

PHYSICS

The Department of Physics offers several programs leading to the baccalaureate degree with a major in physics. The course structure recommended by the department is essentially identical during the first two years of all programs so that a revision in a student's plan need not involve any loss of time.

The Bachelor of Science degree in physics involves the greatest depth in physics and mathematics. This program prepares the student for employment in a technical position upon graduation and also provides a solid foundation for entrance into a graduate program in physics or other technical field.

The physics dual-degree program requires three years of study at Millersville in the liberal arts curriculum, with a physics major plus two years in residence in the engineering program at the cooperating institution, Penn State University. At the end of the five years, the student receives two baccalaureate degrees: a B.A. in physics from Millersville and a B.S. in engineering from the cooperating engineering school.

In addition to the 3/2 arrangement with Penn State, Millersville has three other cooperative programs. One of these is a 4/2 program with Penn State. A student studies for four years at Millersville and earns a B.S. degree in physics. After transferring to Penn State, in two years the student earns a master's degree from the Department of Engineering Science and Mechanics. In practice, it is possible to complete this program in less than two years. Up to six undergraduate credits at the 400 level in physics or mathematics may be transferred as graduate credit towards the master's degree at Penn State. Summer research programs at Penn State are also available and can generate graduate credit in this program. Consequently a student can finish the graduate portion of this program in a year and a half.

The other cooperative program with Penn State leads to a B.A. degree from Millersville with an option in nanotechnology. The standard courses for our B.A. physics degree are required. However, the student also spends a semester at the Penn State Nanofabrication Facility and earns 18 credits learning the use of specialized nanotechnology devices and techniques. The semester at Penn State typically occurs during the junior year.

Finally, the Department of Physics and the Department of Materials Science and Engineering at the University of Delaware have initiated a 3/2 program. In this program, the student spends three years at Millersville and two years at the University of Delaware. Upon completion of the requirements, the student is awarded a Bachelor of Arts degree in physics from Millersville and a master's degree in materials science and engineering from the University of Delaware.

The B.S. Ed. program in secondary education prepares students for careers in precollege teaching, providing certification in physics.

The cooperative education program in physics is an optional arrangement whereby students combine practical on-the-job experience with their formal classroom instruction. After the first year, the co-op program is available to all physics majors who satisfy the departmental admission requirements. For more information, see Cooperative Education in the Special Academic Opportunities (<https://catalog.millersville.edu/undergraduate/special-academic-opportunities/>) section.

Outstanding students majoring in physics may pursue departmental honors during their senior year. Participation in the departmental honors

program is highly selective and offers students in each of our major programs an opportunity to strengthen their background in physics and to work closely with a faculty mentor on an extended research project. General information on departmental honors is found in the Special Academic Opportunities (<https://catalog.millersville.edu/undergraduate/special-academic-opportunities/>) section of this catalog. Specific requirements for honors in each of our major programs are available from the department chairperson.

Two minor programs are also available for students who do not elect to major in physics. The physics minor offers students an exposure to physics through the intermediate level of our major program. In addition, there is also available an interdisciplinary minor in physics and earth sciences.

The department has prepared a student handbook which provides more detailed information on our programs, faculty and resources. This handbook, as well as additional information on any of the above programs, is available from the physics department

the programs

- Physics B.A. - Meteorology Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/physics/physics-ba-meteorology-option/>)
- Physics Minor (<https://catalog.millersville.edu/undergraduate/college-science-technology/physics/physics-minor/>)
- Physics Post-Baccalaureate Certification (<https://catalog.millersville.edu/undergraduate/college-science-technology/physics/physics-bsed/>)
- Physics, B.A. - 3/2 Cooperative Engineering Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/physics/physics-ba-cooperative-engineering-option/>)
- Physics, B.A. - Computer Science Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/physics/physics-ba-computer-science-option/>)
- Physics, B.A. - Nanotechnology Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/physics/physics-ba-nanotechnology-option/>)
- Physics, B.A. - Philosophy Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/physics/physics-ba-philosophy-option/>)
- Physics, B.A. - Polymer Chemistry Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/physics/physics-ba-polymer-chemistry-option/>)
- Physics, B.S. (<https://catalog.millersville.edu/undergraduate/college-science-technology/physics/physics-bs/>)

the faculty

Dushkina Natalia; Professor
College of Science and Technology
B.S., University of Sofia (Bulgaria), 1984; M.S., Ibid., 1984; Ph.D., Bulgarian Academy of Sciences, 1993

Gilani Tariq H.; Professor
College of Science and Technology
B.Sc., University of the Punjab (Pakistan), 1986; M.Sc., Ibid., 1989; M.S., Quaid-i-Azam University (Pakistan), 1991; Ph.D., Kyoto University (Japan), 1997

Goksu Mehmet I.; Professor

College of Science and Technology
B.S., Istanbul Technical University (Turkey), 1991; Ph.D., Case Western Reserve University, 2002

Hendrick Sean; Associate Professor
College of Science and Technology
B.A., University of Virginia, 1994; Ph.D., North Carolina State University, 2003

Li Xin; Associate Professor
College of Science and Technology
B.Sc., Beijing Institute of Tech., 2006; M.S., Ibid., 2008, M.S., Mississippi State University, 2008; M.S., Ibid., 2011; Ph.D., Ibid., 2010

Uy Zenaida; Professor
College of Science and Technology
B.S., University of the Philippines, 1964; M.A., State University of New York at Stony Brook, 1969; Ph.D., Ibid., 1972

the courses

PHYS 101: 3 s.h.

Survey of Physics (G2)

An elementary treatment of fundamental concepts of classical and modern physics. Selected examples from classical mechanics, electromagnetism, thermodynamics, relativity and quantum mechanics. The solving of numerical problems is de-emphasized. 3 hr. lec. and discussion. No credit in block G2 for majors in the School of Science and Mathematics. Credit will be granted for only one of the courses: PHYS 101, 103 or 104. Offered in spring. Prereq: MATH placement at the 100 level or above.

PHYS 103: 4 s.h.

Elements of Physics (G2)

An elementary treatment of fundamental concepts of classical and modern physics. Selected examples from classical mechanics, electromagnetism, thermodynamics, relativity and quantum mechanics. The solving of numerical problems is de-emphasized. 3 hrs. lec., 2 hrs. lab. No credit in block G2 for majors in the following departments: Biology, Chemistry, Computer Science, Earth Science, Math or Physics. Credit will be granted for only one of the courses: PHYS 101, 103 or 104. Offered in fall, periodically in spring.

PHYS 103H: 4 s.h.

Hrs:Introduction to Physics (G2)

PHYS 104: 4 s.h.

Applied Physics (G2)

A study of the application of mathematics to practical problems in physics, using Newtonian ideas, and emphasizing applications to devices such as machines and engines, and systems such as electrical circuits. 3 hrs. lec., 2 hrs. lab. No credit in block G2 for majors in the School of Science and Mathematics. Credit will be granted for only one of the courses: PHYS 101, 103 or 104. Offered in spring. Prereq: math placement at the 100 level or above.

PHYS 117: 3 s.h.

General Astronomy (G2)

Astronomy for a general audience; emphasis on the physical nature of the universe. Terrestrial astronomy, light, telescopes, spectra, stars, stellar evolution, galaxies, cosmology, the solar system. 3 hrs. lec. and discussion. No credit in block G2 for majors in the School of Science and Mathematics. Offered in fall, spring.

PHYS 131: 4 s.h.

Physics 1 with Algebra (G2)

An introductory algebra-based course. Fundamental laws and properties of matter, mechanics and heat. Problems dealing with these laws. 3 hrs. lec., 1 hr. recitation and 2 hrs. lab. Prereq: MATH 101 or MPT score sufficient for the student to enroll in MATH courses above MATH 110. Offered fall, summer.

PHYS 132: 4 s.h.

Physics 2 with Algebra (G2)

Continuation of Physics 131. Fundamental laws and properties of electricity, magnetism, waves, sound, light and radiation. 3 hrs. lec., 1 hr. recitation and 2 hrs. lab. Offered spring, summer. Prereq: PHYS 131 or 231.

PHYS 179: 3,4 s.h.

Experimental

Experimental

PHYS 198: 1 s.h.

Seminar In Physics

An overview of the history, practice, philosophy and unity of physics and its application to other disciplines, orienting beginning physics majors to the study of physics. Mandatory for, and only open to, physics majors in their freshman year. 1 hr. discussion. Offered in fall.

PHYS 205: 3 s.h.

Musical Acoustics (G2)

Intended for musicians dealing with the physical nature of sound and sound sources, and the relation of these to music and musical instruments. The use of mathematics is kept to a minimum. 2 hrs. lec., recitation, 2 hrs. lab. Offered in spring. Prereq: MUSI 112.

PHYS 230H: 1 s.h.

Hrs:General Physics Seminar (G2)

The ideas of introductory physics in extended depth, in the language of calculus, using problems, laboratory exercises, readings and discussion. Grades of B- or higher in both PHYS 231 and PHYS 230H will result in honors designation for the pair. The pair of courses counts as one entry in the science component of the curriculum record form and results in six hours of general education credit. Offered in fall, spring. Coreq: Concurrent registration in PHYS 231 required and either good standing in the Honors College or a 3.35 GPA or permission of instructor.

PHYS 231: 5 s.h.

Physics 1 with Calculus (G2)

An introductory course in classical physics dealing with mechanics, fluids, waves and thermodynamics. 3 hrs. lec., 1 hr. recitation, one 3-hr. lab. Offered in fall, spring, summer. Prereq: C- or higher in MATH 161.

PHYS 232: 5 s.h.

Physics 2 with Calculus (G2)

Continuation of PHYS 231. An introductory course in classical physics dealing with electricity, magnetism and optics. 3 hrs. lec., 1 hr. recitation, one 3-hr. lab. Offered in fall, spring, summer. Prereq: C- or higher in PHYS 231. Coreq: MATH 211.

PHYS 233: 3 s.h.

Wave-Particle Theory

Selected topics from the areas of waves and optics, special relativity, an introduction to the concepts and development of modern physics and single-particle quantum mechanics. 3 hrs. lec. Offered in spring. Prereq: C- or higher in PHYS 232. Coreq: MATH 311.

PHYS 266: 3 s.h.**Electronics**

The fundamentals of analog devices and their application to electronic circuits. Operational amplifiers, power supplies, semiconductor devices, oscillators and an introduction to integrated circuits. Two 3-hr. labs. Offered in spring. Prereq: PHYS 132 or 232. Coreq: MATH 161.

PHYS 279: 1-3 s.h.**Experimental**

Experimental

PHYS 279H: 1-3 s.h.**Experimental Honors**

Experimental Course for Honors Credit

PHYS 300: 3-12 s.h.**Co-Op Ed Experience in Physics**

Co-Op Ed Experience in Physics

PHYS 302: 3 s.h.**Physics and Evolution of Western Civilization (P)**

The history of the mechanization of the world picture. A study of physics in the evolution of Western civilization and thought relating the impact of the Newtonian revolution on technology, society and thought. 3 hrs. lec. and discussion. Offered periodically. Prereq: a physical science course, COMM 100, ENGL 110 and junior status.

PHYS 302H: 3 s.h.**H:Phys and Evol of West Civ (P)**

H:Phys and Evol of West Civ

PHYS 311: 3 s.h.**Mechanics 1**

Lectures, problems and demonstrations developing the fundamental principles and concepts of classical mechanics, including Newton's laws of motion in three dimensions, conservation laws, linear and nonlinear oscillating systems, gravitation and central force problems. 3 hrs. lec. Offered in fall. Prereq: C- or higher in PHYS 232. Coreq: MATH 365.

PHYS 312: 3 s.h.**Mechanics 2**

A continuation of PHYS 311. Includes classical analysis of rigid body motion, noninertial frames of reference, Lagrangian and Hamiltonian dynamics, systems of coupled oscillators, plus special topics. 3 hrs. lec. Offered in spring. Prereq: PHYS 311.

PHYS 317: 3 s.h.**Introduction to Astronomy**

An overview of astronomy and astrophysics for students majoring in the sciences or mathematics, emphasizing selected areas such as terrestrial astronomy, celestial mechanics, stellar evolution, cosmology and the solar system. 3 hrs. lec. Offered in fall of odd years. Prereq: a year of collegelevel physics and calculus.

PHYS 321: 3 s.h.**Electromagnetic Fields 1**

Electrostatic and magnetic fields in vacuum and in dielectric and magnetic materials. Maxwell's equations are developed. 3 hrs. lec. Prereq: PHYS 232. Coreq: MATH 365.

PHYS 322: 3 s.h.**Electromagnetic Fields 2**

Consequences of Maxwell's equations. Solutions to Laplace's equation, electromagnetic radiation and relativistic electrodynamics are discussed. 3 hrs. lec. Offered in fall. Prereq: PHYS 321. Coreq: PHYS 335.

PHYS 331: 2 s.h.**Fundamentals of Optics**

Lab-based course in physical optics, including applications of geometrical optics such as image formation by mirrors and lenses, microscopy, reflection, refraction, and basic phenomena in wave and quantum optics such as interference, diffraction, color mixing and filtration, polarization, birefringence, absorption, dispersion, scattering, laser properties and laser application. 1 hr. lec., 3 hrs. lab. Offered in fall. Prereq: PHYS 232 or PHYS 132 and MATH 211.

PHYS 334: 3 s.h.**Macroscopic Physics**

Lectures and demonstrations which develop the basic ideas of classical continuum physics and the macroscopic behavior of solids, liquids and gases, including an introduction to fluid dynamics, stress-strain relationships in solids, electric and magnetic properties of materials, phase transitions, superconductivity and the classical laws of thermodynamics. 3 hrs. lec. and discussion. Offered in spring. Prereq: C- or higher in PHYS 232. Coreq: MATH 311.

PHYS 335: 3 s.h.**Quantum Systems**

Multi-electron atoms, statistical mechanics of classical and quantum systems and introduction to nuclear physics. Principles are applied to selected examples. 3 hrs. lec. Offered in fall. Prereq: PHYS 233, 334.

PHYS 345: 3 s.h.**Symbolic Computational Methods**

Symbolic computational methods involving procedural, functional, rule-based programming and pattern matching using the graphical and numerical capabilities of Mathematica or other integrated mathematical software systems, with applications to a broad range of computationally challenging problems in physics. Offered in fall of odd years. Prereq: PHYS 233. Coreq: PHYS 311 and MATH 365.

PHYS 351: 1 s.h.**Intermediate Physics Lab 1**

Selected Experiments in classical and modern physics introducing a variety of experimental techniques. 3 hours lab. Prereq: PHYS 232 and either PHYS 266 or CSCI 370. Offered in fall.

PHYS 351H: 1 s.h.**H:Intermediate Physics Lab 1****PHYS 352: 1 s.h.****Intermediate Physics Lab 2**

Continuation of PHYS 351. 3 hrs. lab. Offered in spring. Prereq: PHYS 351.

PHYS 360: 4 s.h.**Circuit Analysis**

Mathematical analysis of linear circuits in the complex domain. Differential equations, operators, transfer functions, Laplace transforms and computer simulation with SPICE. 4 hrs. lec. Offered infrequently. Prereq: PHYS 266 and MATH 365.

PHYS 365: 3 s.h.**Digital Electronics**

Introduction to digital electronics and microprocessors. Design and analysis of combinatorial and sequential digital circuits, microcomputer interfacing and assembly programming. Two 3-hr. labs. Offered infrequently. Prereq: CSCI 140 or permission of instructor.

PHYS 366: 3 s.h.**Analog Electronic Circuits**

Continuation of PHYS 266. Analysis and design of microelectronic circuits. Analytical treatment of discrete and integrated analog and digital circuits. 3 hrs. lec. Offered infrequently. Prereq: PHYS 266, 360 or permission of instructor.

PHYS 379: 3 s.h.**Experimental**

Experimental

PHYS 395: 3 s.h.**Techniques of Mathematical Physics**

Treatment of advanced mathematical techniques such as complex analysis, matrices, Fourier series, calculus of variations, special functions and integral transforms applied to selected areas of physics. Offered in spring. Prereq: PHYS 233, MATH 365.

PHYS 395H: 3 s.h.**Hon: Techniques/Mathmt Physics****PHYS 400: 3-12 s.h.****Co-Op Ed Experience in Physics**

Co-Op Ed Experience in Physics

PHYS 431: 3 s.h.**Solid State Physics**

Classical and quantum analyses of solid matter. Topics include crystal structure, the reciprocal lattice and X-ray diffraction; mechanical properties phonons; semiclassical analysis of electrical and magnetic properties of insulators and metals; electron band theory of metals, insulators and semiconductors. 3 hrs. lec. Offered in spring of odd years. Prereq: PHYS 335.

PHYS 435: 3 s.h.**Statistical Mechanics**

Lectures, problems and computer simulations developing the fundamental principles of classical and quantum statistical mechanics. Subjects include probability theory, the foundations of ensemble development and their application to classical, Fermi and Bose systems. Of special interest is the phenomenology of phase transitions and the modern development of the renormalization group. Offered in fall of even years. Prereq: PHYS 335.

PHYS 451: 1 s.h.**Advanced Physics Lab 1**

Selected experiments in classical and modern physics, with opportunities to apply sophisticated techniques to extended experimental problems. 3 hrs. lab. Offered in fall. Prereq: PHYS 352.

PHYS 452: 1 s.h.**Advanced Physics Lab 2**

Continuation of PHYS 451. 3 hrs. lab. Offered in spring. Prereq: PHYS 451.

PHYS 462: 3 s.h.**Advanced Electronics**

Microprocessor applications and interfacing, real-time programming. Topics are selected from computer design, control loops, phase-locked loops and communications. Two 3-hr. labs. Offered infrequently. Prereq: PHYS 266, 365 or permission of instructor.

PHYS 471: 3 s.h.**Quantum Mechanics**

An introduction to formal quantum theory in terms of operators on a Hilbert space. Dirac notation is introduced and used in the solution of the eigenvalue problems for the harmonic oscillator and angular momentum by operator techniques. Other topics include the dynamics of a spin-1/2 particle, the addition of angular momentum and perturbation theory. Offered in fall. Prereq: MATH 322, MATH 365 and PHYS 335 or permission of instructor.

PHYS 479: 3 s.h.**Experimental**

Experimental

PHYS 489: 1-4 s.h.**Honors Course**

Honors Course

PHYS 492: 1,2 s.h.**Physics Research and Seminar**

The first semester of an independent research experience supervised by a faculty mentor. Attendance at weekly seminars is also required. Offered in fall. Prereq: PHYS 335 and 351.

PHYS 493: 1-3 s.h.**Topics in Astronomy**

Selected topics chosen from the areas of astronomy and astrophysics. Permission of instructor. Offered infrequently.

PHYS 494: 1-3 s.h.**Topics in Classical Physics**

Selected topics chosen from the areas of classical physics. Permission of instructor. Offered infrequently.

PHYS 495: 1-3 s.h.**Special Tpcs: Theoretical Phys**

Lecture course in selected topics of current interest in theoretical physics, such as nuclear structure, elementary particle physics, advanced quantum mechanics, plasma physics, general relativity, nonlinear dynamics, Lie groups and their physics application, statistical mechanics, condensed-matter physics and biophysics. Prereq: MATH 365, PHYS 233 or permission of instructor. Offered infrequently.

PHYS 495H: 1-3 s.h.**H: Quantum Mechanics 2****PHYS 496: 1-3 s.h.****Topics in Applied Physics**

A study of the application of selected physics concepts in experimental physics. Permission of instructor. Offered infrequently.

PHYS 497: 1-3 s.h.**Topics in Modern Physics**

Topics chosen from areas of modern physics. Permission of instructor. Offered infrequently.

PHYS 498: 1-4 s.h.**Independent Study/Research**

An independent research experience supervised by a faculty mentor. Attendance at the weekly seminars associated with PHYS 492 is also required. Prereq: PHYS 492 or permission of instructor. Offered in fall, spring.

PHYS 499: 1-4 s.h.**Departmental Honors**

Departmental Honors

PHYS 500: 3-12 s.h.
Co-Op Ed Experience in Physics
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