerequisite: PHYS 30000

PHYS 41100 - Computational Electrodynamics (3)
This course is a continuation of PHYS 31000 Maxwell's Equations are used to describe EM radiation, reflection and refraction, polarization, and energy density Applications may include radiating charges, antennae, waveguides, transmission lines, and/or relativistic electrodynamics. Computational techniques will be used to study and model these phenomena.
Prerequisite: PHYS 31000

PHYS 44100 - Quantum Mechanics (3)
Building on the theory developed in PHYS 34100 Modern Physics, this course will develop operator techniques, Dirac notation, angular momentum, perturbation theory, and scattering theory. Applications of quantum mechanics in solid state, nuclear, and/or particle physics will be introduced.
Prerequisite: (PHYS 34100 or CHEM 30500)

PHYS 44200 - Solid State Physics (3)
This course covers the structure and properties of crystals, waves in crystals, specific heat and thermal conduction, electrical conduction in metals and semi-conductors, superconductivity and magnetism Other contemporary topics and applications to materials science and optics may also be discussed.
Prerequisite: (PHYS 34200 or PHYS 44100)

PHYS 44300 - Nuclear and Particle Physics (3)
This course builds on the material covered in PHYS 34300 Topics include nuclear structure models, nuclear decay, Standard Model particles and interactions, conservation laws, angular momentum and isospin, Feynman diagrams, boson and fermion properties, and fundamentals of experimental nuclear and particle physics Physics beyond the Standard Model, nuclear and particle astrophysics, or other contemporary topics may be discussed at the instructor discretion. PHYS 44100 is recommended as a prerequisite for this course.
Prerequisite: PHYS 34100

PHYS 46500 - Capstone Project (1)
In this course, students carry out a major project or set of topically-linked smaller projects from proposal through data collection and data analysis to dissemination. Capstone projects may be experimental, computational, or pedagogical depending on the students interests and emphasis within the major Students present their Capstone Project results in a written journal-style article, an oral presentation, and a poster This course partially fulfills the advanced writing requirement for the Physics Major. Laboratory fee applies.
Prerequisite: PHYS 36500 and PHYS 49600

PHYS 47000 - Undergraduate Research (1-6)
Students work under faculty supervision on a research project in Physics, Chemical Physics, Optics, or a related area chosen in consultation with the faculty member. This course may be repeated multiple times for credit.
Attributes: Experiential Learning Gen Ed

PHYS 49600 - Physics Seminar (1)
This seminar gives students the opportunity to explore contemporary topics in Physics though literature research and class presentations and by attending seminars and colloquia. In this seminar, which has a significant writing component, students prepare a proposal for their Capstone project. The writing is spread throughout the semester with regular instruction, peer review, and revision. Students also prepare a poster on their Capstone proposal and present it. This course fulfills the Advanced Writing General Education requirement for the Physics major. Prerequisite: PHYS 29600 or CHEM 29600

PHYS 49800 - Special Topics in Physics (1-4)
Students study a specific area of interest in Physics. Topics vary with semester. Course may be repeated for credit if different topics are offered.