APPLIED & ENGINEERING PHYSICS (AEP)

AEP 1100 - Lasers and Photonics (3 Credits)
Crosslisted with ENGRI 1100
Lasers have had an enormous impact on communications, medicine, remote sensing, and material processing. This course reviews the properties of light that are essential to understanding the underlying principles of lasers and these photonic technologies. There also is a strong, hands-on laboratory component in which the students build and operate a nitrogen laser and participate in several demonstration experiments such as holography, laser processing of materials, optical tweezers, and fiber optics.
Distribution Requirements: (SCT-IL)
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

AEP 1200 - Introduction to Nanoscience and Nanoengineering (3 Credits)
Crosslisted with ENGRI 1200
Lecture/laboratory course designed to introduce first-year students to some of the ideas and concepts of nanoscience and nanotechnology with stronger emphasis on nanobiotechnology in the spring semester. Topics include nanoscience and nanotechnology-what they are and why they are of interest; atoms and molecules; the solid state; surfaces; behavior of light and material particles when confined to nanoscale dimensions; scanning tunneling microscopy (STM), atomic force microscopy (AFM), scanning electron microscopy (SEM); microelectromechanical systems (MEMS) design; basic micromachining and chemical synthesis methods, i.e., top-down and bottom-up approaches to nanofabrication; how to manipulate structures on the nanoscale; physical laws and limits they place on the nanoworld; some far-out ideas. In the laboratory, students construct a simple STM to record atomic resolution images; learn through hands on experience the basic workings of an SEM; use a MEMS computer-aided design software package to model the entire manufacturing sequence of a simple MEMS device, examine the simulated behavior of the device and compare it with real behavior; investigate the optical properties of quantum dots and the unexpected properties of fluids that flow through narrow channels.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- An introductory understanding of quantum mechanics and optics as applied to nanoscience and nanotechnology.
- Acquired a basic understanding of the tools and fabrication techniques used in nanoscience and nanotechnology.

Schedule of Classes (https://classes.cornell.edu/)

AEP 1300 - Conceptual Physics (3 Credits)
Enrollment Information: Enrollment limited to: CPEP students.
Last Four Terms Offered: Fall 2024, Fall 2023, Spring 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

AEP 2170 - Physics II: Electricity and Magnetism (4 Credits)
Crosslisted with PHYS 2217
Second in a three semester introductory physics sequence. Explores quantitative modeling of the physical world through a study of electricity and magnetism. More mathematical and abstract than a typical introductory electricity and magnetism course. Topics include electrostatics, behavior of matter in electric fields, circuits, magnetic fields, Faraday's law, AC circuits, and electromagnetic waves. Makes substantial use of vector calculus. At the level of Electricity and Magnetism by Purcell.
Forbidden Overlaps: AEP 2170, PHYS 1102, PHYS 2208, PHYS 2213, PHYS 2217
Enrollment Information: Primarily for: prospective majors in Physics, Astronomy, or Engineering Physics. Recommended prerequisites: PHYS 1110 with PHYS 1112, PHYS 1116, PHYS 2213, for students matriculating Fall 2021 or later, to complete the required sequence; Vector calculus at the level of MATH 1920, MATH 2220, or MATH 2240. Mathematics prerequisites can be waived at discretion of instructor.
Distribution Requirements: (CHPH-AG, OPHLS-AG), (PHS-AS)
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

AEP 2520 - The Physics of Life (3 Credits)
Crosslisted with ENGRD 2520
Introduces the physics of biological macromolecules (e.g., proteins, DNA, RNA) to students of the physical sciences or engineering who have little or no background in biology. The macromolecules are studied from three perspectives. First, the biological role or function of each class of macromolecules is considered. Second, a quantitative description of the physical interactions that determine the behavior of biomolecular systems. An introduction is provided to probability and statistical methods used to describe the behavior of biological systems. Finally, techniques that are commonly used to probe these systems, with an emphasis on biotechnology applications, are discussed.
Corequisites: PHYS 2213.
Enrollment Information: Recommended prerequisite: MATH 1920, CHEM 2070 or CHEM 2090.
Last Four Terms Offered: Fall 2021, Fall 2020, Spring 2019, Spring 2018
Learning Outcomes:

- An introductory-level understanding of molecular biology.
- An understanding of the importance of basic physics, math and chemistry concepts to molecular biology.
- An understanding of the importance of physics/math/engineering in developing techniques to probe biological systems.

Schedule of Classes (https://classes.cornell.edu/)

AEP 2550 - Engineering Quantum Information Hardware (3 Credits)
Crosslisted with ENGRD 2550
This course examines the physical hardware of quantum information processing, quantum communication, and quantum sensing technologies. Topics include an analysis of qubit attributes and an introduction to the operational principles of physical qubits. Specific systems will include photonic circuits, trapped ions, superconducting quantum circuits, isolated solid-state spins and quantum dots.
Prerequisites: MATH 1920, PHYS 1112 or PHYS 1116. Corequisite: MATH 2930, PHYS 2213 or PHYS 2217.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:

- Understand the basic concepts of quantum information technologies.
- Understand and explain the properties of a qubit and its representation.
- Understand and analyze quantum gate operations.
- Have knowledge of emerging quantum technology platforms and how they relate to quantum engineering goals.

Schedule of Classes (https://classes.cornell.edu/)

AEP 3100 - Introductory Quantum Computing (3 Credits)
An introduction to quantum computing for students who have not necessarily had prior exposure to quantum mechanics. This course is intended for physicists, electrical engineers, and computer scientists. Topics include: foundational algorithmic building blocks and quantum algorithms; variational quantum algorithms (for physics simulation and for combinatorial optimization); quantum machine learning; basic physics of quantum computing hardware implementation. There will be substantial programming exercises implementing quantum algorithms to run on simulators and quantum computers in the cloud.
Enrollment Information: Recommended prerequisite: MATH 2940 or equivalent, and CS 1110 or equivalent exposure to Python.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023
Learning Outcomes:

- Students will be able to understand and have the knowledge to implement core quantum algorithms.
- Students will be able to apply some of the quantum algorithms studied to new application problems.
- Students will be able to explain key challenges in constructing quantum computers and in running quantum algorithms on current quantum computers.

Schedule of Classes (https://classes.cornell.edu/)

AEP 3200 - Introductory Mathematical Physics (4 Credits)
Covers review of vector analysis, tensor calculus, Dirac Delta functions, complex variable theory, Cauchy-Rieman conditions, complex Taylor and Laurent series, Cauchy integral formula and residue techniques, conformal mapping, calculus of variations, Fourier Series.
Corequisites: MATH 2940.
Forbidden Overlaps: AEP 3200, AEP 4210
Enrollment Information: Recommended prerequisite: MATH 2930.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

AEP 3330 - Mechanics of Particles and Solid Bodies (4 Credits)
Newtonian mechanics, especially with dissipative forces; objects rotating around a constant direction and possibly translating, using both torque and energy; coupled and damped-driven linear oscillations and an introduction to nonlinear systems; an introduction to variational calculus; Lagrangian and Hamiltonian formalism for generalized coordinates; central-force motion and a brief introduction to scattering; non-inertial reference systems; 3D motion of rigid bodies. (At the level of Classical Dynamics by Marion and Thornton and Classical Mechanics by John Taylor).
Corequisites: AEP 4200 or equivalent or permission of instructor.
Enrollment Information: Recommended prerequisite: PHYS 1112 or PHYS 1116.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 3550 - Intermediate Electromagnetism (4 Credits)
Intermediate-level course on electromagnetic theory with a focus on statics. Vector calculus, electrostatics, conductors, dielectric materials, boundary conditions, solutions to Laplace's equation, magnetostatics, quasistatic conditions, Maxwell equations, Poynting theorem, Maxwell Stress tensor, EM wave, polarization, energy, momentum. Emphasis is on developing proficiency with analytical techniques and intuitive understanding of fundamental electromagnetism.
Corequisites: AEP 4200 or permission of instructor.
Enrollment Information: Recommended prerequisite: PHYS 2213 or PHYS 2217.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

AEP 3555 - Gaining Intuition Through Symmetry and Computation (3 Credits)
Applied Group Theory. Focus is on the symmetry of geometrical objects, both as abstract objects (up to an isomorphism) and embedded in a physical space (up to a conjugation) such as the Crystallographic Groups. Topics will include: Group Actions (on Sets & Vector Spaces), Numbers & Groups, Permutations & the Symmetric Group, Orbit-Stabilizer Theorem, Regular Objects in 2d/3d & the Platonic solids, applications to problems in physics.
Enrollment Information: Recommended prerequisite: AEP 3200.
Last Four Terms Offered: Fall 2022, Fall 2021, Fall 2020
Schedule of Classes (https://classes.cornell.edu/)

AEP 3560 - Intermediate Electrodynamics (4 Credits)
Second course in theory of electromagnetism: Magnetic materials, Faraday's law, Maxwell equations, electromagnetic waves, reflection and transmission, guided waves, and radiation.
Enrollment Information: Recommended prerequisite: AEP 3550 and AEP 4200.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 3610 - Introductory Quantum Mechanics (4 Credits)
Introductory course in quantum mechanics. Topics include Schrodinger's equation and the statistical interpretation of the wavefunction, potentials in 1 to 3 dimensions, Dirac notation and Hilbert space, ladder operators for harmonic potentials and angular momentum, exact solutions for the hydrogen atom and spin systems. Emphasis is on developing both an intuitive understanding of quantum mechanics and how to apply it rigorously.
Corequisites: AEP 4200.
Enrollment Information: Recommended prerequisite: PHYS 2214 or PHYS 2218.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 3620 - Intermediate Quantum Mechanics (4 Credits)
Continuation of AEP 3610 covering more advanced material in quantum mechanics. Topics include operator formalism and matrix representation, angular momentum and spin, the hydrogen atom, techniques for solving Schrodinger's equation including perturbation theory, two- and three-level systems, interaction with radiation, and identical particles.
Corequisites: AEP 4200 or permission of instructor.
Enrollment Information: Recommended prerequisite: AEP 3610 or PHYS 3316.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

AEP 3630 - Electronic Circuits (4 Credits)
Crosslisted with PHYS 3360
Practical electronics as encountered in a scientific or engineering research/development environment. Analyze, design, build, and test circuits using discrete components and integrated circuits. Analog circuits: resistors, capacitors, operational amplifiers, feedback amplifiers, oscillators, comparators, passive and active filters, diodes, and transistor switches and amplifiers. Digital circuits: combinational and sequential logic (gates, flipflops, registers, counters, timers), analog to digital (ADC) and digital to analog (DAC) conversion, signal averaging, and computer architecture and interfacing. Additional topics may include analog and digital signal processing, light wave communications, transducers, noise reduction techniques, and computer-aided circuit design. At the level of Art of Electronics by Horowitz and Hill.
Enrollment Information: Recommended prerequisite: undergraduate course in electricity and magnetism (e.g., PHYS 2208, PHYS 2213, or PHYS 2217) or permission of instructor.
Distribution Requirements: (CHPH-AG, OPHLS-AG), (PHS-AS)
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

AEP 3640 - Modern Applied Physics Experimental Design (3 Credits)
A hands-on introduction to modern applied physics computer-aided experimental design with weekly laboratory-based problem solving culminating in the development and use of an automated laser scanning microscope system. Students learn fundamentals of the theory and practice of computer-aided control of equipment and data acquisition in an applied physics laboratory. Topics include introductory optical microscopy, analog-to-digital conversion and digital-to-analog conversion, hardware timing, error in digital systems, discrete Fourier analysis and sampling theorem. Data analysis is performed primarily using MATLAB or Python and instrument interfacing is using LabVIEW and serial communication protocols. (No prior knowledge of LabVIEW is required; LabVIEW basics will be learned through weekly laboratory activities rather than by formal instruction.) This course means to introduce students to the practice of scientific and engineering R&D, which includes stages of design, experimentation, and the communication of knowledge gained. Students will develop effective writing and communication skills both as a tool for practicing engineering design and for the dissemination of knowledge through a formal article.
Corequisites: ENGRC 3640.
Last Four Terms Offered: Fall 2022, Fall 2021
Learning Outcomes:

- Demonstrate an automated optical scanning microscope over the course of a semester-long laboratory project.
- Develop skills essential to the practice of modern computer-aided applied physics experimental design, including techniques for interfacing computers with scientific measurements using virtual instrument concepts, and methods for analyzing digital signals and uncertainties in measurements.
- Develop effective writing and communication skills both as a tool for practicing experimental design and for the dissemination of knowledge through a formal article.

Schedule of Classes (https://classes.cornell.edu/)

AEP 4130 - Introduction to Nuclear Science and Engineering (3 Credits)
Crosslisted with ECE 4130, CHEME 4130, MAE 4580
Introduces the fundamental concepts of nuclear science and engineering, including nuclear structure, radioactivity, nuclear reactions and the interaction of neutrons, charged particles, x-rays and gamma-rays with matter. Discusses the neutron chain reaction and its control in the core of a fission reactor. Different reactor designs are introduced and discussed along with their safety features. Other topics include radiation shielding and aspects of the nuclear fuel cycle, including isotope separation, fuel reprocessing, waste disposal and sustainability
Prerequisites: PHYS 2214 and MATH 2940.
Exploratory Studies: (CU-SBY)

Last Four Terms Offered: Fall 2023, Fall 2021, Fall 2020, Fall 2019
Learning Outcomes:

- Demonstrate basic conceptual understanding of atomic and nuclear physics, quantum mechanics and electrostatics relevant to the interaction of radiation with matter, and especially neutron interactions.
- Demonstrate a basic understanding o the fission process and neutron chain reactions.
- Know and understand the advantages and disadvantages of various combinations of fuel and other materials (moderator, coolant, structure) for safety and sustainability.
- Understand the design and operation of a nuclear reactor core as a critical or near critical mass of fissile and other materials in steady state and in times of slowly changing power.
- Demonstrate the ability to calculate the amount of fuel needed by a power reactor per year as well as the amount of nuclear waste that will be produced and its decay rate.
- Know and understand the interaction of radiation with biological systems and the consequences thereof, and methods of shielding to reduce radiation effects.
- Understand case histories of nuclear reactor accidents.

Schedule of Classes (https://classes.cornell.edu/)

AEP 4200 - Intermediate Mathematical Physics (4 Credits)
Covers Fourier and Laplace transforms, ordinary and partial differential equations, separation of variables, Method of Frobenius, Laplace transform techniques. Green's functions, wave and diffusion equations, Solutions to Laplace's Equation, Hermitian Operators, Sturm-Liouville operators, Bessel functions, Legendre Polynomials, spherical harmonics.
Enrollment Information: Recommended prerequisite: AEP 3200.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 4230 - Statistical Thermodynamics (4 Credits)
Crosslisted with PHYS 4230
Quantum statistical basis for equilibrium thermodynamics, microcanonical, canonical and grand canonical ensembles, and partition functions. Classical and quantum ideal gases, paramagnetic and multiple-state systems. Maxwell-Boltzmann, Fermi-Dirac, and Bose-Einstein statistics and applications. Introduction to systems of interacting particles. At the level of Introductory Statistical Mechanics by Bowley and Sanchez.
Enrollment Information: Recommended prerequires: junior level quantum mechanics, electricity and magnetism, and mathematics at the level of AEP 3610, AEP 3550, AEP 3200, and AEP 4200.
Distribution Requirements: (CHPH-AG, OPHLS-AG), (PHS-AS)
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 4300 - Advanced Mathematical Physics (3 Credits)
Covers integral equations, Friedholm equations, kernels, complex variable theory, branch points and cuts, Riemann sheets, method of steepest descent, method of constant phase, tensors, contravariant and covariant representations, group theory, matrix representations, class and character.
Enrollment Information: Recommended prerequisite: AEP 4200.
Last Four Terms Offered: Spring 2024, Spring 2021, Spring 2020
Schedule of Classes (https://classes.cornell.edu/)

AEP 4340 - Fluid and Continuum Mechanics (4 Credits)
Intro to elasticity (including stress and strain tensors and their linear relations for isotropic materials), very brief intro to plastic deformation, fluid properties and some hydrostatics, conservation laws with applications (including pipes), dimensional analysis, vorticity, ideal flow (including forms of Bernoulli equations and potential flow), flow past objects (including boundary layers, drag, lift, and model aerofoils), instabilities, a brief introduction to turbulence (including Reynolds stress from time averaging), some topics in compressible flow (including choking and shock waves).
Enrollment Information: Recommended prerequisite: AEP 3330, AEP 4200, AEP 3550, or equivalent, or permission of instructor.
Last Four Terms Offered: Spring 2025, Spring 2023, Spring 2022, Spring 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 4380 - Computational Engineering Physics (3 Credits)
Introduction to Numerical computation (e.g., derivatives, integrals, differential equations, matrices, boundary-value problems, FFT's, Monte Carlo methods) as applied to engineering physics problems that cannot be solved analytically (e.g., chaotic systems, three-body problem, electrostatic fields, quantum energy levels). C/C++ computer programming required (some Matlab, Python, etc.). Some prior exposure to programming assumed but no previous experience with C/C++ assumed.
Enrollment Information: Recommended prerequisites: AEP 3200, PHYS 2214 or PHYS 2218, CS 1110 or CS 1112, or equivalent, or permission of instructor. Recommended corequisite: AEP 3330, AEP 3610, AEP 4200.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 4400 - Nonlinear and Quantum Optics (3 Credits)
Introduction to the fundamentals of the interaction of laser light with matter, including a survey of phenomena and photonic devices based on these processes with relevance to modern science and technology. Topics include the origins of optical nonlinearities, propagation of laser beams and ultrashort pulses, harmonic generation, parametric amplification, nonlinearly guided waves and self-focusing, solitons, spontaneous and stimulated scattering, optical resonance and two-level atoms, multiphoton processes, and ultra-intense laser-matter interactions.
Enrollment Information: Recommended prerequisite: AEP 3560, AEP 3620, or equivalent.
Last Four Terms Offered: Spring 2025, Spring 2023, Spring 2022, Spring 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 4450 - Electromagnetic and Optical Metamaterials (3 Credits)
Crosslisted with ECE 4380
Introductory Senior-level course on electromagnetic and optical metamaterials. The properties of matter can be molded and tailored on subwavelength spatial scales yielding 'metamaterials' with properties very different from naturally occurring materials, thereby opening up new directions for applications. The course introduces the electromagnetic and optical properties of surface plasmons and polaritons, artificial magnetic materials, negative-index materials, nanostructured optical materials, etc. The course also discusses the applications of these materials in diverse areas including electromagnetic cloaking and invisibility, stealth technologies, optical super-lensing, bio-chemical sensing, conformal optics, meta-surfaces, and non-reciprocal devices.
Enrollment Information: Recommended prerequisite: ECE 3030 or AEP 3550 or permission of instructor.
Last Four Terms Offered: Spring 2025, Spring 2023, Spring 2022, Fall 2020
Schedule of Classes (https://classes.cornell.edu/)

AEP 4500 - Introductory Solid State Physics (4 Credits)
Crosslisted with PHYS 4454
Introduction to the physics of crystalline solids. Covers crystal structures; diffraction; electronic states and density functional theory; lattice vibrations; and metals, insulators, and semiconductors. Covers optical properties, magnetism, and superconductivity as time allows. The majority of the course addresses the foundations of the subject, but time is devoted to modern and/or technologically important topics such as quantum size effects. At the level of Introduction to Solid State Physics by Kittel or Solid State Physics by Ashcroft and Mermin.
Enrollment Information: Recommended prerequisite: PHYS 4443, AEP 3620, or CHEM 7930.
Distribution Requirements: (CHPH-AG, OPHLS-AG), (PHS-AS)
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 4700 - Biophysical Methods (3 Credits)
Crosslisted with BIONB 4700
Overview of the diversity of modern biophysical experimental techniques used in the study of biophysical systems at the molecular, cellular, and population level. Emphasis is placed on groundbreaking methods behind recent Nobel Prizes and other techniques likely to be encountered in cutting-edge research and industry. Topics include: 1) super-resolution, multi-photon, and single molecule microscopy, 2) crystallography and structural biology methods used to characterize DNA, RNA, proteins, cells, tissues, 3) microfluidics, lab-on-a-chip, and single cell culture techniques, 4) molecular dynamics simulations, stochastic modeling, and physical models of a cell, and 5) next-generation sequencing, protein engineering, synthetic biology, genome editing, and other experimental techniques at the intersection of applied physics and biological engineering.
Enrollment Information: Recommended prerequisite: solid knowledge of basic physics and mathematics through sophomore level.
Last Four Terms Offered: Fall 2021, Fall 2020, Fall 2019, Fall 2018
Schedule of Classes (https://classes.cornell.edu/)

AEP 4812 - Quantum Information Processing (3 Credits)
Crosslisted with PHYS 4481
Hardware that exploits quantum phenomena can dramatically alter the nature of computation. Though constructing a general purpose quantum computer remains a formidable technological challenge, there has been much recent experimental progress. In addition, the theory of quantum computation is of interest in itself, offering new perspectives on the nature of computation and information, as well as providing novel insights into the conceptual puzzles posed by quantum theory. This course is intended for physicists, unfamiliar with computational complexity theory or cryptography, and for computer scientists and mathematicians with prior exposure to quantum mechanics. Topics include: simple quantum algorithms, error correction, cryptography, teleportation, and uses of quantum computing devices either currently available or to be available in the near future.
Enrollment Information: Recommended prerequisite: a prior course in quantum mechanics (such as PHYS 3316 or AEP 3610).
Distribution Requirements: (CHPH-AG, OPHLS-AG), (PHS-AS, SMR-AS)
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 4840 - Introduction to Controlled Fusion: Principles and Technology (3 Credits)
Crosslisted with ECE 4840, MAE 4590
Introduction to the physical principles and various engineering aspects underlying power generation by controlled fusion. Topics include: fuels and conditions required for fusion power and basic fusion-reactor concepts, fundamental aspects of plasma physics relevant to fusion plasmas and basic engineering problems for a fusion reactor, and an engineering analysis of proposed magnetic and/or inertial confinement fusion-reactor designs.
Enrollment Information: Recommended prerequisite: one of the following: PHYS 1112, PHYS 2213, PHYS 2214, or equivalent background in electricity and magnetism and mechanics.
Exploratory Studies: (CU-SBY)

Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:

- Understand the scientific basis for controlled fusion by both magnetic confinement and inertial confinement approaches, as well as the technological requirements for practical electric power generation by the controlled fusion process.
- Be able determine the energy release of any nuclear reaction or reaction chain using the mass-energy relationship, and be able to solve well-posed engineering problems in plasma physics as applied to controlled fusion using Maxwell's equations and the equations of motion of charged particles in electric and magnetic fields.
- Be able to solve well-posed engineering problems in energy generation by controlled fusion having to do with the properties of materials in the presence of neutron irradiation and other relevant processes.
- Understand the fundamental role played by energy in our society and in the developing world, the potential role fusion can play, and the reasons that it is potentially more attractive than fission-based electric power generation.
- Be able to determine the state-of-the-art of different aspects of fusion reactor design by independent study using books, journals, conference proceedings, reports on the web and personal communication with experts.

Schedule of Classes (https://classes.cornell.edu/)

AEP 4900 - Undergraduate Research in Engineering Physics (1-6 Credits)
Laboratory or theoretical work in any branch of engineering physics under the direction of a member of the faculty. The study can take a number of forms; for example, design of laboratory apparatus, performance of laboratory measurements, computer simulation or software developments, theoretical design and analysis. Details TBD with respective faculty member.
Exploratory Studies: (CU-UG)

Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

AEP 4910 - Honors Research in Engineering Physics (2-6 Credits)
Laboratory or theoretical work in any branch of engineering physics under the direction of a member of the faculty. The study can take a number of forms; for example, design of laboratory apparatus, performance of laboratory measurements, computer simulation or software developments, theoretical design and analysis. A written report, an oral presentation and at least a grade of A- is required for successful completion of the Engineering Physics honors requirement.
Exploratory Studies: (CU-UG)

Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

AEP 5100 - Introductory Mathematical Physics (4 Credits)
Covers review of vector analysis, tensor calculus, Dirac Delta functions, complex variable theory, Cauchy-Rieman conditions, complex Taylor and Laurent series, Cauchy integral formula and residue techniques, conformal mapping, calculus of variations, Fourier Series.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

AEP 5200 - Intermediate Mathematical Physics (4 Credits)
Covers Fourier and Laplace transforms, ordinary and partial differential equations, separation of variables, Method of Frobenius, Laplace transform techniques. Green's functions, wave and diffusion equations, Solutions to Laplace's Equation, Hermitian Operators, Sturm-Liouville operators, Bessel functions, Legendre Polynomials, spherical harmonics.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 5230 - Statistical Thermodynamics (4 Credits)
Quantum statistical basis for equilibrium thermodynamics, microcanonical, canonical and grand canonical ensembles, and partition functions. Classical and quantum ideal gases, paramagnetic and multiple-state systems. Maxwell-Boltzmann, Fermi-Dirac, and Bose-Einstein statistics and applications. Introduction to systems of interacting particles. At the level of Introductory Statistical Mechanics by Bowley and Sanchez.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 5300 - Advanced Mathematical Physics (3 Credits)
Covers integral equations, Friedholm equations, kernels, complex variable theory, branch points and cuts, Riemann sheets, method of steepest descent, method of constant phase, tensors, contravariant and covariant representations, group theory, matrix representations, class and character.
Last Four Terms Offered: Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

AEP 5310 - Introductory Quantum Computing (3 Credits)
An introduction to quantum computing for students who have not necessarily had prior exposure to quantum mechanics. This course is intended for physicists, electrical engineers, and computer scientists. Topics include: foundational algorithmic building blocks and quantum algorithms; variational quantum algorithms (for physics simulation and for combinatorial optimization); quantum machine learning; basic physics of quantum computing hardware implementation. There will be substantial programming exercises implementing quantum algorithms to run on simulators and quantum computers in the cloud.
Prerequisites: MATH 2940 or equivalent, and CS 1110 or equivalent exposure to Python.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023
Learning Outcomes:

- Students will be able to understand and have the knowledge to implement core quantum algorithms.
- Students will be able to apply some of the quantum algorithms studied to new application problems.
- Students will be able to explain key challenges in constructing quantum computers and in running quantum algorithms on current quantum computers.

Schedule of Classes (https://classes.cornell.edu/)

AEP 5330 - Mechanics of Particles and Solid Bodies (4 Credits)
Newtonian mechanics, especially with dissipative forces; objects rotating around a constant direction and possibly translating, using both torque and energy; coupled and damped-driven linear oscillations and an introduction to nonlinear systems; an introduction to variational calculus; Lagrangian and Hamiltonian formalism for generalized coordinates; central-force motion and a brief introduction to scattering; non-inertial reference systems; 3D motion of rigid bodies. (At the level of Classical Dynamics by Marion and Thornton and Classical Mechanics by John Taylor).
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 5340 - Fluid and Continuum Mechanics (4 Credits)
Intro to elasticity (including stress and strain tensors and their linear relations for isotropic materials), very brief intro to plastic deformation, fluid properties and some hydrostatics, conservation laws with applications (including pipes), dimensional analysis, vorticity, ideal flow (including forms of Bernoulli equations and potential flow), flow past objects (including boundary layers, drag, lift, and model aerofoils), instabilities, a brief introduction to turbulence (including Reynolds stress from time averaging), some topics in compressible flow (including choking and shock waves).
Last Four Terms Offered: Spring 2025, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

AEP 5380 - Computational Engineering Physics (3 Credits)
Introduction to Numerical computation (e.g., derivatives, integrals, differential equations, matrices, boundary-value problems, FFT's, Monte Carlo methods) as applied to engineering physics problems that cannot be solved analytically (e.g., chaotic systems, three-body problem, electrostatic fields, quantum energy levels). C/C++ computer programming required (some Matlab, Python, etc.). Some prior exposure to programming assumed but no previous experience with C/C++ assumed.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 5400 - Nonlinear and Quantum Optics (3 Credits)
Introduction to the fundamentals of the interaction of laser light with matter, including a survey of phenomena and photonic devices based on these processes with relevance to modern science and technology. Topics include the origins of optical nonlinearities, propagation of laser beams and ultrashort pulses, harmonic generation, parametric amplification, nonlinearly guided waves and self-focusing, solitons, spontaneous and stimulated scattering, optical resonance and two-level atoms, multiphoton processes, and ultra-intense laser-matter interactions.
Last Four Terms Offered: Spring 2025, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

AEP 5500 - Applied Solid State: Physics of Renewable Energy (3 Credits)
Can an electric vehicle be made cheaper than a gasoline one with comparable range? How much of our energy needs can be supplied by solar energy? What is the maximum efficiency of a solar cell? Graduate-level analysis of renewable energy devices and materials that you will likely encounter in research or advanced industrial settings, with a goal of understanding their ultimate limits, current efficiencies and opportunities for improvement. The main emphasis is on electrical energy creation, conversion and storage devices - Solar Cells, Fuel Cells, Batteries, Supercapacitors and Thermoelectrics, which are areas of current research at Cornell.
Enrollment Information: Recommended prerequisite: a knowledge of Fermi-Dirac distributions and chemical potentials e.g. from a class in either solid state physics, physical chemistry or statistical mechanics.
Exploratory Studies: (CU-SBY)

Last Four Terms Offered: Spring 2022, Spring 2020, Spring 2018, Spring 2017
Schedule of Classes (https://classes.cornell.edu/)

AEP 5502 - Introductory Solid State Physics (4 Credits)
Introduction to the physics of crystalline solids. Covers crystal structures; diffraction; electronic states and density functional theory; lattice vibrations; and metals, insulators, and semiconductors. Covers optical properties, magnetism, and superconductivity as time allows. The majority of the course addresses the foundations of the subject, but time is devoted to modern and/or technologically important topics such as quantum size effects. At the level of Introduction to Solid State Physics by Kittel or Solid State Physics by Ashcroft and Mermin.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 5510 - Symmetry and Equivariance (3 Credits)
A self-contained pedagogical introduction to Groups acting-on things like sets, modules, vector spaces, manifolds, and other groups, and to the Morphisms and Equivariant Functions between them. The course will intertwine ideas on the Structure of (mostly finite-order) Groups with those on their Representation, making judicious use of Equivalence Relations throughout. In contrast to the usual pedagogy, we will organize the course around the question of where do groups live in physics. Specific examples will vary from year to year but include: Translational and Rotational Symmetry - Isometry, orbits & stabilizers; gauges, wavefunctions, & boundary conditions - U(1) and its finite-order Cyclic subgroups, Character Theory & the Group Algebra; Bloch & Wannier Functions - Morphisms b/w group actions, Pontryagin Duality; Molecules & Bonding - Point Groups, Permutation& Induced Reps; Selection Rules & Tensors - Irreps & Schur's Lemma; Spin-1/2 and Angular Momentum - Complex Numbers, Quaternions, Projective Spaces, groups acting on n-Spheres & Covers.
Enrollment Information: Recommended prerequisite: AEP 3610, AEP 3200, AEP 4200 or equivalent.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

AEP 5550 - Intermediate Electromagnetism (4 Credits)
Intermediate-level course on electromagnetic theory with a focus on statics. Vector calculus, electrostatics, conductors, dielectric materials, boundary conditions, solutions to Laplace's equation, magnetostatics, quasistatic conditions, Maxwell equations, Poynting theorem, Maxwell Stress tensor, EM wave, polarization, energy, momentum. Emphasis is on developing proficiency with analytical techniques and intuitive understanding of fundamental electromagnetism.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

AEP 5555 - Gaining Intuition Through Symmetry and Computation (3 Credits)
Applied Group Theory. Focus is on the symmetry of geometrical objects, both as abstract objects (up to an isomorphism) and embedded in a physical space (up to a conjugation) such as the Crystallographic Groups. Topics will include: Group Actions (on Sets & Vector Spaces), Numbers & Groups, Permutations & the Symmetric Group, Orbit-Stabilizer Theorem, Regular Objects in 2d/3d & the Platonic solids, applications to problems in physics.
Prerequisites: AEP 3200 or AEP 5100.
Enrollment Information: Enrollment limited to: graduate students.
Last Four Terms Offered: Fall 2022, Fall 2021, Fall 2020
Schedule of Classes (https://classes.cornell.edu/)

AEP 5560 - Intermediate Electrodynamics (4 Credits)
Second course in theory of electromagnetism: Magnetic materials, Faraday's law, Maxwell equations, electromagnetic waves, reflection and transmission, guided waves, and radiation.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 5610 - Introductory Quantum Mechanics (4 Credits)
Introductory course in quantum mechanics. Topics include Schrodinger's equation and the statistical interpretation of the wavefunction, potentials in 1 to 3 dimensions, Dirac notation and Hilbert space, ladder operators for harmonic potentials and angular momentum, exact solutions for the hydrogen atom and spin systems. Emphasis is on developing both an intuitive understanding of quantum mechanics and how to apply it rigorously.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 5620 - Intermediate Quantum Mechanics (4 Credits)
Continuation of AEP 5610 covering more advanced material in quantum mechanics. Topics include operator formalism and matrix representation, angular momentum and spin, the hydrogen atom, techniques for solving Schrodinger's equation including perturbation theory, two- and three-level systems, interaction with radiation, and identical particles.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

AEP 5640 - Modern Applied Physics Experimental Design (3 Credits)
Overview of the diversity of modern biophysical experimental techniques used in the study of biophysical systems at the molecular, cellular, and population level. Emphasis is placed on groundbreaking methods behind recent Nobel Prizes and other techniques likely to be encountered in cutting-edge research and industry. Topics include: 1) super-resolution, multi-photon, and single molecule microscopy, 2) crystallography and structural biology methods used to characterize DNA, RNA, proteins, cells, tissues, 3) microfluidics, lab-on-a-chip, and single cell culture techniques, 4) molecular dynamics simulations, stochastic modeling, and physical models of a cell, and 5) next-generation sequencing, protein engineering, synthetic biology, genome editing, and other experimental techniques at the intersection of applied physics and biological engineering.
Last Four Terms Offered: Fall 2021
Learning Outcomes:

- Demonstrate an automated optical scanning microscope over the course of a semester-long laboratory project.
- Develop skills essential to the practice of modern computer-aided applied physics experimental design, including techniques for interfacing computers with scientific measurements using virtual instrument concepts, and methods for analyzing digital signals and uncertainties in measurements.
- Develop effective writing and communication skills both as a tool for practicing experimental design and for the dissemination of knowledge through a formal article.

Schedule of Classes (https://classes.cornell.edu/)

AEP 5700 - Biophysical Methods (3 Credits)
Overview of the diversity of modern biophysical experimental techniques used in the study of biophysical systems at the molecular, cellular, and population level. Emphasis is placed on groundbreaking methods behind recent Nobel Prizes and other techniques likely to be encountered in cutting-edge research and industry. Topics include: 1) super-resolution, multi-photon, and single molecule microscopy, 2) crystallography and structural biology methods used to characterize DNA, RNA, proteins, cells, tissues, 3) microfluidics, lab-on-a-chip, and single cell culture techniques, 4) molecular dynamics simulations, stochastic modeling, and physical models of a cell, and 5) next-generation sequencing, protein engineering, synthetic biology, genome editing, and other experimental techniques at the intersection of applied physics and biological engineering.
Last Four Terms Offered: Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 6060 - Introduction to Plasma Physics (4 Credits)
Crosslisted with ECE 5810, EAS 5810
Topics include plasma state; motion of charged particles in fields; drift-orbit theory; coulomb scattering, collisions; ambipolar diffusion; elementary transport theory; two-fluid and hydromagnetic equations; plasma oscillations and waves, CMA diagram; hydromagnetic stability; and elementary applications to space physics, plasma technology, and controlled fusion.
Enrollment Information: Enrollment limited to: graduate students and exceptional seniors. Recommended prerequisite: ECE 3030 or equivalent.
Last Four Terms Offered: Fall 2023, Fall 2022, Fall 2021, Fall 2020
Schedule of Classes (https://classes.cornell.edu/)

AEP 6610 - Nanocharacterization (3 Credits)
Graduate-level introduction to the tools used to image and probe optical, electronic, chemical, and mechanical properties at the atomic and nano scales.
Enrollment Information: Recommended prerequisite: assumed knowledge includes, basic electromagnetism and undergraduate chemistry or quantum mechanics.
Last Four Terms Offered: Spring 2023, Spring 2021, Spring 2019, Spring 2018
Schedule of Classes (https://classes.cornell.edu/)

AEP 7510 - M.Eng. Project (3-12 Credits)
Independent study under the direction of a member of the university faculty. Students participate in an independent research project through work on a special problem related to their field of interest. A formal and complete research report is required.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

AEP 7530 - Special Topics Seminar in Applied Physics (1 Credit)
Special topics in applied science, with focus on areas of applied physics and engineering that are of current interest. Subjects chosen are presented in a seminar format by the students. A major goal of this course is to provide training and experience planning, preparing, and presenting proposals, progress reports, technical talks, and research papers.
Prerequisites: undergraduate physics.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 7540 - Special Topics in Applied Physics (1 Credit)
Special topics in applied science, with focus on areas of applied physics and engineering that are of current interest. Subjects chosen are presented in a seminar format by the students. A major goal of this course is to provide training and experience planning, preparing, and presenting proposals, progress reports, technical talks, and research papers.
Prerequisites: undergraduate physics.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

AEP 7681 - Quantum Information Processing (3 Credits)
Crosslisted with PHYS 7681
Hardware that exploits quantum phenomena can dramatically alter the nature of computation. Though constructing a general purpose quantum computer remains a formidable technological challenge, there has been much recent experimental progress. In addition, the theory of quantum computation is of interest in itself, offering new perspectives on the nature of computation and information, as well as providing novel insights into the conceptual puzzles posed by quantum theory. This course is intended for physicists, unfamiliar with computational complexity theory or cryptography, and for computer scientists and mathematicians with prior exposure to quantum mechanics. Topics include: simple quantum algorithms, error correction, cryptography, teleportation, and uses of quantum computing devices either currently available or to be available in the near future.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

AEP 8200 - Graduate Thesis (1-15 Credits)
Thesis research for applied physics graduate students.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)