

Physics

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Program Description

The physics curriculum introduces students to concepts and techniques basic to our present understanding of the physical universe. Diverse courses emphasize theories and principles that give a broad, unifying description of nature and develop the analytical reasoning needed for their use. Probing the interrelationships between matter and energy, students and faculty explore such fields as astronomy, electromagnetism, optics, elementary particles, relativity, quantum mechanics, and atomic and nuclear physics. Laboratory training stresses the design of experiments, the techniques of precise measurement, the interpretation of data, and written and oral communication. In advanced courses, students apply their skills through independent studies and research with faculty, in contrast to programs at larger institutions. Our physics faculty is dedicated to teaching, while remaining actively engaged in research. Mentoring relationships between faculty and students are the norm.

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The physics major is flexible. The possibility of a double major is limited only by interests, dedication, and imagination. Gettysburg College physics majors have succeeded in diverse careers, including government, law, and management, as well as engineering, particle physics, and molecular biology. Our majors who choose graduate study have been well prepared for study in a wide range of fields, including astronomy; astrophysics; biophysics; business; geophysics; environmental, electrical, nuclear, and ocean engineering physics; and physiological psychology.

Program Requirements

The department offers both a Bachelor of Science and Bachelor of Arts degree for the major. This diverse, flexible major is well suited for a variety of careers, including secondary school physics teaching, industrial research, and graduate school in such fields as engineering, computer science, law, and medicine.

B.A. requirements: A minimum of ten physics courses is required for the major. This includes the following six core courses: Physics 111, 112, 211, 255, 310, an advanced lab course (Physics 324, Physics 352, Chemistry 306, or an approved course from on-campus or abroad), and three additional courses at the 200-level or higher, at least one of which must be from: Physics 312, 319, 330, and 341 and

either Physics 420 or Physics 460. Physics 460 requires departmental approval by the end of fall semester in the junior year. Students starting the physics major in their sophomore may opt to take Phy109, 110 and one additional elective at the 200-level or higher instead of the Phy111-112-211 sequence.

In addition, all physics majors are required to complete mathematics courses through Mathematics 211 or its equivalent.

First-year students who are considering a major should enroll in Physics 111, 112, and Mathematics 111 and 112 if possible. Those planning on attending graduate school in physics should plan to take the additional courses listed under the B.S. requirement below. Those considering graduate work in astronomy, engineering, or related fields are encouraged to augment their physics major with relevant additional courses in astronomy, mathematics, computer science, and chemistry. Students are not permitted to take more than twelve courses in the department without permission of the department, unless the thirteenth course is Physics 460 (Independent Study).

B.S. requirements: In addition to the six core courses mentioned above, the B.S. degree requires Physics 460; at least three courses from Physics 312, 319, 330, and 341; and any two courses at the 200 level or above. Candidates for the B.S. degree must also complete Mathematics 225 by the end of the fall semester of the junior year.

Minor requirements: A minor in physics consists of six Physics courses which include either the 109-110 or 111-112-211 introductory sequence. The remaining courses must be at the 200-level or above. The minor represents an appropriate complement to a variety of majors, including mathematics and computer science.

Course Listing

Course level:

100 | 200 | 300 | 400

***PHY-101* The Evolving Universe**

Overview of the fundamental principles of classical physics (including gravitation and electromagnetism), the theory of relativity, and quantum physics. Course includes a discussion of the four fundamental forces of nature; nuclear and atomic physics; elementary particles; grand unified theories; and cosmology, including the origin and fate of the universe. Does not count toward the major. Three class hours.

***PHY-102* Contemporary Physics**

Designed for nonscience majors. Course concentrates on the relationship between physical principles, modern technology, and the world in which we live. Topics include heat and thermodynamics, lasers and other optical instruments, electricity and circuits, medical diagnostics, and radiation effects. Not appropriate for students taking Math 112. Three class hours and three laboratory hours. No prerequisite.

PHY-103 Elementary Physics

General coverage of the fields of classical and modern physics. Course is structured for students in biology, environmental science, the health professions, etc. While particularly useful for biology majors, the two-course sequence serves any student as an introduction to a wide range of topics in physics.

Prerequisite: Sophomore status and facility in algebra and geometry. Three class hours and three laboratory hours.

PHY-104 Elementary Physics

General coverage of the fields of classical and modern physics. Course is structured for students in biology, environmental science, the health professions, etc. While particularly useful for biology majors, the two-course sequence serves any student as an introduction to a wide range of topics in physics.

Prerequisite: Physics 103 and facility in algebra and geometry. Three class hours and three laboratory hours.

PHY-107 Physics of Music

An introduction to the physical basis of music and sound production. Topics include the mechanical and sonic characteristics of common musical instruments, room acoustics, human perception of sound, and the mechanics of the human ear. Special emphasis is placed on how fundamental concepts from math and physics (vibrations and waves, logarithmic measurement scales, the Fourier Series, frequency spectra) explain many of the aspects of how music is produced and perceived.

PHY-109 Introductory Physics I

Standard first semester calculus based Physics course designed to support the curricula of Chemistry and Biochemistry & Molecular Biology majors. The course will explore a wide range of topics including Newtonian mechanics, work & energy, circular motion, rotational kinematics/dynamics, fluids, concepts of heat & temperature, kinetic theory, and thermodynamics. Prerequisite: Calculus 111 (can be taken concurrently) and sophomore status. Three class hours and three laboratory hours.

PHY-110 Introductory Physics II

Standard second semester calculus based Physics course designed to satisfy the major requirements for Chemistry, and Biochemistry and Molecular Biology majors but can be taken by other students that meet the requirements. The course will explore a wide range of topics including vibrations and sound, light, optics, electricity and magnetism, and electric circuits. Prerequisite: Physics 109. Three class hours and three laboratory hours.

PHY-111 Introductory Modern Physics I

An introduction to conservation laws and modern physics: the conservation of momentum, energy, and angular momentum as fundamental laws, vectors and the concept of velocity, superposition and the interference of waves, physical optics, introductory principles of quantum physics, and applications in atomic, nuclear, and particle physics. Four class hours and three laboratory hours.

PHY-112 Introductory Modern Physics II

An introduction to classical and relativistic mechanics: Newton's dynamical laws of motion, orbital mechanics, the Newtonian synthesis of terrestrial and celestial mechanics, and the special theory of relativity. Differential and integral calculus is introduced and used. Prerequisites: Physics 111 and Math 111, which may be taken concurrently, or permission of instructor. Four class hours and three laboratory hours.

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PHY-211 Intermediate Physics

An introduction to classical electromagnetic theory and applications: electrostatic fields, currents, magnetic fields, magnetic induction, and Maxwell's equations. Other topics include electric circuits, waves, light as a propagating electromagnetic disturbance, and radiating charge. Prerequisites: Physics 112 and Mathematics 112, which may be taken concurrently; or permission of instructor. Three class hours and six laboratory hours.

PHY-240 Electronics

Principles of electronic devices and circuits using integrated circuits, both analog and digital, including amplifiers, oscillators, and logic circuits. Three class hours and six laboratory hours. No prerequisites.

PHY-246 The Physics of Life

The course is designed to provide a basic familiarity with the most common techniques used in structural biology and their applications to challenging biochemical, biotechnology and medical problems. Course focuses on current state-of-the-art biophysical methods that are being applied to study structure and function of biological macromolecules and biological systems with a focus on the most informative methods, such as X-ray crystallography, NMR spectroscopy, and single molecule techniques. Theoretical underpinnings and the practical applications are covered.

PHY-255 Math Techniques for Physicists

Intermediate treatment of mathematical methods used in physics. Topics include elements of vector calculus, complex variables, ordinary and partial differential equations, solution of Laplace's equation, special functions, determinants, and matrices. Prerequisites: Physics 211 and Math 112. Three class hours.

PHY-290 Mentored Research Internship

Quarter credit internship graded S/U.

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PHY-310 Introduction to Quantum Mechanics

Introduction to quantum mechanics. Potential wells, barriers, one electron atoms, and multielectron atoms are studied. Other topics include nuclear models, decay, and nuclear reactions. Prerequisite: Physics 255. Three class hours and six laboratory hours.

PHY-312 Thermodynamics & Statistical Physics

Temperature, heat, first and second laws of thermodynamics, and introductory statistical mechanics of physical systems based on the principle of maximum entropy. Topics include the ideal gas, Fermi-Dirac and Bose-Einstein 'gases,' electrons in metals, blackbody radiation, low temperature physics, and elements of transport theory. Prerequisite: Physics 211. Three class hours.

PHY-315 The Nature of Space: Philosophical Revolutions in Physics

Study of the notion of space as it has developed from Aristotle to Einstein. Particular focus will be given to relations between scientific accounts of the structure of space and the larger philosophical context in which they arose. Course cross-listed as Philosophy 315. Course does not count toward the physics major.

PHY-319 Classical Mechanics

Intermediate-level course in mechanics for upper class physics majors. Topics include chaos, nonlinear dynamics, central forces, oscillations, and the formalisms of Lagrange and Hamilton. Prerequisites: Physics 211, Physics 255 and Math 211. Three class hours.

PHY-324 Experiments in Quantum Mechanics

Following a lecture-based course Phy310, An Introduction to Quantum Mechanics, the proposed course, Phy324, will give students the opportunity to explore in a laboratory setting many of the peculiar, interesting, and important aspects of quantum physics. In addition to a suite of experiments exploring the statistical nature of quantum particles (single photons) and their counter-intuitive correlations using state-of-the-art optics equipment, students will use a variety of experimental equipment to explore other quantum systems and effects, such as Bragg Scattering in crystals, positron annihilation, and alpha-, beta-, gamma-spectroscopy. In a subset of experiments, students will not be given detailed instructions, but rather will be asked to design and carry out the measurement using techniques and knowledge gained during the semester. During the course, topics in statistics and error analysis not already treated earlier in the curriculum will be covered. Students will also practice writing formal, journal-article style reports on experiments.

PHY-330 Electricity & Magnetism

Intermediate course in electromagnetism, including vector fields and vector calculus, electrostatic field theory, dielectrics, magnetic phenomena, fields in matter, Maxwell's equations, Laplace's equation and boundary value problems, and electromagnetic waves. Prerequisites: Physics 211 and Physics 255. Three class hours.

PHY-341 Quantum Mechanics

Introduction to the Schrodinger and Heisenberg formulations of quantum mechanics. Topics include free particles, harmonic oscillator, angular momentum, hydrogen atom, matrix mechanics, spin wave functions, helium atom, and perturbation theory. Prerequisites: Physics 255, Physics 310 and Math 225, or permission of instructor.

PHY-343 From Babylonia to the Big Bang: The History and Philosophy of Cosmology

Examination of the development of views about the origin and evolution of the universe. From ancient times, humans have tried to answer the biggest of the big questions: where did it all come from? This course traces the course of the answers given from ancient mythology through contemporary models of contemporary Big Bang cosmology, focusing the interaction between advances in physical science and their philosophical ramifications.

PHY-352 Optics and Laser Physics

Intermediate treatment of modern optics and laser physics. Topics include radiometry and optical detector technology, geometric optics and human vision, electromagnetic theory of light, interference,

polarization, coherence, holography, fundamentals of laser operations, laser spectroscopy and other contemporary laser applications. Prerequisites: Physics 211 and Math 211 or permission of instructor. Three class hours and six laboratory hours.

PHY-381 Special Topics in Physics

Topics in physics not covered in the usual curriculum. Topics vary from year to year and may include relativity; astrophysics; advanced topics in modern optics, solid state physics and electromagnetism; fundamental particles and nuclear structure; the physics of plasmas and various mathematical topics in physics (topology, special functions, fractals). Prerequisites: Upper division standing and approval by instructor. Three class hours

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PHY-420 Advanced Research Methods in Physics

Laboratory course with experiments drawn from various areas of physics, such as optics, electromagnetism, atomic physics, and nuclear physics, with particular emphasis on contemporary methods. Error analysis, experimental techniques, and written and oral communication are stressed. Prerequisite: Physics 310 and either Physics 324, Physics 352, Chemistry 306 or an approved junior-level laboratory course.

PHY-450 Individualized Study-Tutorial

Individualized tutorial counting toward the minimum requirements in a major or minor, graded A-F. Designed to cover physics or physics-related topics not otherwise available in the curriculum. Open to upper class physics majors who arrange with a staff member for supervision. Possible areas of study include advanced electronics, medical physics, astrophysics, acoustics, nuclear physics and plasma physics. Prerequisite: Approval by Department.

PHY-451 Individualized Study-Tutorial

Individualized tutorial counting toward the minimum requirements in a major or minor, graded S/U. Designed to cover physics or physics-related topics not otherwise available in the curriculum. Open to upper class physics majors who arrange with a staff member for supervision. Possible areas of study include advanced electronics, medical physics, astrophysics, acoustics, nuclear physics and plasma physics. Prerequisite: Approval by Department.

PHY-452 Individualized Study-Tutorial

Individualized tutorial not counting in the minimum requirements in a major or minor, graded A-F. Designed to cover physics or physics-related topics not otherwise available in the curriculum. Open to upper class physics majors who arrange with a staff member for supervision. Possible areas of study include advanced electronics, medical physics, astrophysics, acoustics, and optics. Prerequisite: Approval by department.

PHY-453 Individualized Study-Tutorial

Individualized tutorial not counting in the minimum requirements in a major or minor, graded S/U. Designed to cover physics or physics-related topics not otherwise available in the curriculum. Open to upper class physics majors who arrange with a staff member for supervision. Possible areas of study include advanced electronics, medical physics, astrophysics, acoustics, and optics. Prerequisite: Approval by department.

PHY-460 Individualized Study-Research

Individualized research counting toward the minimum requirements in a major or minor, graded A-F. Experimental or theoretical investigation of a research-level problem selected by a student in consultation with a faculty member. Students should arrange for supervision by the end of the junior year. Open only to senior physics majors. Results of the investigation are reported in a departmental colloquium and senior thesis. Prerequisite: Approval by department by the end of junior year.

PHY-461 Individualized Study-Research

Individualized research counting toward the minimum requirements in a major or minor, graded S/U. Experimental or theoretical investigation of a research-level problem selected by a student in consultation with a faculty member. Students should arrange for supervision by the end of the junior year. Open only to senior physics majors. Results of the investigation are reported in a departmental colloquium and senior thesis. Prerequisite: Approval by department by the end of junior year.

PHY-462 Individualized Study-Research

Individualized research not counting in the minimum requirements in a major or minor graded A-F. Experimental or theoretical investigation of a research-level problem selected by a student in consultation with a faculty member. Students should arrange for supervision by the end of the junior year. Open only to senior physics majors. Results of the investigation are reported in a departmental colloquium. Prerequisite: Approval by department.

PHY-463 Individualized Study-Research

Individualized research not counting in the minimum requirements in a major or minor graded S/U. Experimental or theoretical investigation of a research-level problem selected by a student in consultation with a faculty member. Students should arrange for supervision by the end of the junior year. Open only to senior physics majors. Results of the investigation are reported in a departmental colloquium. Prerequisite: Approval by department.

PHY-473 Individualized Study-Internship

Internship not counting in the minimum requirements in a major or minor, graded S/U. Prior approval by Department required. Results of the internship are reported in a departmental colloquium.

Course level: [100](#) | [200](#)

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AST-101 Solar System Astronomy

Overview of behavior and properties of planets, satellites, and minor members of the solar system. Subjects include basic phenomena of the visible sky, gravitation and orbital mechanics, results of telescopic and space research, and theories of the origin and evolution of the solar system. Course satisfies science distribution requirement for nonscience majors. Three classes and a laboratory.

AST-102 Stellar Astronomy

Overview of current knowledge about the universe beyond the solar system from a physical and evolutionary standpoint. Subjects include observational properties of stars, methods of observation and analysis of light, nature of stellar systems and interstellar material, principles of stellar structure and evolution, and overall structure and development of the physical universe. Course satisfies laboratory science distribution requirement for nonscience majors. Three classes and a laboratory.

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AST-208 Topics in Astronomy

A detailed investigation of a topic of current interest in astronomy. The course sets forth a major subdiscipline of astronomy at a level beyond that of the introductory astronomy sequence, presuming some knowledge of the scale and structure of astronomical objects, the vocabulary of astronomy, and the fundamentals of physics. Topics may include the Search for Extraterrestrial Intelligence, Exploration of the Planetary System, Variable Stars and Stellar Evolution, or Galaxies and Cosmology. The class will examine the observational data, the techniques of research in the field, the state of knowledge in the field at present, and the major questions that form the focus of current research.

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Gettysburg College
300 North Washington Street
Gettysburg , Pennsylvania 17325
717.337.6300

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