# PHYSICS (PHYS)

**PHYS 1012 - Physics 1112 Supplement (1 Credit)**
Provides auxiliary instruction and practice for PHYS 1112 and promotes a deep understanding of basic concepts in mechanics. Recommended for students who seek additional opportunities to engage with course content, to gain confidence in applying physics principals, or to develop their problem-solving skills. Class time is also spent exploring real-life applications and discussing strategies for successful learning and performance in PHYS 1112 .
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 1013 - Physics 2213 Supplement (1 Credit)**
Provides auxiliary instruction and practice for PHYS 2213 and promotes a deep understanding of basic concepts in electromagnetism. Recommended for students who seek additional opportunities to engage with course content, to gain confidence in applying physics principals, or to develop their problem-solving skills. Class time is also spent exploring real-life applications and discussing strategies for successful learning and performance in PHYS 2213 .
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 1090 - Foundation Physics (0 Credits)**
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 1091 - Fundamentals of Physics (3 Credits)**
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2023, Fall 2022
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**PHYS 1101 - General Physics I (4 Credits)**
PHYS 1101 and PHYS 1102 emphasize both quantitative and conceptual understanding of the topics and tools of introductory physics developed without the use of calculus. The courses offer individualized instruction. Students learn through completing assigned readings, problems, and laboratory exercises, and through individualized tutoring. Additionally, recorded lectures, overview sessions, short videos, sample tests, and one-on-one tutorials are provided. The course format provides flexibility, but in some ways is more demanding than a course with a traditional format. Success requires discipline and well-developed study habits. Students without high school physics should allow extra time. Evaluation includes an oral lab check, a selection of graded homework problems, and a written test for each unit; these must be completed within a flexible set of deadlines. Major topics for PHYS 1101: forces and equilibrium, kinematics, dynamics, momentum, energy, fluid mechanics, waves and sound, thermal physics, and thermodynamics. At the level of College Physics, 5th edition, by Giambattista.
**Prerequisites:** three years of high school mathematics, including trigonometry.
**Forbidden Overlaps:** PHYS 1101, PHYS 1112, PHYS 2207
**Enrollment Information:** Not open to: first-year students.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG, PSC-AG), (PHS-AS), (SCT-IL)
**Last Four Terms Offered:** Fall 2025, Summer 2025, Fall 2024, Summer 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 1102 - General Physics II (4 Credits)**
PHYS 1101 and PHYS 1102 emphasize both quantitative and conceptual understanding of the topics and tools of introductory physics developed without the use of calculus. The courses offer individualized instruction. Students learn through completing assigned readings, problems, and laboratory exercises, and through individualized tutoring. Additionally, recorded lectures, overview sessions, short videos, sample tests, and one-on-one tutorials are provided. The course format provides flexibility, but in some ways is more demanding than a course with a traditional format. Success requires discipline and well-developed study habits. Students without high school physics should allow extra time. Evaluation includes an oral lab check, a selection of graded homework problems, and a written test for each unit; these must be completed within a flexible set of deadlines. Major topics for PHYS 1102: electric and magnetic forces and fields, electric currents and circuits, electromagnetic induction, alternating current, electromagnetic waves, optics, interference and diffraction, relativity, quantum physics, and nuclear physics. At the level of College Physics, 5th edition, by Giambattista.
**Prerequisites:** PHYS 1101 or PHYS 1112 or PHYS 2207 or at least a 5 on the AP Physics exam.
**Forbidden Overlaps:** AEP 2170, PHYS 1102, PHYS 2208, PHYS 2213, PHYS 2217
**Enrollment Information:** Not open to: first-year students.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG, PSC-AG), (PHS-AS), (SCT-IL)
**Last Four Terms Offered:** Summer 2025, Spring 2025, Summer 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 1110 - Introduction to Experimental Physics (1 Credit)**
This laboratory course is an introduction to the nature and skills of experimentation in physics. Students will engage in multi-week investigations, creatively design their own experiments, and explore questions of how we develop models in physics through experiments. Students will learn how to design experiments, analyze data, develop interesting research questions, and consider issues of ethics in physics experiments. Students will also develop communication and collaboration skills. The course aims to provide an opportunity for students to consider the nature of measurement and experimentation and evaluate the relationship between physical theories and experimental data.
**Corequisites:** PHYS 1112 or PHYS 1116, or PHYS 2213 or PHYS 2217, or if you have AP, Advanced Standing Exam, or transfer credit without lab credit for these courses. Students who take PHYS 1110 with PHYS 1112 or PHYS 1116 will not need to re-take PHYS 1110 with PHYS 2213 or PHYS 2217 .
**Distribution Requirements:** (SCT-IL)
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 1112 - Physics I: Mechanics and Heat (3 Credits)**
First course in a three-semester introductory physics sequence. This course is taught in a largely flipped', highly interactive manner, with reading preparation and online reading quizzes required for class. Covers the mechanics of particles with focus on kinematics, dynamics, conservation laws, central force fields, periodic motion. Mechanics of many-particle systems: center of mass, rotational mechanics of a rigid body, translational & rotational equilibrium. Temperature, heat, the laws of thermodynamics. At the level of University Physics, Vol. 1, by Young and Freedman.
**Prerequisites:** MATH 1910 or MATH 1120. Recommended corequisite: MATH 1920 in order to continue with PHYS 2213 the following semester. Corequisite: PHYS 1110 must be taken to remain enrolled in PHYS 1112. MATH 1910 may be allowed by instructor in exceptional cases, but continuation in PHYS 2213 will then have to be deferred until MATH 1920 is completed.
**Forbidden Overlaps:** PHYS 1101, PHYS 1112, PHYS 2207
**Enrollment Information:** Primarily for: students in Engineering, Physics or related subjects.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG, PSC-AG), (PHS-AS), (SCT-IL)
**Last Four Terms Offered:** Fall 2025, Summer 2025, Spring 2025, Fall 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 1116 - Physics I: Mechanics and Special Relativity (4 Credits)**
First in a three-semester introductory physics sequence. Explores quantitative modeling of the physical world through a study of mechanics. More mathematical than a typical mechanics course - for example, considers how choice of coordinate system (Cartesian, cylindrical, etc.) influences the nature of kinematical equations. Includes kinematics, dynamics, conservation laws, central force fields, periodic motion, and special relativity. At the level of An Introduction to Mechanics by Kleppner and Kolenkow, which assumes a strong mathematical foundation in calculus.
**Corequisites:** PHYS 1110 must be taken to remain enrolled in PHYS 1116. Prerequisite: students must have Calculus II credit (AP Calculus BC, MATH 1910, MATH 1120, or equivalent). A strong high school math and physics course background (at the AP/IB level or equivalent) is expected.
**Forbidden Overlaps:** PHYS 1116, PHYS 2216
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS)
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
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**PHYS 1190 - Introductory Laboratory (Transfer Supplement) (1 Credit)**
Students perform the laboratory component of one of the introductory courses ( PHYS 1101 , PHYS 1102 , PHYS 2207, PHYS 2208, PHYS 2214) to complement the lecture-related course credit acquired elsewhere. Those wishing to take equivalent of one of these introductory courses at another institution should receive prior approval from the physics director of undergraduate studies.
**Prerequisites:** three transfer credits for introductory physics lecture material and a degree requirement for laboratory component of that introductory course.
**Distribution Requirements:** (OPHLS-AG)
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 1199 - Introduction to Physics: Classical Mechanics (3 Credits)**
The course prepares students for the faster paced PHYS 2299 - Fundamentals of Physics for Premed Students. The course is not calculus based, and it does not include a laboratory component. The topics include Classical Mechanics and conservation laws. This course does not satisfy nor substitute for any Pre-Medical coursework at WCM-Q or elsewhere.
**Enrollment Information:** Enrollment limited to: Weill Cornell Medicine-Qatar students.
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 1201 - Why the Sky Is Blue: Aspects of the Physical World (4 Credits)**
One of the existential problems of our time is telling the difference between something that is fake and something that is real. Physics can be a powerful tool for making such distinctions because it provides physical laws that cannot be violated. In this class you will learn about these laws and how to use them to analyze everyday phenomena. Aimed specifically at the nonscience student, this course will examine the principles of physics from a conceptual point of view, with emphasis on the methodology of science and the nature of evidence.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS), (SCT-IL)
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 1203 - Physics of the Heavens and the Earth (4 Credits)**
This course offers an opportunity to discuss fundamental ideas about the physical world, the applications of these ideas to big questions in modern physics, and the relationship between physics, fundamental science, and society. By the end of the course, students will be able to: 1) Describe and discuss fundamental concepts in physics such as forces, linear and rotational motion, and energy, 2) Apply those fundamental physics concepts to discuss cutting edge physics ideas such as special and general relativity, quantum mechanics, gravitational waves, black holes, and particle physics, 3) Use examples of historical investigations to explore how scientific knowledge develops and evolves over time, 4) Consider how fundamental physics relates to students' major and career interests and to society more broadly, such as to debate the role and funding of fundamental research, understand issues of representation and diversity in science, and evaluate how science is perceived by the public, and 5) Not immediately respond I hate physics and maybe even look back fondly or be inspired to learn more beyond this course.
**Enrollment Information:** Primarily for: non-science majors.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS), (SCT-IL)
**Last Four Terms Offered:** Spring 2025, Spring 2024, Spring 2021, Spring 2020
**Learning Outcomes:**

- How science is done and what the scientific process is.
- Understanding of force, acceleration, velocity, and position, as well as how they relate to each other at the level applicable to every-day life.
- A high-level understanding of modern physics, including special and general relativity, quantum mechanics and particle physics. In particular, an understanding of the technologies these physics ideas have created.

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**PHYS 1204 - Physics of Musical Sound (4 Credits)**
Crosslisted with MUSIC 1466
This course explores the physics of musical sound. How and what do our ears hear? How does that determine the kinds of sounds we find pleasant and not so pleasant? How is sound generated by strings, pipes, and plates, and what determines the characteristics - pitch, timbre, attack, consonance, or dissonance - of that sound? How do the major families of musical instruments (string, wind, reed, brass, percussion) and specific examples (violin, guitar, piano, flute, oboe, trumpet, chimes, pipe organ) work, and how does that affect how they are played and the sounds they produce? How do we generate sound when we sing, and how does that vary in different kinds of singing? What makes for a good concert hall or listening space? These are explained using physical and mathematical concepts including vibrations, standing waves, harmonic series, beats, spectra, and logarithms, and illustrated using demonstrations, audio clips, and musical selections from a wide variety of genres. This course is a Writing In The Majors course: both science writing and physics problem-solving skills are developed through weekly assignments. Student activities include hands-on investigations of musical instruments and field trips. Students can expect to gain facility with physical and mathematical ideas having broad applicability; with music theory and psychoacoustics; and with their combined application to musical sound and how it is generated. At the level of The Science of Sound by Rossing, Moore, and Wheeler. (MT)
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS), (SCT-IL)
**Last Four Terms Offered:** Spring 2023, Spring 2022, Spring 2021, Spring 2020
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 1205 - The Physics of Sailing (3 Credits)**
This course teaches quantitative reasoning by combining the science and technology of sailboats with an outdoors experience of its practical application. A basic mathematics and physics education is a prerequisite. Topics will include: wind power, boat types, sail plans, winches and pulleys; keels; propelling and resistive forces; water waves and hull speed; real and apparent wind velocity; the wind rose; weather formations; heaving to and storm techniques; knots and why they work; and water waves. Experimental projects performed on Cayuga Lake include measuring phase and group velocities, the wind rose, and the hull speed, to compare to data sheets.
**Prerequisites:** students must be able to swim (75 yds or equivalent to university swim test requirement).
**Course Fee:** Course Fee, $500. Course fee.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS)
**Last Four Terms Offered:** Fall 2025, Fall 2024
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**PHYS 2207 - Fundamentals of Physics I (4 Credits)**
Physics 2207-PHYS 2208 is a two-semester introductory physics sequence with lab. The first course, Physics 2207, builds the foundations for quantitatively modeling the world around us and reasoning about physical phenomena. These skills are developed in the context of mechanics, thermodynamics, fluid mechanics, and waves. Includes applications from the sciences, medicine, and everyday life. Taught at the level of College Physics by Knight, Jones, and Field.
**Prerequisites:** high school physics plus MATH 1110 or MATH 1106, or solid understanding of the basic concepts of introductory calculus.
**Forbidden Overlaps:** PHYS 1101, PHYS 1112, PHYS 2207
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS), (SCT-IL)
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 2208 - Fundamentals of Physics II (4 Credits)**
PHYS 2208 follows PHYS 2207 in the two-semester introduction to physics intended for students majoring in biological science, physical science, or mathematics. PHYS 2208 provides a rich exposure to the methods of physics and to the basic analytical and scientific skills required by all scientists. Lectures are highly interactive and illustrated with applications from the sciences, medicine, and everyday life. Labs highlight lecture topics via a hands-on environment. Recitation sections reinforce the lecture topics via cooperative problem-solving. The course content includes electricity and magnetism, electric circuits, waves, optics, and topics from quantum mechanics, atomic physics, nuclear physics, and particle physics. The course is taught at the level of "College Physics" by Knight, Jones, and Field. If you have not had calculus, or do not feel confident with calculus, you are likely to still be able to succeed in this course. We encourage anyone who is unsure to reach out to the instructor to discuss the math level of the class.
**Prerequisites:** PHYS 2207 or PHYS 1112 or PHYS 1101; and MATH 1110 or MATH 1106 or high school calculus.
**Forbidden Overlaps:** AEP 2170, PHYS 1102, PHYS 2208, PHYS 2213, PHYS 2217
**Enrollment Information:** Discuss with the lead instructor or an academic advisor if you plan to take this course after PHYS 1101, as materials covered may differ from PHYS 2207.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS), (SCT-IL)
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
**Learning Outcomes:**

- Define fundamental physics principles, quantities, and relationships between quantities associated with electricity and magnetism and waves in words, using diagrams, and with mathematical symbols.
- Generate, make sense of, evaluate, and apply mathematical models to describe the world around you, including familiar and novel contexts. Mathematical models can be symbolic and graphical representations, as well as models of experimental data.
- Use a small set of tools together to solve a wide variety of unfamiliar problems flexibly; make a plan and solve problems for which there is no single correct, or obvious, procedure to use.
- Describe the interdisciplinary nature of science and draw connections between physics, biology, chemistry, and other sciences as well as everyday life.

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

**PHYS 2210 - Exploring Experimental Physics (1 Credit)**
In this laboratory course, students will build on the knowledge and skills developed in Physics 1110 (Introduction to Experimental Physics) to conduct semester-long experimental physics projects. Students will work in lab project teams to iteratively develop a research question, write a proposal that is reviewed by their peers and experts, engage for multiple weeks with their project, and present their findings in a public poster session at the end of the semester. Students will learn additional skills in experimental design and data analysis, with broader focuses on how to generate interesting, testable, and feasible research questions, how to provide critical and constructive feedback to others, and how to present research to a broad audience. The course provides an early opportunity for students to get a glimpse of experimental physics research, employ creativity to generate an answer to a novel research question and/or design a unique experimental approach.
**Prerequisites:** PHYS 1110.
**Corequisites:** PHYS 2218.
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
**Learning Outcomes:**

- Collect data and revise an experimental procedure iteratively and reflectively.
- Evaluate the process and outcomes of an experiment quantitatively and qualitatively.
- Extend the scope of an investigation whether or not results come out as expected.
- Communicate the process and outcomes of an experiment.
- Conduct an experiment collaboratively and ethically.

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**PHYS 2213 - Physics II: Electromagnetism (4 Credits)**
Second course in a three semester introductory physics sequence. The course emphasizes active learning during class. Video lectures are viewed before class; most class time is devoted to problem-solving. Topics include: electric forces and fields, Gauss' Law, electric energy and potential, DC and AC circuits, magnetic forces and fields, Ampere's Law, magnetic induction, and Maxwell's equations. University Physics, Vol. 2, by Young and Freedman. The math prerequisite is essential: vector dot and cross products, as well as line, surface, and volume integrals are done routinely.
**Prerequisites:** PHYS 1112 (or strong performance in PHYS 2207) and one of MATH 1920, MATH 2220, or MATH 2240.
**Forbidden Overlaps:** AEP 2170, PHYS 1102, PHYS 2208, PHYS 2213, PHYS 2217
**Enrollment Information:** Primarily for: students of engineering, physics and related disciplines.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG, PSC-AG), (PHS-AS), (SCT-IL)
**Last Four Terms Offered:** Fall 2025, Summer 2025, Spring 2025, Fall 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 2214 - Physics III: Oscillations, Waves, and Quantum Physics (4 Credits)**
For majors in engineering (including bio-, civil, and environmental engineering), computer and information science, physics, earth and atmospheric science, and other physical and biological sciences who wish to understand the oscillation, wave, and quantum phenomena behind everyday experiences and modern technology including scientific/medical instrumentation. Covers the physics of oscillations and wave phenomena, including driven oscillations and resonance, mechanical waves, sound waves, electromagnetic waves, standing waves, Doppler effect, polarization, wave reflection and transmission, interference, diffraction, geometric optics and optical instruments, wave properties of particles, particles in potential wells, light emission and absorption, and quantum tunneling. With applications to phenomena and measurement technologies in engineering, the physical sciences, and biological sciences. Some familiarity with differential equations, complex representation of sinusoids, and Fourier analysis is desirable but not essential. As with PHYS 1112 and PHYS 2213, pre-class preparation involves reading notes and/or watching videos, and in-class activities focus on problem solving, demonstrations, and applications.
**Prerequisites:** PHYS 2213 (or strong performance in PHYS 2208), plus vector calculus at the level of one of the following: MATH 1920, MATH 2220, or MATH 2240.
**Forbidden Overlaps:** PHYS 2214, PHYS 2218
**Enrollment Information:** Primarily for: students of Engineering, Physics, and Physical Sciences and related disciplines.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS)
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 2216 - Introduction to Special Relativity (1 Credit)**
Introduction to Einstein's Theory of Special Relativity, including Galilean and Lorentz transformations, the concept of simultaneity, time dilation and Lorentz contraction, the relativistic transformations of velocity, momentum and energy, and relativistic invariance in the laws of physics. At the level of An Introduction to Mechanics by Kleppner and Kolenkow.
**Prerequisites:** PHYS 1112 or PHYS 2207 or permission of instructor.
**Forbidden Overlaps:** PHYS 1116, PHYS 2216
**Distribution Requirements:** (OPHLS-AG)
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 2217 - Physics II: Electricity and Magnetism (4 Credits)**
Crosslisted with AEP 2170
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:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 2218 - Physics III: Waves and Thermal Physics (3 Credits)**
This course is divided into two parts. The larger segment of the course typically focuses on wave phenomena. Topics include: coupled harmonic oscillators, strings, sound and light waves, superposition principle, wave equations, Fourier series and transforms, diffraction and interference. The discussion is at the level of The Physics of Waves by Georgi. The second segment of the course covers thermodynamics and statistical mechanics at the level of Thermal Physics by Schroeder.
**Corequisites:** PHYS 2210 must be taken to remain enrolled in PHYS 2218.
Prerequisite: PHYS 2217 or very strong performance in PHYS 2213. Students would benefit from prior exposure to differential equations at the level of MATH 2930 or from concurrent enrollment in that course. Some linear algebra may be used, either prior or concurrent enrollment in linear algebra is recommended (MATH 2940, MATH 2210, or MATH 2230).
**Forbidden Overlaps:** PHYS 2214, PHYS 2218
**Enrollment Information:** Intended mainly but not exclusively for: prospective majors in Physics, Astronomy, or Engineering Physics.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS)
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 2299 - Fundamentals of Physics for Premed Students (4 Credits)**
This course provides a rich exposure to the methods of physics and to basic analytical and scientific communication skills. The course content includes mechanics, conservation laws, oscillations and waves, electricity and magnetism, X-rays, and nuclear physics. Special emphasis is placed on the application of physics to human physiology.
**Enrollment Information:** Enrollment limited to: Qatar premedical students planning to enroll in a physiology course sequence.
**Last Four Terms Offered:** Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 3310 - Intermediate Experimental Physics (3 Credits)**
Would you find it appealing to operate a physical system that allows you to sharply distinguish between rational and irrational numbers? How about using a microwave thermometer to measure the temperature of a distant object namely the sun's outer surface? Would you like to measure fundamentals of nature, such as the charge to mass ratio of the electron, or the atomic structure of Hydrogen? In Physics 3310, you will have experiences such as these as you decide for yourself how valid or applicable various theoretical results are that you have already encountered or look forward to encountering in 3000 level intermediate level courses such as quantum and classical mechanics and electrodynamics. You'll acquire essential skills to tease out the truth about nature as an experimental physicist with particular emphasis on the awareness and management of uncertainty. The environment of 3310 promotes individual creativity and discovery with the encouragement and aid of coursemates and staff.
**Prerequisites:** PHYS 2208 or PHYS 2214 or PHYS 2218.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS)
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
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**PHYS 3316 - Basics of Quantum Mechanics (4 Credits)**
A modern approach to the introduction of quantum mechanics. Topics include: the breakdown of classical physics in the Stern-Gerlach experiment; the postulates of quantum mechanics; spin 1/2, state vectors, operators, and measurements; time evolution with the Schrodinger equation; spatial wavefunctions with particle in a box and the harmonic oscillator; tunnelling and scattering; angular momentum and the hydrogen atom; and the basics of quantum computation. At the level of "Quantum Mechanics: A Paradigms Approach" by McIntyre.
**Prerequisites:** PHYS 2214 or PHYS 2218; PHYS 1116 or PHYS 2216; and coregistration in MATH 2940 or MATH 2210 or MATH 2230.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS)
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
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**PHYS 3317 - Applications of Quantum Mechanics (4 Credits)**
Covers a number of applications of quantum mechanics to topics in modern physics. Uses the tools developed in PHYS 3316 , and does not introduce new formalism. Topics include the physics of single and multi-electron atoms, molecular physics, introduction to quantum statistics, topics in solid-state physics, nuclear structure, and elementary particle physics. Students will develop their order-of-magnitude reasoning and their modeling skills.
**Prerequisites:** PHYS 3316.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS)
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2023, Fall 2022
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**PHYS 3318 - Analytical Mechanics (4 Credits)**
Covers Newtonian mechanics of particles and systems of particles, including Lagrangian and Hamiltonian formulations, conservation laws from symmetries, with applications to two-body orbits in a central force, systems undergoing small amplitude oscillations, rigid body motion, motion in non-inertial reference frames, perturbation theory, and nonlinear behavior. Both analytical and numerical methods for solving problems in mechanics are covered. At the level of Classical Mechanics by Goldstein, Mechanics by Landau and Lifshitz, and Analytical Mechanics by Hand and Finch.
**Prerequisites:** intro sequence in Physics (1116, 2217, 2218, or 1112, 2213, 2214).
**Enrollment Information:** Primarily for: students with exceptional background in physics/math.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS, SMR-AS)
**Last Four Terms Offered:** Spring 2025, Spring 2024, Spring 2023, Spring 2022
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**PHYS 3327 - Advanced Electricity and Magnetism (4 Credits)**
Focuses on advanced electro/magnetostatics, such as multipole expansion of the potential solutions to Laplace's Equation and boundary value problems, as well as time-dependent electrodynamics: Maxwell's Equations, electromagnetic waves, reflection and refraction, wave guides, and generation of electromagnetic radiation (retarded potential). As time permits, topics will be drawn from antennas, relativistic electrodynamics, four vectors, Lorentz, and transformation of fields based on the interest of the class. At the level of Classical Electromagnetic Radiation by Heald and Marion or the more advanced chapters of Introduction to Electrodynamics by Griffiths.
**Prerequisites:** PHYS 2217/PHYS 2218, or PHYS 2213/PHYS 2214. Recommended prerequisite: AEP 3200. Corequisite: AEP 4200 or appropriate mathematics course(s) that cover complex analysis, vector calculus, Fourier transforms and techniques for studying boundary value problems recommended.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS, SMR-AS)
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2023, Fall 2022
**Learning Outcomes:**

- Gain familiarity with advanced techniques in electrostatics.
- Understand the dynamical aspect of Maxwell's equations and the role of electromagnetic fields in the conservation of energy and momentum.
- Understand plane waves as the building blocks for EM radiation and the frequency-dependent behavior of EM waves in a variety of materials and waveguides.
- Gain exposure to mechanisms for the generation of EM waves.
- Explore more deeply the relationship between Special Relativity and Maxwell's Equations.

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**PHYS 3360 - Electronic Circuits (4 Credits)**
Crosslisted with AEP 3630
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/)

**PHYS 4230 - Statistical Thermodynamics (4 Credits)**
Crosslisted with AEP 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 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4400 - Informal Advanced Laboratory (1-3 Credits)**
Experiments of widely varying difficulty in one or more areas, as listed under PHYS 4410, may be done to fill the student's special requirements.
**Prerequisites:** two years physics.
**Enrollment Information:** Enrollment limited to: Physics and A&EP seniors.
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4410 - Advanced Experimental Physics (4 Credits)**
Over 30 available experiments on various topics including atomic and molecular spectroscopy, optics, condensed matter physics, nuclear physics, electrical and microwave circuits, x-rays, and magnetic resonance. Each student selects and performs two experiments and completes one project. Independent work is stressed, and scientific writing and presentation skills are emphasized. Weekly lectures will cover techniques and skills necessary for the class and experimental physics in general.
**Prerequisites:** PHYS 3327, PHYS 3318.
**Enrollment Information:** Enrollment limited to: seniors in Physics or A&EP.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS)
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4433 - Introduction to Cosmology (3 Credits)**
Crosslisted with ASTRO 4433
This course provides an introduction to theoretical and observational cosmology for science and engineering majors. Topics include general relativity in cosmology, the history of cosmic expansion, early universe processes, galaxy and cluster formation, and current and upcoming cosmological surveys, such as those of galaxies, galaxy clusters, gravitational lensing, and the cosmic microwave background. The course is designed at a less technical level than the graduate-level course ASTRO 6599.
**Prerequisites:** math/calculus at 2000-level, physics at 3000-level or permission of instructor.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS)
**Last Four Terms Offered:** Fall 2023, Fall 2021, Fall 2019, Spring 2017
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4443 - Intermediate Quantum Mechanics (4 Credits)**
Provides an introduction to concepts and techniques of quantum mechanics, at the level of An Introduction to Quantum Mechanics by Griffiths.
**Prerequisites:** PHYS 3316, PHYS 3317, PHYS 3327, and MATH 2940 or appropriate mathematics course(s). Corequisite:PHYS 3318,or permission of instructor.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS)
**Last Four Terms Offered:** Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4444 - Introduction to Particle Physics (4 Credits)**
Covers the standard model of particle physics; Introduction to fields and particles and relativistic Quantum Mechanics; Symmetries in physics; Basic introduction the Feynman diagrams. At the level of Introduction to Elementary Particles by Griffiths or Modern Elementary Particle Physics by Kane.
**Prerequisites:** PHYS 3316, PHYS 3317, and PHYS 3318 or permission of instructor.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS)
**Last Four Terms Offered:** Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4445 - Introduction to General Relativity (4 Credits)**
Crosslisted with ASTRO 4445
One-semester introduction to general relativity that develops the essential structure and phenomenology of the theory without requiring prior exposure to tensor analysis. General relativity is a fundamental cornerstone of physics that underlies several of the most exciting areas of current research, including relativistic astrophysics, cosmology, and the search for a quantum theory of gravity. The course briefly reviews special relativity, introduces basic aspects of differential geometry, including metrics, geodesics, and the Riemann tensor, describes black hole spacetimes and cosmological solutions, and concludes with the Einstein equation and its linearized gravitational wave solutions. At the level of Gravity: An Introduction to Einstein's General Relativity by Hartle.
**Prerequisites:** classical mechanics at the level of PHYS 3318 and special relativity at the level of PHYS 1116 or PHYS 2216. Electromagnetism at the level of PHYS 3327 is useful.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS, SMR-AS)
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4454 - Introductory Solid State Physics (4 Credits)**
Crosslisted with AEP 4500
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 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4480 - Computational Physics (3 Credits)**
Develops tools for using computers to model the physical world. Uses examples pulled broadly from core areas of physics: Mechanics, Electricity and Magnetism, Statistical Mechanics and Thermodynamics, and Quantum Mechanics. Focus is on algorithmic thinking, converting mathematical representations into practical algorithms, working with data, and drawing physical conclusions from numerical results. Model problems will involve numerical quadratures, ordinary and partial differential equations, numerical linear algebra, event based simulations, and Monte Carlo techniques. May include modern techniques, such as those drawn from machine learning and artificial intelligence. Instruction will largely be in Julia, with computer labs integrated into lectures. No prior experience with Julia is necessary, but students should have some experience with programming. Graduate versions, PHYS 7680 and ASTRO 7690, require an additional project which is not required in the undergraduate version, PHYS 4480.
**Enrollment Information:** Requires familiarity with core undergraduate curriculum, and some experience with programming.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS, SDS-AS)
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2022, Fall 2020
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4481 - Quantum Information Processing (3 Credits)**
Crosslisted with AEP 4812
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.
**Forbidden Overlaps:** AEP 4812, AEP 7681, CS 4813, PHYS 4481, PHYS 7681
**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/)

**PHYS 4484 - Teaching and Learning Physics (1 Credit)**
This 1.5-hour weekly seminar provides undergraduate and graduate students with an introduction to core concepts in teaching and learning physics. Participants read and discuss articles and videos, reflect on their own teaching and learning experiences, and engage in collaborative activities that help them become more effective teachers, learners, and communicators. This seminar is especially valuable for those considering teaching physics at some point in their careers, or who want to improve their own physics learning skills. Topics may include: question types and questioning strategies; classroom discourse; neurological basis of learning; expertise acquisition and expert performance; deliberate practice; misconceptions, mental models and conceptual change; mindsets and psychological interventions; classroom diversity and microaggressions; multiple intelligences and multiple representations; metacognition; active learning; the nature of science; the qualities of effective teachers; and evaluating teaching and learning.Text: None. Readings will be provided.
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4485 - Teaching Experience I (1 Credit)**
Designed to provide qualified undergraduate students who possess an interest in teaching with a structured experience teaching physics. Participants collaborate with instructors and graduate teaching assistants to facilitate cooperative learning sessions, laboratory investigations, or homework help sessions. Total weekly time commitment is 3-4 hours, including instructional contact time (2 hours), preparation time, and instructional staff meeting time.
**Prerequisites:** previous enrollment in course to be taught or equivalent, and concurrent or previous enrollment in PHYS 4484.
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4486 - Teaching Experience II (1-3 Credits)**
Teaching experience for qualified undergraduate students in PHYS 1101/PHYS 1102. Contact time will be in the course's Learning Center, in a team environment with graduate student TAs and faculty. Activities include tutoring individual students, working with small groups, assisting students with lab experiments, and participating in course development initiatives.
**Prerequisites:** minimum grade of A in PHYS 1101/PHYS 1102/PHYS 2207/PHYS 2208, or A- in PHYS 1112/PHYS 2213, or B+ in PHYS 1116/PHYS 2217, or comparable AP or transfer credit.
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4487 - Teaching Experience III (1-3 Credits)**
Continuation of PHYS 4486. Teaching experience for qualified undergraduate students to help with PHYS 1101/PHYS 1102. Contact time will be in the course's Learning Center, in a team environment with graduate student TAs and faculty. Activities include tutoring individual students, working with small groups, assisting students with lab experiments, and participating in course development initiatives.
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4488 - Statistical Mechanics (3 Credits)**
This course focuses on those topics in statistical mechanics of interest to scholars in many fields. Topics include random walks and emergent properties; temperature and equilibrium; phase space dynamics and ergodicity; entropy; free energies; quantum statistical mechanics; calculation and computation; order parameters, broken symmetries, and topology; correlations, response, and dissipation; abrupt phase transitions; and continuous phase transitions, fractals, and the renormalization group. Taught in conjunction with the graduate course PHYS 6562, this version is advised for undergraduates and interested graduates outside of Physics.
**Prerequisites:** some sophistication with calculus and introductory physics.
**Distribution Requirements:** (CHPH-AG, OPHLS-AG), (PHS-AS)
**Last Four Terms Offered:** Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4490 - Independent Study in Physics (1-4 Credits)**
Individual project work (reading or laboratory) in any branch of physics. Products vary, but may include a thesis. Evaluation criteria are decided between student and faculty member.
**Exploratory Studies:** (CU-UG)

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

**PHYS 4498 - Senior Thesis (3 Credits)**
The first half of a two-semester thesis course involving physics-related research under the direct supervision of a faculty member. The thesis research may take many forms including but not restricted to : theoretical calculations, design of instrumentation, experimental research, or numerical simulations. Students wishing to pursue the senior thesis must submit a proposal, with the approval of a faculty supervisor, in spring of their junior year.
**Prerequisites:** completion of the core requirements for the physics major.
**Enrollment Information:** Enrollment limited to: seniors.
**Exploratory Studies:** (CU-UG)

**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4499 - Senior Thesis II (3 Credits)**
The second half of a two-semester thesis course involving physics-related research under the direct supervision of a faculty member. The thesis research may take many forms including but not restricted to : theoretical calculations, design of instrumentation, experimental research, or numerical simulations. Students wishing to pursue the senior thesis must submit a proposal, with the approval of a faculty supervisor, in spring of their junior year.
**Prerequisites:** PHYS 4498.
**Enrollment Information:** Enrollment limited to: seniors.
**Last Four Terms Offered:** Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4500 - Cultivating Public Engagement in Physics (2 Credits)**
**Last Four Terms Offered:** Spring 2023, Fall 2022, Spring 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4688 - Topics in Accelerator Physics (3 Credits)**
**Last Four Terms Offered:** Spring 2025
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 4997 - Cross-Cultural Work Experience in Physics (1 Credit)**
This independent study course offers physics majors (i.e., undergraduates whose applications to affiliate with the physics major have been approved) an opportunity to reflect on concepts from physics as they were encountered and applied in a recent internship. Students write a short paper describing their work experience and how it connects to the educational objectives of the physics major.
**Enrollment Information:** Primarily for: international undergraduate physics majors whose application to affiliate has been approved.
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 5520 - Supramolecular Biophysics (3 Credits)**
Crosslisted with MSE 5625
This course will describe how biomolecules cooperate to assembly structures, build material, and process information. We will start by discussing stoichiometric assembly macromolecular complexes. Then, we'll discuss how biomolecules assemble to make 1D, 2D and 3D materials. These include, cytoskeletal filaments, phospholipid bilayers, and biomolecular condensates. Finally, we'll discuss how cells use these phenomena for control (regulation) and computation.
**Prerequisites:** statistical physics and/or thermodynamics; electrostatics; vector calculus; differential equations; basic scientific computing; introductory biology.
**Enrollment Information:** Primarily for: seniors and graduate students.
**Last Four Terms Offered:** Fall 2025, Fall 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 6500 - Informal Graduate Laboratory (1-2 Credits)**
Experiments of widely varying difficulty in one or more areas, as listed under PHYS 6510, may be done to fill special requirements.
**Enrollment Information:** Enrollment limited to: Physics and A&EP graduate students.
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 6510 - Advanced Experimental Physics (3 Credits)**
Over 30 available experiments on various topics including atomic and molecular spectroscopy, optics, condensed matter physics, nuclear physics, electrical and microwave circuits, x-rays, and magnetic resonance. Each student selects and performs two experiments and completes one project. Independent work is stressed, and scientific writing and presentation skills are emphasized. Weekly lectures will cover techniques and skills necessary for the class and experimental physics in general.
**Enrollment Information:** Enrollment limited to: Physics and A&EP graduate students.
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 6520 - Projects in Experimental Physics (1-3 Credits)**
Projects of modern topical interest that involve some independent development work by student. Opportunity for more initiative in experimental work than is possible in PHYS 6510.
**Corequisites:** PHYS 6510.
**Enrollment Information:** Enrollment limited to: Physics or A&EP seniors concurrrently enrolled in PHYS 6510.
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 6525 - High Energy Astrophysics (3 Credits)**
Crosslisted with ASTRO 6511
Compact objects (neutron stars, black holes and white dwarfs) are the endpoints of stellar evolution. They are responsible for some of the most exotic phenomena in the universe such as supernovae, magnetars, gamma-ray bursts, neutron star and black hole mergers. Supermassive black holes also lie at the heart of the violent processes in active galactic nuclei. The study of compact objects allows one to probe physics under extreme conditions (high densities, strong magnetic fields, and gravity). This course surveys the astrophysics of compact stars and related subjects. Emphasis is on the application of diverse theoretical physics tools to various observations of compact stars. There are no astronomy or general relativity prerequisites.
**Prerequisites:** senior level physics at upper-division undergraduate level.
**Last Four Terms Offered:** Spring 2025, Fall 2022, Spring 2021, Fall 2018
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 6553 - General Relativity I (3 Credits)**
Crosslisted with ASTRO 6509
A comprehensive introduction to Einstein's theory of relativistic gravity. This course focuses on the formal structure of the theory.
**Prerequisites:** knowledge of special relativity and methods of dynamics at level of Classical Mechanics by Goldstein.
**Last Four Terms Offered:** Fall 2024, Fall 2022, Fall 2020, Fall 2018
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 6554 - General Relativity II (3 Credits)**
Crosslisted with ASTRO 6510
A continuation of PHYS 6553 and ASTRO 6509 that covers a variety of advanced topics and applications of general relativity in astrophysics, cosmology, and high-energy physics.
**Prerequisites:** PHYS 6553 or permission of instructor.
**Last Four Terms Offered:** Spring 2025, Spring 2023, Spring 2021, Spring 2019
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 6561 - Electrodynamics (3 Credits)**
Covers special relativity, Maxwell's equations, electromagnetic potentials, conservation laws, Green's functions, electromagnetic waves, dispersion, radiation theory, and scattering. The practical application of appropriate mathematical methods is emphasized. The course will use Classical Electrodynamics by Jackson and Modern Electrodynamics by Zangwill.
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 6562 - Statistical Physics I (3 Credits)**
A broad, graduate level view of statistical mechanics, with applications to not only physics and chemistry, but to computation, mathematics, dynamical and complex systems, and biology. Some traditional focus areas will not be covered in detail (thermodynamics, phase diagrams, perturbative methods, interacting gasses and liquids).
**Prerequisites:** a high level of sophistication, equivalent to but not necessarily the same as that of a first-year physics graduate student (undergrad-level quantum, classical mechanics, and thermodynamics).
**Enrollment Information:** Primarily for: graduate students.
**Last Four Terms Offered:** Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 6572 - Quantum Mechanics I (3 Credits)**
First part of the two-semester graduate quantum mechanics sequence. Covers non-relativistic quantum physics, focusing on fundamental conceptual issues and methods. Topics include: fundamental concepts of quantum mechanics using the Dirac notation, theory of angular momentum and spin, symmetries, approximation methods and identical particles, at the level of Sakurai Modern Quantum Mechanics.
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 6574 - Applications of Quantum Mechanics II (3 Credits)**
**Last Four Terms Offered:** Spring 2021, Spring 2020, Spring 2019, Spring 2018
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 6599 - Cosmology (3 Credits)**
Crosslisted with ASTRO 6599
This course explores modern cosmology, covering the Big Bang theory, the universe’s matter content, and its evolution. Topics include the early universe, symmetry breaking, inflation, nucleosynthesis, recombination, structure formation, galaxy clustering, and dark energy. Students will also examine current and future observational techniques in cosmology.
**Prerequisites:** statistical physics, quantum mechanics, and electromagnetic theory courses.
**Last Four Terms Offered:** Fall 2024, Fall 2022, Fall 2020, Fall 2018
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7601 - Foundations of Fluid Mechanics I (4 Credits)**
Crosslisted with MAE 6010
Foundations of fluid mechanics from an advanced viewpoint, including formulation of continuum fluid dynamics; kinematic descriptions of fluid flow, derivation of the Navier-Stokes equations and energy equation for compressible fluids; and sound waves, viscous flows, boundary layers, and potential flows.
**Prerequisites:** MAE 3230 or higher, in addition to basic knowledge in vector calculus, ordinary differential equations, partial differential equations, and complex variable analysis.
**Enrollment Information:** Enrollment limited to: Graduate students.
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2023, Fall 2022
**Learning Outcomes:**

- Students will be able to identify important fluid properties and physical processes in fluid flows.
- Students will be able to formulate mathematical models for fluid flows.
- Students will be able to select methods of analysis and computation.
- Students will be able to develop solutions and interpret them in physical terms.
- Students will be able to explain what was learned in written and oral form.

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

**PHYS 7635 - Solid-State Physics I (3 Credits)**
Survey of the physics of solids starting with crystal structures and the band theory of electrons and phonons. Selected topics from semiconductors, magnetism, superconductivity, spin liquids, disordered materials, topology, and mesoscopic physics. The focus is to enable graduate research at the current frontiers of condensed matter physics.
**Prerequisites:** undergraduate statistical mechanics, and familiarity with graduate-level quantum mechanics. Recommended prerequisite: comprehensive undergraduate solid-state physics course (e.g., PHYS 4454).
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2023, Fall 2022
**Learning Outcomes:**

- Upon completion of the course, skills the students will acquire include (but are not limited to) calculating band structures using tight binding models, calculating the positions and relative intensities of Bragg peaks for X-rays scattering experiments, performing simple calculations of transport coefficients such as conductivity, calculating phonon dispersion curves for different crystal structures, and calculating Berry phases in topological systems.

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

**PHYS 7636 - Solid-State Physics II (3 Credits)**
Continuation of PHYS 7635. The course is structured in two parts. The first half is on setting up the formalism and language of correlation function and responses that are used to define properties of phases. The second half is on applying the formalism to different symmetry broken phases (magnetism, superconductivity) and topological phases. The second half will also include topical subjects that are at the frontier of research.
**Prerequisites:** PHYS 7635, grad level quantum mechanics, grad level statmech.
**Last Four Terms Offered:** Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7645 - An Introduction to the Standard Model of Particle Physics (4 Credits)**
This course is an introduction to the Standard Model of particle physics. Familiarity with Feynman rules, Lagrangians, and relativistic wave equations at the level of PHYS 7651 is required. Topics covered include strong and electro-weak interactions, Higgs mechanism, and phenomenology of weak interactions, the quark model, and particle detectors. The course is taught at the level of Particle Physics: A Comprehensive Introduction by Abe Seiden, and The Standard Model and Beyond by Paul Langacker.
**Prerequisites:** PHYS 7651 and PHYS 4444 or equivalent. Undergrads by permission of instructor.
**Last Four Terms Offered:** Spring 2024, Spring 2022, Spring 2020, Spring 2019
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7651 - Relativistic Quantum Field Theory I (3 Credits)**
Introduction to relativistic quantum field theory for applications in particle physics. Topics include quantization of scalar fields, perturbation theory, Feynman diagrams, conservation laws, calculation of decay rates and cross sections, causality and unitarity, introduction to radiative corrections, renormalization and effective field theories, introduction to the Lorentz and Poincare groups, Weyl, Majorana and Dirac fermions, quantization and Feynman rules for fermionic theories. At the level of Quantum Field Theory and the Standard Model by Schwartz.
**Prerequisites:** PHYS 6572, and PHYS 6561 (one of these courses may be taken concurrently).
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7652 - Relativistic Quantum Field Theory II (3 Credits)**
A continuation of PHYS 7651. Introduces more advanced methods and concepts in quantum field theory. Topics include functional integral methods, quantization of spin-1 fields, quantum electrodynamics, non-Abelian gauge theories, renormalization group techniques, spontaneous symmetry breaking, and anomalies. At the level of An Introduction to Quantum Field Theory by Peskin and Schroeder.
**Prerequisites:** PHYS 6572, PHYS 6561, and PHYS 7651. Recommended prerequisite: background in particle physics at the level of PHYS 4444.
**Last Four Terms Offered:** Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7653 - Statistical Physics II (3 Credits)**
An advanced, graduate-level exploration of selected topics in statistical mechanics - topics such as mean-field theory, scaling analysis, theories of quantum and classical phase transitions, renormalization-group methods, classical spin models, quantum rotor models, etc.
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7654 - Basic Training in Condensed Matter Physics (3 Credits)**
Advanced topics in condensed-matter physics are taught by several members of the faculty. Past modules include random matrix theory, the quantum Hall effect, disordered systems and computational complexity, asymptotic analysis, superfluid physics, generalized rigidity, many-body methods applied to nanotubes, crystal defects, probes of cold atoms, probes of cuprate superconductors, conformal field theory and symmetry, geometry in quantum mechanics, quantum many-body physics in one dimension, sloppy models, asymptotic analysis, applied dynamics, competing ferroic orders, quantum criticality, equation of motion approach to many-body physics, dynamics of infectious diseases, Ginzburg-Landau theory, constraint problems, quantum optics, Luttinger liquids, quantum antiferromagnets, density functional theory, Feynman diagrams and excited states, quantum Monte Carlo methods, path integrals for quantum statistics and dynamics, and, tensor networks for quantum many-body problems. Future topics may include dilute cold gases and exotic quantum phenomena, thermodynamic Green's functions, 1/N expansions, instantons, Fermi liquid theory and superconductivity, localization and disordered metals, renormalization groups, duality transformations, and Chern-Simons gauge theory. Detailed course content will be announced at the end of the previous fall semester.
**Enrollment Information:** Primarily for: graduate students and senior undergraduates entering research work.
**Last Four Terms Offered:** Spring 2024, Spring 2020, Spring 2019, Spring 2018
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7661 - Advanced Topics in High-Energy Particle Theory (3 Credits)**
**Last Four Terms Offered:** Fall 2021, Spring 2018, Fall 2017, Fall 2015
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7667 - Physics of Stars, Neutron Stars and Black Holes (3 Credits)**
Crosslisted with ASTRO 6560
Covers stellar structure, evolution, and the physics of compact objects, including neutron stars and black holes.
**Prerequisites:** Math above 2000 level, physics above 3000 level.
**Enrollment Information:** Recommended prerequisite: PHYS 4443.
**Last Four Terms Offered:** Fall 2025, Fall 2024, Spring 2023, Fall 2020
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7680 - Computational Physics (3 Credits)**
Crosslisted with ASTRO 7690
Develops tools for using computers to model the physical world.
Uses examples pulled broadly from core areas of physics: Mechanics, Electricity and Magnetism, Statistical Mechanics and Thermodynamics, and Quantum Mechanics. Focus is on algorithmic thinking, converting mathematical representations into practical algorithms, working with data, and drawing physical conclusions from numerical results. Model problems will involve numerical quadratures, ordinary and partial differential equations, numerical linear algebra, event based simulations, and Monte Carlo techniques. May include modern techniques, such as those drawn from machine learning and artificial intelligence. Instruction will largely be in Julia, with computer labs integrated into lectures.
No prior experience with Julia is necessary, but students should have some experience with programming. Graduate versions, PHYS 7680 and ASTRO 7690, require an additional project which is not required in the undergraduate version, PHYS 4480.
**Enrollment Information:** Requires familiarity with core undergraduate curriculum, and some experience with programming.
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2022, Fall 2020
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7681 - Quantum Information Processing (3 Credits)**
Crosslisted with AEP 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.
**Forbidden Overlaps:** AEP 4812, AEP 7681, CS 4813, PHYS 4481, PHYS 7681
**Last Four Terms Offered:** Fall 2024, Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7684 - Teaching and Learning Physics (1 Credit)**
This 1.5-hour weekly seminar provides undergraduate and graduate students with an introduction to core concepts in physics education. Participants discuss articles and videos drawn from physics and science education research and from cognitive science, and engage in collaborative activities that help them become more effective teachers, communicators and learners. This seminar is especially valuable for those considering teaching physics at some point in their careers. Topics include: Questioning Strategies, Classroom Discourse, Teaching through misconceptions, Argumentation approach to instruction, Learning Theory, Conceptions and Conceptual Change and Fixed vs Growth Mind-set, Science communication. Text: Articles from science, engineering, and math education journals.
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7685 - First Year Physics Grad Seminar (1 Credit)**
This seminar is indented for first-year graduate students in the Department of Physics. Topics covered include general resources and policies, Q-exam preparation and practice, fellowship applications, library services, resources for well-being, diversity and inclusion, and faculty research presentations. This course provides some of the foundations and tools for graduate research in the field of Physics and surveys some of the available research opportunities and groups.
**Enrollment Information:** Enrollment limited to: first-year graduate students in the field of Physics.
**Last Four Terms Offered:** Fall 2025, Fall 2024, Fall 2023, Fall 2022
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7687 - Special Topics in Physics (2 Credits)**
Graduate Topics course; topics change every year. Please see the syllabus for more information.
**Enrollment Information:** Primarily for: graduate students.
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7688 - Topics in Accelerator Physics (3 Credits)**
**Last Four Terms Offered:** Spring 2025, Fall 2019
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7689 - Special Topics - AI for Quantum Many Body Physics (3 Credits)**
**Last Four Terms Offered:** Spring 2024
Schedule of Classes (https://classes.cornell.edu/)

**PHYS 7690 - Independent Study in Physics (1-4 Credits)**
Special graduate study in some branch of physics, either theoretical or experimental, under the direction of any professorial member of the staff.
**Last Four Terms Offered:** Fall 2025, Spring 2025, Fall 2024, Spring 2024
Schedule of Classes (https://classes.cornell.edu/)