

PHYSICS (PHY)

The program for each student majoring in physics is developed through consultation with the student's major adviser and may lead to either a bachelor of arts or a bachelor of science degree. The bachelor of arts degree requires a minimum of basic physics courses and allows a wide selection of electives related to the student's interests in other disciplines, such as medicine, law, and business. The bachelor of science degree is designed for students planning careers in physics.

While the physics major can be started in the sophomore year, students are encouraged to take PHY 123 (or PHY 113) and PHY 124 (or PHY 114) and MST 111 and MST 112 in the first year. If this sequence is followed, the physics major may be completed with considerable flexibility in exercising various options, such as the five-year BS/MS program. If physics is not taken in the first year, the degree requirements in physics may still be completed by the end of the senior year if a beginning course is taken in the sophomore year. A candidate for the 3-2 engineering program would also complete three years of the bachelor of science physics major program prior to transfer. (Consult the chair of the department for additional information on these five-year programs.)

No student may be a candidate for a degree with a major in physics with a grade less than C in General Physics without special permission of the department. Students must achieve a minimum GPA of 2.0 in physics courses for graduation. In addition, all major students, except BS Engineering, must take the ETS Major Field Test in Physics during their senior year, or as determined by the department and communicated by the major adviser(s).

Physics courses satisfying Division V requirements must be taken at Wake Forest. Satisfactory completion of the laboratory work is required for a passing grade in all courses with a laboratory.

Contact Information

Physics Department (<http://www.physics.wfu.edu/>)
Olin Physical Laboratory 100, Box 7507
Phone 336-758-5337

Programs

Majors

- Biophysics, B.S. (<https://bulletin.wfu.edu/undergraduate/departments-programs/physics/bs-biophysics/>)
- Physics, B.A. (<https://bulletin.wfu.edu/undergraduate/departments-programs/physics/ba-physics/>)
- Physics, B.S. (<https://bulletin.wfu.edu/undergraduate/departments-programs/physics/bs-physics/>)

Minor

- Physics, Minor (<https://bulletin.wfu.edu/undergraduate/departments-programs/physics/minor-physics/>)

Courses

Physics (PHY)

PHY 105. Descriptive Astronomy. (4 h)

Introductory study of the universe, from the solar system to the galaxies. No lab.

PHY 109. Astronomy. (4 h)

An introductory study of the universe consisting of descriptive astronomy, the historical development of astronomical theories, and astrophysics. Knowledge of basic algebra and trigonometry is required. Lab-2 hours. (D)

PHY 109L. Astronomy Lab. (0-1 h)

PHY 110. Introductory Physics. (4 h)

A conceptual, non-calculus one-semester survey of the essentials of physics, including mechanics, wave motion, heat, sound, electricity, magnetism, optics, and modern physics. Not recommended for premedical, mathematics, or science students. A student who has credit for PHY 111, 113, 114, 123 or 124 or who is currently taking PHY 113, 114, 123 or 124 is not allowed to register for PHY 110. Lab-2 hours. (D, QR)

PHY 110L. Introductory Physics Lab. (0 h)

PHY 111. Mechanics Waves and Heat. (4 h)

Introduction to mechanics, wave motion, thermodynamics, and sound. Extensive use of algebra and trigonometry. Credit allowed for either PHY 111, 113 or 123 but not for more than one. Lab-2 hours. Available for transfer, AP, IB, or A-levels credit only; not approved for summer school elsewhere. (QR)

PHY 113. General Physics I. (4 h)

Essentials of mechanics, wave motion, heat, and sound treated with some use of calculus. Recommended for science, mathematics, and premedical students. Credit allowed for either PHY 111, 113 or 123 but not for more than one. Lab-2 hours. C-MST 111 or 112 or equivalent. (D, QR)

PHY 113L. General Physics Lab. (0 h)

PHY 114. General Physics II. (4 h)

Essentials of electricity, magnetism, optics, and modern physics treated with some use of calculus. Recommended for science, mathematics, and premedical students. Credit allowed for either PHY 114 or 124, but not both. Lab-2 hours. P-MST 111 or 112 or equivalent and PHY 111, 113, or 123. (D, QR)

PHY 114L. General Physics II Lab. (0 h)

PHY 115. The Physics of Music. (4 h)

Introduction to the physics of music, using algebra and trigonometry. Basic physical concepts associated with motion, force and energy are applied to ideal vibrating systems, resonant systems, strings, and sound waves. Uses of these concepts are explored in relation to musical instruments the human voice, signal processing and room acoustics (D, QR).

PHY 120. Physics and Chemistry of Environment. (4 h)

Covers the basic physical and chemical processes in the earth's atmosphere, biosphere and the oceans. Also listed as PHY 120. (D, QR)

PHY 120L. Physics and Chemistry of the Environment Lab. (0 h)

C-PHY 120.

PHY 123. General Physics I - Studio Format. (4 h)

In-depth introduction to mechanics, wave motion, heat, and sound treated with use of calculus and employing advanced techniques and interactive learning. Recommended for potential physics majors. Credit allowed for either PHY 111 or 113 or 123, but not more than one. Lab - 2 hours. C-MST 111 or 112 or equivalent. (D, QR)

PHY 123L. General Physics I - Studio Format Lab. (0 h)**PHY 124. General Physics II - Studio Format. (4 h)**

In-depth introduction to electricity, magnetism, optics, and modern physics treated with use of calculus and employing advanced techniques and interactive learning. Recommended for potential physics majors.

Credit allowed for either PHY 114 or 124, but not both. Lab - 2 hours. P-MST 111 or 112 or equivalent and PHY 111 or 113 or 123. (D, QR)

PHY 124L. General Physics II - Studio Format Lab. (0 h)**PHY 215. Elementary Modern Physics. (3 h)**

Development of 20th-century physics and an introduction to quantum ideas. The physics department recommends that PHY 215 be taken concurrently with PHY 265. P-PHY 114 or 124 and MST 111 or MST 112. (D, QR)

PHY 230. Electronics. (3 h)

Introduction to the theory and application of transistors and electronic circuits. Lab-three hours. P - PHY 114 or 124. (D, QR)

PHY 262. Mechanics. (3 h)

Study of the equations of motion describing several kinds of physical systems: velocity-dependent forces; damped and forced simple harmonic motion; orbital motion; inertial and non-inertial reference frames. Includes extensive use of computers. P-PHY 113 or 123, and MST 205 or MST 251, and C-MST 113. (D, QR)

PHY 265. Intermediate Laboratory I. (1 h)

Experiments on modern physics. P or C-PHY 215.

PHY 266. Intermediate Laboratory II. (1 h)

Experiments on mechanics, electronics, and computer simulations. P or C-PHY 262.

PHY 301. Physics Seminar. (0.5 h)

Discussion of contemporary research, usually with visiting scientists. Attendance required of junior and senior physics majors. Does not count toward the six hours of electives required for the BA major. Pass/Fail only.

PHY 303. Physics Internship. (0 h)

Independent study in Physics under faculty mentorship. P-POI.

PHY 307. Biophysics. (3 h)

Introduction to the structure, dynamic behavior, and function of DNA and proteins, and a survey of membrane biophysics. The physical principles of structure determination by X-ray, NMR, and optical methods are emphasized. Also listed as BIO 307. P-BIO 114 or 214, PHY 113 or 123, PHY 114 or 124, or POI. BIO 150, 150L, 160, and 160L may be substituted for BIO 114 and 214.

PHY 310. Extragalactic Astronomy and Cosmology. (3 h)

Topics covered include galactic structure, models for galaxies and galaxy formation, the large scale structure of the universe, the big bang model of the universe, physical processes such as nucleosynthesis in the early universe, and observational cosmology. P-PHY 262 and MST 205 or 251. (D)

PHY 320. Physics of Biological Macromolecules. (3 h)

The physics of large biologically important molecules, especially proteins and nucleic acids. Topics covered include the physical basis of biomolecular structure, the energetics and statistical mechanics of biomolecular dynamics, and the electrostatics and solvation of biomolecules. Designed for students with biochemistry, chemistry, or physics backgrounds. P-PHY 113 or 123, 114 or 124. (D)

PHY 325. Biophysical Methods Laboratory. (1.5 h)

Experiments using various biophysical techniques such as electron paramagnetic resonance, atomic force microscopy, stopped-flow absorption spectroscopy, X-ray diffraction, and gel electrophoresis. C-PHY 307.

PHY 335. Computational Physics. (3 h)

An introduction to finding numerical solutions to scientific problems. Topics include understanding computational errors, differentiation, integration, interpolation, root finding, random numbers, linear systems, Fourier methods, and the solution of ODEs and PDEs. There is no computer programming prerequisite. Credit will not be given for both PHY 335 and CSC 355/MST 355. P-MST 113 and 205 (or instead of MST 205, P-MST 121 and 251), or POI.

PHY 337. Analytical Mechanics. (1.5 h)

The Lagrangian and Hamiltonian formulations of mechanics with applications. Taught in the first half of the fall semester. P-PHY 262, MST 113 and 205 (or instead of MST 205, P-MST 121 and 251).

PHY 339. Electricity and Magnetism. (1.5 h)

Electrostatics, magnetostatics, dielectric and magnetic materials, Maxwell's equations and applications to radiation, relativistic formulation. PHY 339 is taught in the second half of the fall semester, following PHY 337. These should be taken in sequence. P-PHY 114 or 124, MST 113 and MST 205 or 251. (D)

PHY 340. Electricity and Magnetism. (3 h)

Electrostatics, magnetostatics, dielectric and magnetic materials, Maxwell's equations and applications to radiation, relativistic formulation. PHY 340 is taught in the spring semester after PHY 339. These should be taken in sequence. P-PHY 339. (D)

PHY 341. Thermodynamics and Statistical Mechanics. (3 h)

Introduction to classical and statistical thermodynamics and distribution functions. Also listed as CHM 341. Also offered in Salamanca. P-PHY 215 and MST 113. (D)

PHY 343. Quantum Physics. (3 h)

Basic quantum theory and applications including the time-independent Schrodinger equation, formalism and Dirac notation, the hydrogen atom, spin, identical particles, and approximation methods. P-PHY 215, MST 113 and 205 (or instead of MST 205, P-MST 121 and 251). (D)

PHY 344. Quantum Physics. (3 h)

Basic quantum theory and applications including the time-independent Schrodinger equation, formalism and Dirac notation, the hydrogen atom, spin, identical particles, and approximation methods. P-PHY 343. (D)

PHY 347. Intellectual Property in Science and Engineering. (1 h)

Introduction to the process of creating and protecting intellectual property, with discussion of economic impact of IP rulings and concept of a non-disclosure agreement. Working with representative examples from physics, engineering, and biotechnology, the students, working in small teams, will analyze and create invention disclosures, patent applications, and issued patents. Recommended background: three courses from the major tracks in physics, chemistry, biology, or computer science.

PHY 352. Physical Optics and Optical Design. (4 h)

Interaction of light with materials; diffraction and coherent optics; ray trace methods of optical design. Lab-3 hours. P-PHY 114 or 214 and PHY 215. (D)

PHY 352L. Physical Optics Lab. (0 h)**PHY 354. Introduction to Solid State Physics. (3 h)**

A survey of the structure, composition, physical properties, and technological applications of condensed matter. P-PHY 343. (D)

PHY 355. Exotic Materials. (1.5 h)

Study of materials that express exotic properties that are derived from some aspect of the system's dimensionality, introduces the thermal, electrical, optical and magnetic properties of exotic materials systems. Discusses simple models for the structure-property relationships for a wide range of of nanoscale and low-dimensional systems. C - PHY 343.

PHY 356. Electron-Imaging Sciences. (1.5 h)

Introduces the theory and application of the electron imaging systems: transmission electron microscopy (TEM) and scanning electron microscopy (SEM). Focuses on basic materials science though some biological materials will be covered. Taught as a series of lectures followed by laboratories. P - PHY 215.

PHY 357. Scanning Probes. (1.5 h)

Examines the theory and application of scanning tunneling microscopy and atomic force microscopy (STM/AFM). Introduces how each type of imaging works, how to model spectroscopic data, and how to use each microscope. Students will image using the STM and AFM as well as take and reduce spectroscopy data using models built in Maple or Mathematica. P - PHY 215.

PHY 358. Kinetics of Materials. (1.5 h)

Study of driving forces for atomic and ionic motion within solids leading to a range of materials properties from work hardening to phase transformations and formation. Atomic-level models for diffusion will be introduced as well as techniques and examples of the solution to the diffusion equation. Complements the traditional thermodynamics course. C - PHY 341 and 354 or POI.

PHY 361. Biophysics Seminar. (1 h)

Seminal and current publications in biophysics will be studied. Each week a member of the class will make an oral presentation on a chosen publication and will lead the ensuing discussion. Pass-fail only.

PHY 363. Condensed Matter Seminar. (1 h)

Seminal and current publications in condensed matter physics are studied. Each week a member of the class makes an oral presentation on a chosen publication and leads the ensuing discussion. Pass-fail only.

PHY 381. Research. (1.5-3 h)

Library, conference, computation, and laboratory work performed on an individual basis. May be repeated for credit.

PHY 385. Bioinformatics. (3 h)

Introduction to computational approaches essential to modern biological inquiry. Approaches may include large biological dataset analyses, sequence similarity and motif searches, and analysis of high-throughput genomic technologies. Emphasizes interdisciplinary interaction and communication. Also listed as CSC 385 and BIO 385. P-CSC 201 or 221 (and BIO 150, 150L, 160, and 160L if taken as BIO 385) or POI.

PHY 391. Special Topics in Physics. (1-4 h)

Courses in selected topics in physics. May be repeated if course content differs.

PHY 392. Special Topics in Physics. (1-4 h)

Courses in selected topics in physics. May be repeated if course content differs.

Faculty

Chair Daniel Kim-Shapiro

Professor Harbert Family Distinguished Chair for Excellence in Teaching and Scholarship Daniel Kim-Shapiro

Professor and Wright Family Endowed Chair in Physics Timo Thonhauser

Baker Family Professor of Physics Oana D. Jurchescu

Professor and Associate Chair Martin Guthold

Professor and Associate Provost for Research and Scholarly Activities Keith Bonin

Professors Paul R. Anderson, David L. Carroll, Natalie A. W. Holzwarth, Jed Macosko

Scott Family Faculty Fellow and Professor Freddie Salsbury

Research Professors George Holzwarth, George Eric Matthews, William Kerr, Richard T. Williams

Emeritus Professor Howard Shields

Associate Professors Eric D. Carlson, Samuel S. Cho, Gregory B. Cook

Assistant Professors Ilaria Bargigia, Ajay Ram Srimath Kandada, Stephen M. Winter

Research Associate Professors Swati Basu, Kamil Burak Ücer

Associate Teaching Professor Jack Dostal

Adjunct Professor John D. Bourland, Michale Munley, Mark W. Roberson, Peter Santago

Adjunct Assistant Professor Adam Hall

Affiliate Assistant Professor Erin Henslee, Lauren Lowman