**APPLIED PHYSICS (APHY)**

* APHY 050a or b / ENAS 050a or b / PHYS 050a or b, Science of Modern Technology and Public Policy  
  Daniel Prober  
  Examination of the science behind selected advances in modern technology and implications for public policy, with focus on the scientific and contextual basis of each advance. Topics are developed by the participants with the instructor and with guest lecturers, and may include nanotechnology, quantum computation and cryptography, renewable energy technologies, optical systems for communication and medical diagnostics, transistors, satellite imaging and global positioning systems, large-scale immunization, and DNA made to order. Enrollment limited to first-year students. Preregistration required; see under First-Year Seminar Program. SC

* APHY 100b / ENAS 100b / EPS 105b / EVST 100b / PHYS 100b, Energy, Environment, and Public Policy  
  Daniel Prober  
  The technology and use of energy. Impacts on the environment, climate, security, and economy. Application of scientific reasoning and quantitative analysis. Intended for non-science majors with strong backgrounds in math and science. QR, SC

APHY 110b / ENAS 110b, The Technological World  
Owen Miller  
An exploration of modern technologies that play a role in everyday life, including the underlying science, current applications, and future prospects. Examples include solar cells, light-emitting diodes (LEDs), computer displays, the global positioning system, fiber-optic communication systems, and the application of technological advances to medicine. For students not committed to a major in science or engineering; no college-level science or mathematics required. Prerequisite: high school physics or chemistry. QR, SC

APHY 151a or b / ENAS 151a or b, Multivariable Calculus for Engineers  
Staff  
An introduction to multivariable calculus focusing on applications to engineering problems. Topics include vector-valued functions, vector analysis, partial differentiation, multiple integrals, vector calculus, and the theorems of Green, Stokes, and Gauss. Prerequisite: MATH 115 or equivalent. QR

APHY 194a or b / ENAS 194a or b, Ordinary and Partial Differential Equations with Applications  
Staff  
Basic theory of ordinary and partial differential equations useful in applications. First- and second-order equations, separation of variables, power series solutions, Fourier series, Laplace transforms. Prerequisites: ENAS 151 or MATH 120 or equivalent, and knowledge of matrix-based operations. QR

APHY 322b, Electromagnetic Waves and Devices  
Michel Devoret  
Introduction to electrostatics and magnetostatics, time varying fields, and Maxwell’s equations. Applications include electromagnetic wave propagation in lossless, lossy, and metallic media and propagation through coaxial transmission lines and rectangular waveguides, as well as radiation from single and array antennas. Occasional experiments and demonstrations are offered after classes. Prerequisites: PHYS 180, 181, or 200, 201. QR, SC

APHY 439a / PHYS 439a, Basic Quantum Mechanics  
Peter Rakich  
The basic concepts and techniques of quantum mechanics essential for solid-state physics and quantum electronics. Topics include the Schrödinger treatment of the harmonic oscillator, atoms and molecules and tunneling, matrix methods, and perturbation theory. Prerequisites: PHYS 181 or 201, PHYS 301, or equivalents, or permission of instructor. QR, SC

APHY 448a / PHYS 448a, Solid State Physics I  
Sohrab Ismail-Beigi  
The first term of a two-term sequence covering the principles underlying the electrical, thermal, magnetic, and optical properties of solids, including crystal structure, phonons, energy bands, semiconductors, Fermi surfaces, magnetic resonances, phase transitions, dielectrics, magnetic materials, and superconductors. Prerequisites: APHY 322, 439, PHYS 420. QR, SC

APHY 449b / PHYS 449b, Solid State Physics II  
Yu He  
The second term of the sequence described under APHY 448. QR, SC

* APHY 450b / ENAS 450b / MENG 450b, Advanced Synchrotron Techniques and Electron Spectroscopy of Materials  
Charles Ahn  
Introduction to concepts of advanced x-ray and electron-based techniques used for understanding the electronic, structural, and chemical behavior of materials. Students learn from world-leading experts on fundamentals and practical applications of various diffraction, spectroscopy, and microscopy methods. Course highlights the use of synchrotrons in practical experiments. Prerequisites: physics and quantum mechanics/physical chemistry courses for physical science and engineering majors, or by permission of instructor. QR, SC

APHY 458a / PHYS 458a, Principles of Optics with Applications  
Hui Cao  
Introduction to the principles of optics and electromagnetic wave phenomena with applications to microscopy, optical fibers, laser spectroscopy, and nanostructure physics. Topics include propagation of light, reflection and refraction, guiding light, polarization, interference, diffraction, scattering, Fourier optics, and optical coherence. Prerequisite: PHYS 430. QR, SC

* APHY 469a, Special Projects  
Daniel Prober  
Faculty-supervised individual or small-group projects with emphasis on research (laboratory or theory). Students are expected to consult the director of undergraduate studies and appropriate faculty members to discuss ideas and suggestions for suitable topics. This course may be taken more than once, is graded pass/fail, is limited to Applied Physics majors, and does not count toward the senior requirement. Permission of the faculty adviser and of the director of undergraduate studies is required.
* APHY 471a and APHY 472b, Senior Special Projects  Daniel Prober
Faculty-supervised individual or small-group projects with emphasis on research (laboratory or theory). Students are expected to consult
the director of undergraduate studies and appropriate faculty members to discuss ideas and suggestions for suitable topics. This course
may be taken more than once and is limited to Applied Physics majors in their junior and senior years. Permission of the faculty adviser
and of the director of undergraduate studies is required.