PHYSICS (PH-GY)

PH-GY 955X Readings in Applied Physics (1-4 Credits)
Typically offered occasionally
These guided studies courses in physics are supervised by faculty member. | Prerequisite: Graduate Physics advisor approval. Note: Course may be repeated for additional credit.
Grading: Grad Poly Graded
Repeatable for additional credit: Yes

PH-GY 996X MS Project in Applied Physics (1-9 Credits)
Typically offered occasionally
This project course in applied physics is supervised by a faculty member. A written project proposal and final report must be submitted to the department chair and the advisor, and may be extended to a thesis with the project advisor's recommendation. | Prerequisite: Advisor Approval
Grading: Grad Poly Graded
Repeatable for additional credit: Yes

PH-GY 997X MS Thesis in Applied Physics (1-9 Credits)
Typically offered occasionally
Independent research project performed under guidance of thesis advisor. Bound thesis volume and oral defense in presence of at least three faculty members. Continuous registration with total 9 credits required.
Grading: Satisfactory/Unsatisfactory
Repeatable for additional credit: Yes

PH-GY 999X PhD Diss in Applied Physics (3-9 Credits)
Typically offered occasionally
An original investigation in some branch of physics, which may serve as basis for the PhD degree, is performed under the direction of a member of the department. The number of research credits registered for each semester should realistically reflect the time devoted to research. | Prerequisites: Passing grade in RE-GY 9990 PhD Qualifying Exam, degree status and graduate advisers and research director's consent.
Grading: Satisfactory/Unsatisfactory
Repeatable for additional credit: Yes
Corequisites: RE-GY 9990 AND Restriction: Academic Plan = PHD Physics-PHD.

PH-GY 5493 Physics of Nanoelectronics (3 Credits)
Typically offered Spring
This course covers limits to the ongoing miniaturization (Moore's Law) of the successful silicon-device technology imposed by physical limitations of energy dissipation, quantum tunneling and discrete quantum electron states. Quantum physical concepts and elementary Schrodinger theory. Conductance quantum and magnetic flux quantum. Alternative physical concepts appropriate for devices of size scales of 1 to 10 nanometers, emphasizing role of power dissipation. Tunnel diode, resonant tunnel diode, electron wave transistor; spin valve, tunnel valve, magnetic disk and random access memory; single electron transistor, molecular crossbar latch, quantum cellular automata including molecular and magnetic realizations. Josephson junction and "rapid single flux quantum" computation. Photo- and x-ray lithographic patterning, electron beam patterning, scanning probe microscopes for observation and for fabrication; cantilever array as dense memory, use of carbon nanotubes and of DNA and related biological elements as building blocks and in self-assembly strategies. | Prerequisites: PH-UY 2023
Grading: Grad Poly Graded
Repeatable for additional credit: No

PH-GY 5553 Physics of Quantum Computing (3 Credits)
Typically offered Fall
This course explores limits to the performance of binary computers, traveling salesman and factorization problems, security of encryption. The concept of the quantum computer based on linear superposition of basis states. The information content of the qubit. Algorithmic improvements enabled in the hypothetical quantum computer. Isolated two-level quantum systems, the principle of linear superposition as well established. Coherence as a limit on quantum computer realization. Introduction of concepts underlying the present approaches to realizing qubits (singly and in interaction) based on physical systems. The systems in present consideration are based on light photons in fiber optic systems; electron charges in double well potentials, analogous to the hydrogen molecular ion; nuclear spins manipulated via the electron-nuclear spin interaction, and systems of ions such as Be and Cd which are trapped in linear arrays using methods of ultra-high vacuum, radiofrequency trapping and laser-based cooling and manipulation of atomic states. Summary and comparison of the several approaches. | Prerequisites: PH-UY 2023
Grading: Grad Poly Graded
Repeatable for additional credit: No

PH-GY 6403 Physical Concepts of Polymer Nanocomposites (3 Credits)
Typically offered occasionally
This course presents fundamental aspects of polymer nanocomposites and updates on recent advancements and modern applications. Topics include nanostructured materials; assembly at interfaces; interactions on surfaces; properties of polymer nanocomposites; reliability; nanodevices.
Grading: Grad Poly Graded
Repeatable for additional credit: No

PH-GY 6603 Introduction to Quantum Computing (3 Credits)
Typically offered Fall
This course offers a rigorous introduction to the theoretical foundations of quantum computing. Topics include Hilbert spaces, tensor products, unitary evolution, quantum gates and circuits, entanglement, quantum algorithms (Deutsch-Jozsa, Grover's, and Shor's), quantum measurement, and error correction. Emphasis is placed on formal reasoning, mathematical structure, and conceptual understanding. | Knowledge of linear algebra, complex numbers, and basic probability theory
Grading: Grad Poly Graded
Repeatable for additional credit: No

PH-GY 6613 Mathematical Methods for Quantum Computing (3 Credits)
Typically offered Fall
This course develops the mathematical foundations essential for quantum computing and information, with emphasis on linear algebra, vector spaces, tensor products, spectral theory, measurement, and probability. Additional topics include generalized measurements, entropy, and open quantum systems. Concepts are presented through low-dimensional examples and interactive in-class derivations to ensure clarity and accessibility. | Knowledge of basic matrix algebra and vectors (e.g., from an undergraduate linear algebra course). | Corequisites: PH-GY 6603
Grading: Grad Poly Graded
Repeatable for additional credit: No
Corequisites: PH-GY 6603.

PH-GY 6623 Quantum Programming (3 Credits)
Typically offered Fall
This course offers a rigorous, hands-on introduction to quantum programming and algorithm implementation using frameworks such as Qiskit, Cirq, and PennyLane. Students learn to build and analyze quantum circuits, implement algorithms, and simulate or run them on real quantum hardware. | Corequisites: PH-GY 6603 or equivalent; proficiency in Python programming.
Grading: Grad Poly Graded
Repeatable for additional credit: No
Corequisites: PH-GY 6603 or equivalent; proficiency in Python programming.

PH-GY 6653 Introduction to Quantum Optics (3 Credits)
Typically offered Summer term
This course introduces the quantum theory of light, starting from classical electromagnetic waves and progressing to field quantization, photon statistics, and light–matter interaction. Topics include coherent states, photodetection, quantum interference, entanglement, and photonic implementations of quantum computing and communication. Emphasis is placed on conceptual clarity, with guided derivations and instructor-prepared notes. | Prerequisites: PH-GY 6603, PH-GY 6613, and PH-GY 6643. Corequisites: PH-GY 6713
Grading: Grad Poly Graded
Repeatable for additional credit: No
Prerequisites: PH-GY 6603, PH-GY 6613, and PH-GY 6643.
Corequisites: PH-GY 6713.

PH-GY 6673 Quantum Mechanics I (3 Credits)
Typically offered Fall
Quantum mechanics with applications to atomic systems. The use of Schrodinger's equations. Angular momentum and spin. Semi-classical theory of field-matter interaction. | Prerequisites: MA-UY 2114, PH-UY 3234 equivalents.
Grading: Grad Poly Graded
Repeatable for additional credit: No

PH-GY 6683 Quantum Mechanics II (3 Credits)
Typically offered occasionally
Quantum mechanics with applications to atomic systems. The use of Schrodinger's equations. Angular momentum and spin. Semi-classical theory of field-matter interaction. | Prerequisites PH-GY 6673.
Grading: Grad Poly Graded
Repeatable for additional credit: No

PH-GY 6713 Quantum Optics Laboratory (3 Credits)
Typically offered Summer term
A hands-on lab course exploring fundamental and applied aspects of quantum optics using single-photon experiments. Students perform a series of experiments involving formation and manipulation of entangled photons, single-photon interference, and applications in quantum technology such as quantum cryptography. | Prerequisites: Undergraduate labs that includes optics, PH-GY 6603, and PH-GY 6613. Corequisites: PH-GY 6653
Grading: Grad Poly Graded
Repeatable for additional credit: No
Prerequisites: Undergraduate labs that includes optics, PH-GY 6603, and PH-GY 6613.
Corequisites: PH-GY 6653.

PH-GY 8013 Selected Topics in Advanced Physics (3 Credits)
Typically offered occasionally
Current or advanced topics of particular interest to graduate students are examined. Subject matter is determined each year by students and faculty. The course may be given in more than one section. Consult department office for current offerings. | Note: this course is not offered every semester.
Grading: Grad Poly Graded
Repeatable for additional credit: Yes

PH-GY 9531 Graduate Seminar I (1.5 Credits)
Typically offered occasionally
Students presenting current topics in Physics in a seminar setting to other students and supervising faculty. Topics chosen by the student with guidance from faculty.
Grading: Grad Poly Pass/Fail
Repeatable for additional credit: No

PH-GY 9541 Graduate Seminar II (1.5 Credits)
Typically offered occasionally
Students presenting current topics in Physics in a seminar setting to other students and supervising faculty. Topics chosen by the student with guidance from faculty.
Grading: Grad Poly Pass/Fail
Repeatable for additional credit: No