BPIE Program Course Options

Visit: http://guide.berkeley.edu for a full list of pre-requisites. All students are required to meet pre-requisites as listed for each course.
Physics core courses often taken by our BPIE students are marked with an asterisk (*).

PHYSICS C10 Descriptive Introduction to Physics 3 Units
The most interesting and important topics in physics, stressing conceptual understanding rather than math, with applications to current events. Topics covered may vary and may include energy and conservation, radioactivity, nuclear physics, the Theory of Relativity, lasers, explosions, earthquakes, superconductors, and quantum physics. (may be offered fall/spring)

PHYSICS C21 Physics and Music 3 Units
What can we learn about the nature of reality and the ways that we humans have invented to discover how the world works? An exploration of these questions through the physical principles encountered in the study of music. The applicable laws of mechanics, fundamentals of sound, harmonic content, principles of sound production in musical instruments, musical scales. Numerous illustrative lecture demonstrations will be given. Only the basics of high school algebra and geometry will be used (offered spring only)

*PHYSICS 77 Introduction to Computational Techniques in Physics 2 Units
Introductory scientific programming in Python with examples from physics. Topics include: visualization, statistics and probability, regression, numerical integration, simulation, data modeling, function approximation, and algebraic systems. Recommended for freshman physics majors. (offered both fall and spring)

*PHYSICS 89 Introduction to Mathematical Physics 4 Units
Complex numbers, linear algebra, ordinary differential equations, Fourier series and transform methods, introduction to partial differential equations, introduction to tensors. Applications to physics will be emphasized. This course or an equivalent course required for physics major. (offered both fall and spring)

*PHYSICS 105 Analytic Mechanics 4 Units
Newtonian mechanics, motion of a particle in one, two, and three dimensions, Lagrange's equations, Hamilton's equations, central force motion, moving coordinate systems, mechanics of continuous media, oscillations, normal modes, rigid body dynamics, tensor analysis techniques. Some knowledge of Python required for homework assignments. Students who have not taken Physics 77 or Data Science 8 are encouraged to complete the Python tutorials provided by the Physics Department. (offered both fall and spring)

*PHYSICS 110A Electromagnetism and Optics 4 Units
Part I. A course emphasizing electromagnetic theory and applications; charges and currents; electric and magnetic fields; dielectric, conducting, and magnetic media; relativity, Maxwell equations. Wave propagation in media, radiation and scattering, Fourier optics, interference and diffraction, ray optics and applications. (offered both fall and spring)

*PHYSICS 110B Electromagnetism and Optics 4 Units
Part II. A course emphasizing electromagnetic theory and applications; charges and currents; electric and magnetic fields; dielectric, conducting, and magnetic media; relativity, Maxwell equations. Wave propagation in media, radiation and scattering, Fourier optics, interference and diffraction, ray optics and applications. (offered both fall and spring)

PHYSICS 111A Instrumentation Laboratory 3 Units
The instrumentation lab (formerly Basic Semiconductor Circuits) is an introductory course in basic design, analysis and modeling of circuits, and data analysis and control. Topics include but not limited to: linear circuits, semiconductor diodes, JFETS, Op-Amps, Labview programming, ADC and DAC converters, signal processing, and feedback control. (offered both fall and spring – enrollment is limited)

PHYSICS 111B Advanced Experimentation Laboratory 1 - 3 Units
In the advanced experimentation lab students complete four of 20+ advanced experiments. These include many experiments in atomic, nuclear, particle physics, biophysics, and solid-state physics, among others. (offered both fall and spring – enrollment is limited)

*PHYSICS 112 Introduction to Statistical and Thermal Physics 4 Units
Basic concepts of statistical mechanics, microscopic basis of thermodynamics and applications to macroscopic systems, condensed states, phase transformations, quantum distributions, elementary kinetic theory of transport processes, fluctuation phenomena. Some knowledge of Python required for homework assignments. Students who have not taken Physics 77 or Data Science 8 are encouraged to complete the Python tutorials provided by the Physics Department. (offered both fall and spring)

PHYSICS 129 Particle Physics 4 Units
Tools of particle and nuclear physics. Properties, classification, and interaction of particles including the quark-gluon constituents of hadrons. High energy phenomena analyzed by quantum mechanical methods. Course will survey the field including some related topics in nuclear physics. Some knowledge of Python required. Students who have not taken Physics 77 or Data Science 8 are encouraged to complete the Python tutorials provided by the Physics Department. (offered fall only)

PHYSICS 130 Quantum and Nonlinear Optics 3 Units
Detailed theory and experimental basis of quantum and nonlinear optics, exhibiting concepts of quantum measurement, noise, stochastic processes and dissipative quantum systems. Topics include second-quantization of electromagnetic fields, photodetection, coherence properties, light-atom interactions, cavity quantum electrodynamics, nonlinear optical systems, squeezed light, aspects of quantum information science, and contemporary research. (offered spring, every other year)

*PHYSICS 137A Quantum Mechanics 4 Units
Part I. Introduction to the methods of quantum mechanics with applications to atomic, molecular, solid state, nuclear and elementary particle physics. (offered both fall and spring)

*PHYSICS 137B Quantum Mechanics 4 Units
Part II. Introduction to the methods of quantum mechanics with applications to atomic, molecular, solid state, nuclear and elementary particle physics. (offered both fall and spring)

PHYSICS 138 Modern Atomic Physics 3 Units
This course covers atomic, molecular, and optical physics as a quantitative description of atoms and fields, a generalized toolbox for controlling quantum systems, and a vibrant research area. Topics covered include atomic structure and spectra, atom-field interactions, topics in quantum electrodynamics, methods of resonant manipulation of quantum systems, resonance optics, and experimental techniques. (offered spring, every other year)

PHYSICS 139 Special Relativity and General Relativity 3 Units
Historical and experimental foundations of Einstein's special theory of relativity; spatial and temporal measurements, particle dynamics, electrodynamics, Lorentz invariants. Introduction to general relativity. Selected applications. Designed for advanced undergraduates in physics and astronomy. (offered spring only)

*PHYSICS 141A Solid State Physics 4 Units
Part I. A thorough introductory course in modern solid state physics. Crystal symmetries; classification of solids and their bonding; electromagnetic, elastic, and particle waves in periodic lattices; thermal magnetic and dielectric properties of solids; energy bands of metals and semi-conductors; superconductivity; magnetism; ferroelectricity; magnetic resonances. (offered both fall and spring)

PHYSICS 141B Solid State Physics 3 Units
Part II. A thorough introductory course in modern solid state physics. Crystal symmetries; classification of solids and their bonding; electromagnetic, elastic, and particle waves in periodic lattices; thermal magnetic and dielectric properties of solids; energy bands of metals and semi-conductors; superconductivity; magnetism; ferroelectricity; magnetic resonances. (offered spring only)

PHYSICS 142 Introduction to Plasma Physics 4 Units
Motion of charged particles in electric and magnetic fields, dynamics of fully ionized plasma from both microscopic and macroscopic point of view, magnetohydrodynamics, small amplitude waves; examples from astrophysics, space sciences and controlled-fusion research. (offered spring, every other year)

PHYSICS 151 Elective Physics: Special Topics 3 Units
Topics vary from semester to semester. The subject matter level and scope of the course are such that it is acceptable as the required elective course in the Physics major. See Department of Physics course announcements. (may be offered fall/spring)

PHYSICS C161 Relativistic Astrophysics and Cosmology 4 Units
Elements of general relativity. Physics of pulsars, cosmic rays, black holes. The cosmological distance scale, elementary cosmological models, properties of galaxies and quasars. The mass density and age of the universe. Evidence for dark matter and dark energy and concepts of the early universe and of galaxy formation. Reflections on astrophysics as a probe of the extrema of physics. (offered spring only – enrollment is limited)

PHYSICS 177 Principles of Molecular Biophysics 3 Units
We will review the structure of proteins, nucleic acids, carbohydrates, lipids, and the forces and interactions maintaining their structure in solution. We will describe the thermodynamics and kinetics of protein folding. The principles of polymer chain statistics and of helix-coil transitions in biopolymers will be reviewed next, together with biopolymer dynamics. We will then cover the main structural methods in biology: X-ray crystallography, MNR and fluorescence spectroscopy, electron and probe microscopy, and single molecular methods. (offered spring only)

PHYSICS 188 Bayesian Data Analysis and Machine Learning for Physical Sciences 4 Units
The course design covers data analysis and machine learning, highlighting their importance to the physical sciences. It covers data analysis with linear and nonlinear regression, logistic regression, and gaussian processes. It covers concepts in machine learning such as unsupervised and supervised regression and classification learning. It develops Bayesian statistics and information theory, covering concepts such as information, entropy, posteriors, MCMC, latent variables, graphical models and hierarchical Bayesian modeling. It covers numerical analysis topics such as integration and ODE, linear algebra, multi-dimensional optimization, and Fourier transforms. (offered fall only)

PHYSICS H190 Physics Honors Course 2 Units
A seminar which includes study and reports on current theoretical and experimental problems. Open only to students officially in the physics honors program or with consent of instructor. (offered spring only)

PHYSICS C191 Quantum Information Science and Technology 3 Units
This multidisciplinary course provides an introduction to fundamental conceptual aspects of quantum mechanics from a computational and informational theoretic perspective, as well as physical implementations and technological applications of quantum information science. Basic sections of quantum algorithms, complexity, and cryptography, will be touched upon, as well as pertinent physical realizations from nanoscale science and engineering. (may be offered fall/spring)