PHYSICS (PHYS)

Explanation of Course Numbers

- Courses in the 1000s are primarily introductory undergraduate courses
- Those in the 2000s to 4000s are upper-division undergraduate courses that also may be taken for graduate credit with permission and additional work assigned
- Those in the 6000s and 8000s are for master's, doctoral, and professional-level students
- The 6000s are open to advanced undergraduate students with approval of the instructor and the dean or advising office

PHYS 1000. Dean's Seminar. 4 Credits.
The Dean's Seminars provide Columbian College first-year students focused scholarship on specific intellectual challenges.Topics vary by semester. See department for more details Restricted to first-year students. Recommended background: Prior completion of courses in basic algebra and calculus and high school physics.

PHYS 1003. Physics for Future Presidents. 4 Credits.
A serious but accessible presentation of topics important for leaders to know—energy, global climate, high-tech devices, space travel, nuclear weapons, etc. Students possessing any level of scientific background are equipped with the concepts and analytical tools needed to make informed decisions and to argue their view persuasively. Laboratory fee.

PHYS 1003W. Physics for Future Presidents. 4 Credits.

PHYS 1005. How Things Work. 4 Credits.
Primarily for non-science majors. Physical principles are introduced through a study of everyday objects to see what makes them tick. This unconventional approach is primarily conceptual in nature and intended for students seeking a connection between science and the world in which they live. Prerequisite: high school algebra and trigonometry. Laboratory fee.

PHYS 1007. Music and Physics. 4 Credits.
Primarily for non-science majors. A comparative study of music and physics, showing parallels in the history of the two fields and emphasizing those topics in physics related to the theory of music and the production of sound by musical instruments, particularly classical mechanics and wave motion. Prerequisite: high school algebra and geometry. Laboratory fee.

PHYS 1007W. Music and Physics. 4 Credits.
Primarily for non-science majors. A comparative study of music and physics, showing parallels in the history of the two fields and emphasizing those topics in physics related to the theory of music and the production of sound by musical instruments, particularly classical mechanics and wave motion. Laboratory fee. Includes a significant engagement in writing as a form of critical inquiry and scholarly expression to satisfy the WID requirement. Prerequisites: high school algebra and geometry.

PHYS 1008. Origin and Evolution of Ideas in Physics. 4 Credits.
Primarily for non-science majors. The evolution of ideas and their historical continuity in the search for basic physical theories. By presenting the world-views of great physicists of the past, the division of physics into many sub-disciplines is avoided and a humanistic approach is achieved. Prerequisite: high school algebra. Laboratory fee.

PHYS 1008W. Origin and Evolution of Ideas in Physics. 4 Credits.
Primarily for non-science majors. The evolution of ideas and their historical continuity in the search for basic physical theories. By presenting the world-views of great physicists of the past, the division of physics into many sub-disciplines is avoided and a humanistic approach is achieved. Laboratory fee. Includes a significant engagement in writing as a form of critical inquiry and scholarly expression to satisfy the WID requirement. Prerequisite: high school algebra.

PHYS 1011. General Physics I. 4 Credits.
Classical physics; mechanics, including Newton's laws of motion, force, gravitation, equilibrium, work and energy, momentum, and rotational motion; periodic motion, waves, and sound; heat and thermodynamics. Laboratory fee.

PHYS 1012. General Physics II. 4 Credits.
Classical and modern physics; electrostatics, electromagnetism, direct and alternating current circuits, and electromagnetic radiation; geometrical and physical optics; special relativity; quantum theory; atomic physics; nuclear physics; particle physics; astrophysics and cosmology. Prerequisites: PHYS 1011 or PHYS 1021 or PHYS 1025.

PHYS 1021. University Physics I. 4 Credits.
Classical mechanics and thermodynamics using calculus. Newtonian mechanics: force, momentum, work and energy, mechanical equilibrium, linear, and rotational motion. Gravitation and fields; atoms, physical properties of matter; energy transfer and waves, sound. Prerequisites: MATH 1220 or MATH 1221 or MATH 1231. Credit cannot be earned for this course and PHYS 1025.

PHYS 1022. University Physics II. 4 Credits.
Periodic motion, waves, and classical electromagnetism using calculus; waves and sound. Electrostatics, Gauss's law, capacitance; electric resistance, electric current; magnetism. Electrodynamics and electromagnetic induction; Maxwell's theory and electromagnetic radiation. Geometric and physical optics. Prerequisites: PHYS 1021 or PHYS 1025; and MATH 1232. Credit cannot be earned for this course and PHYS 1026.

PHYS 1025. University Physics I with Biological Applications. 4 Credits.
Classical mechanics and thermodynamics using calculus; Newtonian mechanics (force, momentum, work and energy, mechanical equilibrium, linear and rotational motion, fluids). Energy transfer, statistical models, and entropy. Credit cannot be earned for both PHYS 1025 and PHYS 1021. Prerequisites: MATH 1220 or MATH 1221 or MATH 1231. Credit cannot be earned for this course and PHYS 1021.

PHYS 1026. University Physics II with Biological Applications. 4 Credits.
Periodic motion waves, and classical electromagnetism using calculus; waves and sound. Electrostatics, Gauss's law, capacitance; electric resistance, electric current; magnetism; electrostatics in ionic solutions and cells, circuit models for nerves and ion channels; geometric and physical optics; physics principles and problem solving taught with examples and problems from the life sciences. Credit cannot be earned for both PHYS 1026 and PHYS 1022. Prerequisites: MATH 1232; and PHYS 1021 or PHYS 1025. Credit cannot be earned for this course and PHYS 1022.

PHYS 1099. Variable Topics. 1-36 Credits.

PHYS 2000. Sophomore Colloquium. 3 Credits.
Sophomore colloquia are small, seminar-type classes that deeply engage CCAS second-year students in a discipline, focus on a narrow issue of high interest and impact, and require independent research projects. May be repeated provided topic differs. Consult the Schedule of Classes for more details. Restricted to CCAS sophomores.

PHYS 2023. Modern Physics. 3 Credits.
Modern physics using calculus; relativity; wave–particle duality, quantum mechanics; the hydrogen atom, Pauli principle; quantum statistics and radiation; quantum theory of the condensed state, superconductivity; nuclear physics; applications to astrophysics and nucleosynthesis; general relativity; the big bang theory. Prerequisites: PHYS 1022 or PHYS 1026; MATH 2233.

PHYS 2151. Intermediate Laboratory I: Techniques and Methods. 3 Credits.
Experiments in electromagnetism, classical and quantum mechanics, atomic and nuclear physics with emphasis on experimental methods. Laboratory fee.

PHYS 2151W. Intermediate Laboratory I: Techniques and Methods. 3 Credits.
Experiments in electromagnetism, classical and quantum mechanics, atomic and nuclear physics with emphasis on experimental methods. Prerequisites: PHYS 2023. Includes a significant engagement in writing as a form of critical inquiry and scholarly expression to satisfy the WID requirement.

PHYS 2152. Intermediate Laboratory II: Instrumentation. 3 Credits.
Elementary electric and electronic analog and digital circuits. Topics include passive and active components in DC and AC circuits and operational amplifiers, with emphasis on measurement techniques. Laboratory fee.

PHYS 2183. Computational Modern Physics. 3 Credits.

PHYS 3099. Variable Topics. 1-12 Credits.

PHYS 3100. Math Methods for Physics. 3 Credits.
Applications of infinite series, complex variables, linear algebra, vector analysis Fourier series, differential equations, probability theory, and calculus of variations in various physical contexts. Prerequisites: MATH 3342 and PHYS 2023.

PHYS 3127. Biophysics: Macroscopic Physics in the Life Sciences. 3 Credits.
Physical principles applied to biological systems and medicine; blood flow, ultrasonics, spectroscopy, radiation biology, bioenergetics, ordering theory, and neural networks. Prerequisites: MATH 2233; and PHYS 1022 or PHYS 1026.

PHYS 3128. Biophysics: Microscopic Physics in the Life Sciences. 3 Credits.
Physical principles applied to biological systems on the nanometer scale; intermolecular forces, statistical principles applied to biological microstates, determining protein and nucleic acid structures, operation of protein motors and transport systems, and nanotechnology and instrumentation. Prerequisites: PHYS 1022 or PHYS 1026; MATH 2233.

PHYS 3161. Mechanics. 3 Credits.
Mechanics of mass points and rigid bodies. Newton's laws, conservation laws, Euler's equations, inertia tensor, small vibrations, and elements of Lagrange's and Hamilton's equations. Prerequisites: MATH 3342 and PHYS 2023.

PHYS 3163. Physical and Quantum Optics. 3 Credits.
Wave motion, electromagnetic aspects of light, dispersion of light in media, geometrical optics, polarization and optical properties of crystals, interference, diffraction, lasers, holography; mathematical tools, including Fourier methods, developed as needed; the quantum description of light complements the classical description. Prerequisites: MATH 2233 and PHYS 2023.

PHYS 3164. Thermal and Statistical Physics. 3 Credits.
Principles and application of thermodynamics to reversible and irreversible processes, with derivation from statistical postulates applied to the microscopic behavior of large systems at or near equilibrium; equilibrium thermodynamics, statistical mechanics, and kinetic theory of gases. Prerequisites: MATH 3342 and PHYS 2023.

PHYS 3165. Electromagnetic Theory I. 3 Credits.
Electrostatics and magnetostatics, electric and magnetic fields in matter, scalar and vector potentials, electromagnetic induction. Maxwell's equations. Methods of vector and tensor calculus are developed as needed, as are the method of images, Fourier series, and some computational methods. Prerequisites: MATH 3342 and PHYS 2023.

PHYS 3166. Electromagnetic Theory II. 3 Credits.
Conservation laws, electromagnetic waves, radiation, relativistic formulation of electrodynamics and potential fields. Prerequisites: PHYS 2023, PHYS 3165, MATH 2184, MATH 3342 and MATH 3343; or permission of the instructor.

PHYS 3167. Principles of Quantum Physics. 3 Credits.
Conceptual framework and mathematical formalism of quantum mechanics; wave-particle duality, wave functions, and eigenvalues; Schrödinger equation and one-dimensional potential problems; angular momentum, central potentials, and the hydrogen atom; identical particles and spin; scattering theory; perturbation theory. Prerequisites: MATH 3342 and PHYS 2023.

PHYS 3181. Computational Physics. 3 Credits.
Numerical methods with physics, math, and engineering applications; numerical integration, ODE, PDE, Monte-Carlo methods, linear algebra, and other relevant numerical techniques. In addition to the course prerequisites, students must be familiar with a programming language. Prerequisites: MATH 3342 and PHYS 3161.

PHYS 4170. Solid-State Physics. 3 Credits.
Structure of solids, lattices and lattice defects, deformation, vibrational and electronic contribution to specific heats, binding energies, electronic states in metals and semiconductors, magnetic properties of solids, superconductivity. Prerequisites: MATH 2233 and PHYS 2023.

PHYS 4175. Nuclear Physics. 3 Credits.
Application of quantum physics to the description of nuclei and their interactions; properties of nuclei, nuclear models, nuclear forces, and nuclear reactions are considered. Includes the deuteron, n-p scattering, the optical model, the shell model, the liquid-drop model, beta decay, fission, and fusion. Prerequisites: MATH 2233 and PHYS 2023.

PHYS 4190. Special Topics. 1-4 Credits.
Topics vary by semester. May be repeated for credit provided topic differs. Consult the Schedule of Classes for more details.

PHYS 4192. Independent Study. 1-3 Credits.
Independent readings or directed study under the supervision of a faculty member. Credit varies, depending upon the nature of the work. May be repeated once for credit.

PHYS 4195. Physics Capstone. 3 Credits.
Students work in a mentored learning environment to design and conduct research in physics in an ethical manner, explore and prepare for various careers in physics, and disseminate research findings to different audiences. May be repeated for credit. Restricted to physics majors with junior standing.

PHYS 4195W. Physics Capstone. 3 Credits.
Students work in a mentored learning environment to design and conduct research in physics in an ethical manner, explore and prepare for various careers in physics, and disseminate research findings to different audiences. May be repeated for credit. Includes a significant engagement in writing as a form of critical inquiry and scholarly expression to satisfy the WID requirement. Restricted to physics majors with junior standing.

PHYS 4196. Undergraduate Research in Biophysics. 3 Credits.
Research on problems in biophysics approved by the faculty. May be repeated once for credit.

PHYS 4197. Undergraduate Research in Nuclear Physics. 3 Credits.
Research on problems in nuclear physics approved by the faculty. May be repeated once for credit.

PHYS 4200. Physics Symposium. 1 Credit.
Culmination of physics undergraduate studies. Communication of physics research orally and in writing with peer review of presentations and reports. Restricted to physics majors with senior standing.

PHYS 5099. Variable Topics. 1-99 Credits.

PHYS 5701. Selected Topics. 4 Credits.

PHYS 6110. Mathematical Methods of Theoretical Physics. 4 Credits.
Calculus of variations. Group theory. Tensor calculus. Review of techniques of linear algebra. Hilbert spaces and operator theory. Special functions and expansion in complete orthogonal sets of functions. Solutions of partial differential equations, Green's functions method and boundary-value problems. Integral equations. Complex analysis and theory of analytic functions. Permission of the department graduate advisor required prior to enrollment. Corequisite: PHYS 6130.

PHYS 6120. Advanced Mechanics. 4 Credits.
Analytic methods of mechanics as a basis for modern theory. Variational principles. Lagrange's equations. Hamiltonian formulation. Canonical transformations. Classical perturbation theory. Nonlinear systems. Special relativity. Permission of the department graduate advisor required prior to enrollment. Corequisite: PHYS 6130.

PHYS 6130. Computational Physics I. 1 Credit.
Taken in conjunction with PHYS 6110 and PHYS 6120.

PHYS 6210. Electrodynamics and Classical Field Theory. 4 Credits.
Principles of electro- and magneto-statics. Classical field theory. Maxwell's equations, least-action and symmetry principles. Time-varying fields and plane–wave propagation. Radiating systems and scattering of radiation, including multipole fields. Dynamics of relativistic particles and radiation from moving charges. Electrodynamics in media: relation between microscopic parameters and macroscopic observables. Permission of the department graduate advisor required prior to enrollment. Corequisite: PHYS 6230.

PHYS 6220. Quantum Mechanics I. 4 Credits.
General aspects of quantum mechanics with emphasis upon the developmental principles involved. Operators, representations, transformation theory. Schroedinger and Heisenberg pictures, angular momentum, perturbation and scattering theory. Introduction to relativistic quantum field theory, first-order electromagnetic processes. Many-body theory. Prerequisite: Consent of a departmental graduate advisor. Corequisite to PHYS 6220: PHYS 6230; to PHYS 6320: PHYS 6330.

PHYS 6230. Computational Physics II. 1 Credit.

PHYS 6310. Statistical Mechanics. 4 Credits.
Classical and quantum statistics. Gibbs paradox, microscopic origins of entropy and other thermodynamic variables, fluctuations, ensemble theory, partition functions, distribution functions, density matrices. Applications include the harmonic oscillator, magnetic systems, ideal Fermi–Dirac and Bose–Einstein systems, blackbody radiation, phonons. Renormalization group, phase transitions and critical phenomena. Permission of the department graduate advisor required prior to enrollment. Corequisite: PHYS 6330.

PHYS 6320. Quantum Mechanics II. 4 Credits.

PHYS 6330. Computational Physics III. 1 Credit.

PHYS 6510. Communications in Physics. 3 Credits.
Student presentations on advanced topics in physics. Permission of the department graduate advisor required prior to enrollment.

PHYS 6590. Seminar. 1 Credit.
Lectures on current topics in physics. Permission of the department graduate advisor required prior to enrollment. May be repeated for credit.

PHYS 6599. Advanced Study. 3 Credits.
For students who have completed three semesters of course work in the core graduate physics curriculum. Problem sets aimed at development of a deeper and more advanced understanding of physics.

PHYS 6610. Nuclear and Particle Physics I. 3 Credits.
Theory and experiment of the standard model of elementary particle physics of strong and electro-weak interactions. Emergence of nuclear interactions and pion physics. Effective field theory, non-perturbative methods, lattice simulations, nuclear models, nuclear reactions. Path integral, gauge fields, S-matrix theory, dispersion relations, renormalization program. Prerequisite: PHYS 6320 and permission of the graduate advisor.

PHYS 6620. Biophysics I. 3 Credits.
Topics include molecular biophysics, modern simulation methodologies and experimental methodologies for probing biological systems.

PHYS 6630. Astrophysics I - Radiative Processes in Astrophysics. 3 Credits.
Physics of radiative processes and multiwavelength radiation from cosmic sources; application of theoretical framework to real measurements; nature of various cosmic objects; recent developments in multiwavelength and gravitational wave astrophysics. Prerequisites: PHYS 6210.

PHYS 6710. Nuclear and Particle Physics II. 3 Credits.
Theory and experiment of the standard model of elementary particle physics of strong and electro-weak interactions. Emergence of nuclear interactions and pion physics. Effective field theory, non-perturbative methods, lattice simulations, nuclear models, nuclear reactions. Path integral, gauge fields, S-matrix theory, dispersion relations, renormalization program. (Academic year) Prerequisite: PHYS 6320.

PHYS 6720. Biophysics II. 3 Credits.
Topics include theoretical and computational methods for genes, proteins, and bionetworks; models of biological complexity; applications of non-equilibrium statistical mechanics and combinatorial optimization. This course may be taken repeatedly for credit to a maximum of 15 credits. Prerequisite: PHYS 6310.

PHYS 6730. Astrophysics II - High-Energy Astrophysics. 3 Credits.
High-energy processes; neutron stars and black holes; life and death of massive stars; X-ray and gamma-ray observatories; recent developments in gravitational wave and neutrino astronomy; basics of instrumentation, data access and data analysis. Prerequisites: PHYS 6630.

PHYS 6810. Applied Statistics and Data Analysis in Physics. 3 Credits.
Statistical inference applied to physical science data; modern statistical methods; informative visualizations of data and inferred trends. Analytical and practical skills for physical data analysis and interpretation using solid statistical methods. Prerequisites: MATH 2184, MATH 2233, PHYS 2023.

PHYS 6999. Thesis Research. 3 Credits.
May be repeated for credit. Restricted to students in the MS in physics program.

PHYS 8110. Selected Topics in Theoretical Nuclear Physics. 3 Credits.
May be repeated once for credit with permission of the graduate advisor.

PHYS 8120. Selected Topics in Experimental Nuclear Physics. 3 Credits.
May be repeated once for credit with the permission of the graduate advisor.

PHYS 8130. Selected Topics in Theoretical Biophysics. 3 Credits.
May be repeated once for credit with the permission of the graduate advisor.

PHYS 8140. Selected Topics in Experimental Biophysics. 3 Credits.
May be repeated once for credit with the permission of the graduate advisor.

PHYS 8150. Selected Topics in Astrophysics. 3 Credits.
May be repeated once for credit with the permission of the graduate advisor.

PHYS 8998. Advanced Reading and Research. 1-4 Credits.
May be repeated once for credit. Restricted to doctoral candidates preparing for the general examination.

PHYS 8999. Dissertation Research. 3-12 Credits.
May be repeated for credit. Restricted to doctoral candidates.