Physics (PHYS)

Courses

PHYS 101. Essentials of Physics. 4 Credits.
Fundamental physical principles. Mechanics.
Additional Information:
Science Area

PHYS 152. Physics of Sound and Music. 4 Credits.
Introduction to the wave nature of sound; hearing; musical instruments and scales; auditorium acoustics; and the transmission, storage, and reproduction of sound.
Additional Information:
Science Area

PHYS 153. Physics of Light, Color, and Vision. 4 Credits.
Light and color, their nature, how they are produced, and how they are perceived and interpreted.
Additional Information:
Science Area

PHYS 155. Physics Behind the Internet. 4 Credits.
How discoveries in 20th-century physics mesh to drive modern telecommunications. Topics include electron mobility in matter, the development of transistors and semiconductors, lasers, and optical fibers.

Additional Information:
Science Area

PHYS 156M. Scientific Revolutions. 4 Credits.
Surveys several major revolutions in our views of the natural and technological world, focusing on scientific concepts and methodological aspects. For nonscience majors. Multilisted with ERTH 156M.
Equivalent to: GEOL 156M
Additional Information:
Science Area

PHYS 161. Physics of Energy and Environment. 4 Credits.
Practical study of energy generation and environmental impact, including energy fundamentals, fossil fuel use, global warming, nuclear energy, and energy conservation.
Additional Information:
Science Area

PHYS 162. Solar and Other Renewable Energies. 4 Credits.
Topics include photovoltaic cells, solar thermal power, passive solar heating, energy storage, geothermal energy, and wind energy.
Additional Information:
Science Area

PHYS 171. The Physics of Life. 4 Credits.
Explores how physical laws guide the structure, function, and behavior of living organisms, and examines the physical properties of biological materials. Topics span microscropic and macroscopic scales.
Additional Information:
Science Area

PHYS 181. Quantum Mechanics for Everyone. 4 Credits.
Introduction to quantum mechanics, a set of sometimes counterintuitive scientific principals describing atoms and light, along with the modern technologies it makes possible.
Additional Information:
Science Area

PHYS 196. Field Studies: [Topic]. 1-2 Credits.
A series of practical experiences on or off campus to understand principles or develop skills in performing selected tasks.
Repeatable 99 times

PHYS 198. Worskhop: [Topic]. 1-2 Credits.
An intensive experience, limited in scope and time, in which a group of students focus on skills development rather than content mastery.
Repeatable 99 times

PHYS 199. Special Studies: [Topic]. 1-5 Credits.
Experimental course - topic varies.
Repeatable 99 times

PHYS 201. General Physics. 4 Credits.
Introductory series. Mechanics and fluids.
Requisites: Prereq: MATH 112Z or equivalent.
Additional Information:
Science Area

PHYS 202. General Physics. 4 Credits.
Introductory series. Thermodynamics, waves, optics.
Requisites: Prereq: PHYS 201.
Additional Information:
Science Area

PHYS 203. General Physics. 4 Credits.
Introductory series. Electricity, magnetism, modern physics.
Requisites: Prereq: PHYS 201.
Additional Information:
Science Area

PHYS 204. Introductory Physics Laboratory. 2 Credits.
Practical exploration of the principles studied in general-physics lecture. Measurement and analysis methods applied to experiments in mechanics, waves, sound, thermodynamics, electricity and magnetism, optics, and modern physics. Sequence.
Requisites: Pre- or coreq: PHYS 201.

PHYS 205. Introductory Physics Laboratory. 2 Credits.
Practical exploration of the principles studied in general-physics lecture. Measurement and analysis methods applied to experiments in mechanics, waves, sound, thermodynamics, electricity and magnetism, optics, and modern physics.
Requisites: Pre- or coreq: PHYS 202.

PHYS 206. Introductory Physics Laboratory. 2 Credits.
Practical exploration of the principles studied in general-physics lecture. Measurement and analysis methods applied to experiments in mechanics, waves, sound, thermodynamics, electricity and magnetism, optics, and modern physics.
Requisites: Pre- or coreq: PHYS 203.

PHYS 251. Foundations of Physics I. 4 Credits.
Newtonian mechanics; units and vectors; one-dimensional motion; Newton’s laws; work and energy; momentum and collisions. Sequence.
Requisites: Prereq: MATH 112Z or equivalent. Coreq: MATH 251Z.
Additional Information:
Science Area

PHYS 252. Foundations of Physics I. 4 Credits.
Vibrations and waves; oscillations; wave mechanics; dispersion; modes; introductory optics.
Requisites: Prereq: PHYS 251; coreq: MATH 252Z or equivalent.
Additional Information:
Science Area

PHYS 253. Foundations of Physics I. 4 Credits.
Electricity and magnetism; charge and electric field; electric potential; circuits; magnetic field; inductance.
Requisites: Prereq: PHYS 252; coreq: MATH 253Z or equivalent.
Additional Information:
Science Area

PHYS 290. Foundations of Physics Laboratory. 1 Credit.
Repeatable. Introduction to laboratory measurements, reports, instrumentation, and experimental techniques.
Requisites: Coreq: PHYS 251, PHYS 252 or PHYS 253.
Repeatable 2 times for a maximum of 3 credits

PHYS 299. Special Studies: [Topic]. 1-5 Credits.
Experimental course - topic varies.
Repeatable 99 times

PHYS 351. Foundations of Physics II. 4 Credits.
Introduction to relativity and quantum physics with applications to atomic, solid-state, nuclear, and astro-particle systems
Requisites: Coreq: MATH 253Z.

PHYS 352. Thermal Physics and Statistical Mechanics I. 4 Credits.
Thermodynamic systems; first and second laws; kinetic theory of gases; entropy. Sequence.
Requisites: Prereq: PHYS 351; coreq: MATH 281.

PHYS 353. Thermal Physics and Statistical Mechanics II. 4 Credits.
Thermal radiation; Maxell-Boltzmann statistics; Fermi and Bose gases; phase transitions. Sequence.
Requisites: Prereq: PHYS 352; coreq: MATH 282.

PHYS 389. Mathematical Methods. 4 Credits.
Essential mathematical background for 400-level physics courses in classical mechanics, electricity and magnetism, and quantum mechanics. The emphasis is on the conceptual basis of the following topics and their connections, with an emphasis on physical applications, vector algebra and calculus. Dirac delta function, partial differential equations, linear algebra of function spaces, orthonormal bases, Dirac notation, special functions, standard and general Fourier analysis, matrices, eigenvalue equations, Fourier transforms.
Requisites: Prereq: MATH 281.

PHYS 391. Physics Experimentation Data Analysis Laboratory. 4 Credits.
Practical aspects of physics experimentation, including data acquisition, statistical analysis, and introduction to scientific programming, and use of Fourier methods for data analysis.
Requisites: Prereq: PHYS 253.

PHYS 399. Special Studies: [Topic]. 1-5 Credits.
Experimental course - topic varies.
Repeatable 99 times

PHYS 401. Research: [Topic]. 1-16 Credits.
Disciplined inquiry of a topic with varying techniques and assignments suited to the nature and conditions of the problem being investigated. Often pursued in relation to a dissertation or thesis.
Repeatable 99 times

PHYS 402. Supervised Tutoring. 1-12 Credits.
A student, under faculty supervision, accepts responsibility for tutoring other students within the discipline.
Repeatable 99 times

PHYS 403. Thesis. 1-12 Credits.
A written document resulting from study or research and submitted as a major requirement for a degree.
Repeatable 99 times

PHYS 405. Reading and Conference: [Topic]. 1-16 Credits.
A particular selection of material read by a student and discussed in conference with a faculty member.
Repeatable 99 times

PHYS 406. Practicum: [Topic]. 1-21 Credits.
A series of clinical experiences under academic supervision designed to integrate theory and principles with practice.
Repeatable 99 times

PHYS 407. Seminar: [Topic]. 1-4 Credits.
A small group of students studying a subject with a faculty member. Although practices vary, students may do original research and exchange results through informal lectures, reports, and discussions.
Repeatable 99 times

PHYS 408. Workshop: [Topic]. 1-21 Credits.
An intensive experience, limited in scope and time, in which a group of students focus on skills development rather than content mastery.
Repeatable 99 times

PHYS 409. Terminal Project. 1-12 Credits.
A presentation incorporating the knowledge and skills acquired from course work completed for a degree.
Repeatable 99 times

PHYS 410. Experimental Course: [Topic]. 1-4 Credits.
Experimental course - topic varies.
Repeatable 99 times

PHYS 410L. Experimental Course: [Topic]. 4 Credits.
Experimental course - topic varies.
Repeatable 99 times

PHYS 411. Mechanics. 4 Credits.
Fundamental principles of Newtonian mechanics, conservation laws, small oscillations, planetary motion, systems of particles. Electromagnetic phenomena. Only nonmajors may earn graduate credit.
Requisites: Prereq: MATH 282.

PHYS 412. Electricity and Magnetism I. 4 Credits.
Fundamental principles of Newtonian mechanics, conservation laws, small oscillations, planetary motion, systems of particles. Electromagnetic phenomena.
Requisites: Prereq: MATH 281.

PHYS 413. Electricity and Magnetism II. 4 Credits.
Fundamental principles of Newtonian mechanics, conservation laws, small oscillations, planetary motion, systems of particles. Electromagnetic phenomena.
Requisites: Prereq: PHYS 412.

PHYS 414. Quantum Physics. 4 Credits.
Planck's and de Broglie's postulates, the uncertainty principle, Bohr's model of the atom, the Schroedinger equation in one dimension, the harmonic oscillator, the hydrogen atom, molecules and solids, nuclei and elementary particles. Sequence.
Requisites: Prereq: PHYS 413.

PHYS 415. Quantum Physics. 4 Credits.
Planck's and de Broglie's postulates, the uncertainty principle, Bohr's model of the atom, the Schroedinger equation in one dimension, the harmonic oscillator, the hydrogen atom, molecules and solids, nuclei and elementary particles. Sequence.
Requisites: Prereq: PHYS 414.

PHYS 417. Topics in Quantum Physics. 4 Credits.
Perturbation theory, variational principle, time-dependent perturbation theory, elementary scattering theory.
Requisites: Prereq: PHYS 415.

PHYS 421M. Partial Differential Equations: Fourier Analysis I. 4 Credits.
Introduction to PDEs with a view towards applications in physics. Wave and heat equations, classical Fourier series on the circle, Bessel and Legendre series. Multilisted with MATH 421M.
Requisites: Prereq: MATH 253Z; MATH 256 or MATH 281.
Equivalent to: MATH 421M

PHYS 422. Electromagnetism. 4 Credits.
Study of electromagnetic waves. Topics include Maxwell's equations, wave equation, plane waves, guided waves, antennas, and other related phenomena.
Requisites: Prereq: PHYS 413.

PHYS 423M. Introduction to Space Physics. 4 Credits.
Course explores the interaction of the solar wind with the Earth's magnetosphere using fundamental plasma physics supported and motivated by spacecraft observations. Students will gain an understanding of the physics governing the interaction building from single particle plasma motion to specific observation supported examples.

Requisites: Prereq: PHYS 253, MATH 282.
Equivalent to: ERTH 423M

PHYS 424. Classical Optics. 4 Credits.
Geometrical optics, polarization, interference, Frauenhofer and Fresnel diffraction.
Requisites: Prereq: PHYS 353.

PHYS 425. Modern Optics. 4 Credits.
Special topics in modern applied optics such as Fourier optics, coherence theory, resonators and lasers, holography, and image processing.
Requisites: Prereq: PHYS 424.

PHYS 431. Analog Electronics. 4 Credits.
Passive and active discrete components and circuits. General circuit concepts and theorems. Equivalent circuits and black box models. Integrated circuit operational amplifiers.
Requisites: Prereq: PHYS 203 or PHYS 253; MATH 256.

PHYS 432. Digital Electronics. 4 Credits.
Digital electronics including digital logic, measurement, signal processing and control. Introduction to computer interfacing.
Requisites: Prereq: PHYS 203 or PHYS 253; MATH 253Z.

PHYS 433. Radiofrequency and Low-noise Measurements. 4 Credits.
This course provides a hands-on introduction to radio-frequency technology, essential in communications, physics labs, and quantum computing. Students will learn radio-frequency device design, test equipment, and quantum measurement techniques through lectures and structured labs. In the second half, they will set up and program advanced radio-frequency test instruments used in quantum research, performing real-world measurements.
Requisites: Prereq: PHYS 413.

PHYS 444. Introduction to Biological Physics. 4 Credits.
The application of physical principles to the study of the living world, especially at molecular and cellular scales. Topics include the mechanical properties of biomaterials, the sensory abilities of cells and organisms, and the dynamical properties of information processing networks.
Requisites: Prereq: PHYS 353, MATH 281, basic computer programming skills.

PHYS 445. Computational Physics. 4 Credits.
The goal of this course is to build a strong foundation in computational physics. With a particular emphasis on topics in modeling and data analysis for drawing physical insights from data in physics and astronomy, we will cover tools and techniques useful for conducting computationally demanding science.
Requisites: Prereq: PHYS 391.

PHYS 481. Design of Experiments. 4 Credits.
Applies statistics to practical data analysis, data-based decision making, model building, and the design of experiments. Emphasizes factorial designs.

PHYS 483. General Relativity I. 4 Credits.
This course will serve as an introduction to the concept of gravity as geometry. The course begins by motivating the need for General Relativity and culminate in the presentation of the Einstein equation, presenting some of the simplest solutions to the Einstein equation.
Requisites: Prereq: PHYS 411, PHYS 413.

PHYS 489. The Physics Behind Quantum Computers. 4 Credits.
Quantum computing is a new way of computing based on the rules of Quantum mechanics. We study what sort of computations can be performed by atoms, ions, and superconducting electric circuits.
Requisites: Prereq: PHYS 414 is co-req.

PHYS 491. Research Project I. 2-4 Credits.
For physics and other science majors, Physics Projects entails construction and use of apparatus, interfaces and computers to perform technically-sophisticated experiments, analyze and communicate results.
Requisites: Prereq: PHYS 253.

PHYS 492. Research Project II. 2-4 Credits.
For physics and other science majors, Physics Projects entails construction and use of apparatus, interfaces and computers to perform technically-sophisticated experiments, analyze and communicate results.
Requisites: Prereq: PHYS 491.

PHYS 493. Research Project III. 2-4 Credits.
For physics and other science majors, Physics Projects entails construction and use of apparatus, interfaces and computers to perform technically-sophisticated experiments, analyze and communicate results.
Requisites: Prereq: PHYS 492.

PHYS 495. Nanofabrication. 4 Credits.
This course introduces students to the design and fabrication of micro- and nanoscale devices. The course will cover fundamental fabrication principles, including optical and electron-beam lithography, thin-film deposition, etching, and characterization. This framework will aid in understanding the processes used in manufacturing chip-based devices in semiconductor electronics, photonics, micro/nano-electromechanical systems, microwave electronics, microfluidics, and superconducting quantum circuits. In the hands-on lab component of this course, students will learn build, optimize and better understand these systems and fabrication processes through the statistical design and analysis of experiments (i.e. Design of Experiments, DOE).

PHYS 503. Thesis. 1-16 Credits.
A written document resulting from study or research and submitted as a major requirement for a degree.
Repeatable 99 times

PHYS 507. Seminar: [Topic]. 1-4 Credits.
A small group of students studying a subject with a faculty member. Although practices vary, students may do original research and exchange results through informal lectures, reports, and discussions.
Repeatable 99 times

PHYS 508. Workshop: [Topic]. 1-21 Credits.
An intensive experience, limited in scope and time, in which a group of students focus on skills development rather than content mastery.
Repeatable 99 times

PHYS 510. Experimental Course: [Topic]. 1-4 Credits.
Experimental course - topic varies.
Repeatable 99 times

PHYS 510L. Experimental Course: [Topic]. 4 Credits.
Experimental course - topic varies.
Repeatable 99 times

PHYS 521M. Partial Differential Equations: Fourier Analysis I. 4 Credits.
Introduction to PDEs with a view towards applications in physics. Wave and heat equations, classical Fourier series on the circle, Bessel and Legendre series. Multilisted with MATH 521M.
Equivalent to: MATH 521M

PHYS 523M. Introduction to Space Physics. 4 Credits.
Course explores the interaction of the solar wind with the Earth's magnetosphere using fundamental plasma physics supported and motivated by spacecraft observations. Students will gain an understanding of the physics governing the interaction building from single particle plasma motion to specific observation supported examples.

Equivalent to: ERTH 523M

PHYS 525. Modern Optics. 4 Credits.
Special topics in modern applied optics such as Fourier optics, coherence theory, resonators and lasers, holography, and image processing.

PHYS 533. Radiofrequency and Low-noise Measurements. 4 Credits.
This course provides a hands-on introduction to radio-frequency technology, essential in communications, physics labs, and quantum computing. Students will learn radio-frequency device design, test equipment, and quantum measurement techniques through lectures and structured labs. In the second half, they will set up and program advanced radio-frequency test instruments used in quantum research, performing real-world measurements.

PHYS 544. Introduction to Biological Physics. 4 Credits.
The application of physical principles to the study of the living world, especially at molecular and cellular scales. Topics include the mechanical properties of biomaterials, the sensory abilities of cells and organisms, and the dynamical properties of information processing networks.
Requisites: Prereq: Basic computer programming skills.

PHYS 545. Computational Physics. 4 Credits.
The goal of this course is to build a strong foundation in computational physics. With a particular emphasis on topics in modeling and data analysis for drawing physical insights from data in physics and astronomy, we will cover tools and techniques useful for conducting computationally demanding science.

PHYS 581. Design of Experiments. 4 Credits.
Applies statistics to practical data analysis, data-based decision making, model building, and the design of experiments. Emphasizes factorial designs.

PHYS 583. General Relativity I. 4 Credits.
This course will serve as an introduction to the concept of gravity as geometry. The course begins by motivating the need for General Relativity and culminate in the presentation of the Einstein equation, presenting some of the simplest solutions to the Einstein equation.

PHYS 589. The Physics Behind Quantum Computers. 4 Credits.
Quantum computing is a new way of computing based on the rules of Quantum mechanics. We study what sort of computations can be performed by atoms, ions, and superconducting electric circuits.

PHYS 595. Nanofabrication. 4 Credits.
This course introduces students to the design and fabrication of micro- and nanoscale devices. The course will cover fundamental fabrication principles, including optical and electron-beam lithography, thin-film deposition, etching, and characterization. This framework will aid in understanding the processes used in manufacturing chip-based devices in semiconductor electronics, photonics, micro/nano-electromechanical systems, microwave electronics, microfluidics, and superconducting quantum circuits. In the hands-on lab component of this course, students will learn build, optimize and better understand these systems and fabrication processes through the statistical design and analysis of experiments (i.e. Design of Experiments, DOE).

PHYS 601. Research: [Topic]. 1-16 Credits.
Disciplined inquiry of a topic with varying techniques and assignments suited to the nature and conditions of the problem being investigated. Often pursued in relation to a dissertation or thesis.
Repeatable 99 times

PHYS 603. Dissertation. 1-16 Credits.
A written document resulting from study or research and submitted as a major requirement for a degree.
Repeatable 99 times

PHYS 604. Internship: [Topic]. 1-16 Credits.
Professional practice in an organization that integrates concepts studied at the university with career-related work experience.
Requisites: Coreq: good standing in applied physics master's degree program.
Repeatable 99 times

PHYS 605. Reading and Conference: [Topic]. 1-16 Credits.
A particular selection of material read by a student and discussed in conference with a faculty member.
Repeatable 99 times

PHYS 606. Practicum: [Topic]. 1-16 Credits.
A series of clinical experiences under academic supervision designed to integrate theory and principles with practice.
Repeatable 99 times

PHYS 607. Seminar: [Topic]. 1-4 Credits.
Recent topics include Astrophysics and Gravitation, Biophysics, Condensed Matter, High Energy Physics, Physics Colloquium, Theoretical Physics.
Repeatable 99 times

PHYS 608. Workshop: [Topic]. 1-16 Credits.
An intensive experience, limited in scope and time, in which a group of students focus on skills development rather than content mastery.
Repeatable 99 times

PHYS 609. Terminal Project. 1-16 Credits.
A presentation incorporating the knowledge and skills acquired from course work completed for a degree.
Repeatable 99 times

PHYS 610. Experimental Course: [Topic]. 1-4 Credits.
Experimental course - topic varies.
Repeatable 99 times

PHYS 610L. Experimental Course: [Topic]. 4 Credits.
Experimental course - topic varies.
Repeatable 99 times

PHYS 611. Theoretical Mechanics. 4 Credits.
Lagrangian and Hamiltonian mechanics, small oscillations, rigid bodies. Sequence.

PHYS 612. Theoretical Mechanics. 2 Credits.
Lagrangian and Hamiltonian mechanics, small oscillations, rigid bodies. Sequence.
Requisites: Prereq: PHYS 611.

PHYS 613. Statistical Physics. 4 Credits.
Thermodynamics, statistical mechanics, kinetic theory, application to gases, liquids, solids, atoms, molecules, and the structure of matter. Sequence.

PHYS 614. Statistical Physics. 4 Credits.
Thermodynamics, statistical mechanics, kinetic theory, application to gases, liquids, solids, atoms, molecules, and the structure of matter. Sequence.
Requisites: Prereq: PHYS 613.

PHYS 622. Electromagnetic Theory. 4 Credits.
Microscopic form of Maxwell's equations, derivation and solution of the wave equation, Lorentz covariant formulation, motion of charges in given fields, propagation and diffraction, radiation by given sources, coupled motion of sources and fields, the electromagnetic field in dense media.

PHYS 623. Electromagnetic Theory. 4 Credits.
Microscopic form of Maxwell's equations, derivation and solution of the wave equation, Lorentz covariant formulation, motion of charges in given fields, propagation and diffraction, radiation by given sources, coupled motion of sources and fields, the electromagnetic field in dense media. Sequence.
Requisites: Prereq: PHYS 622.

PHYS 626. Physical Optics with Labs. 4 Credits.
Fundamentals of applied geometric and wave optics theory, reinforced through homework assignments, and explored in experiments conducted with lasers and optical components. Sequence with PHYS 627, PHYS 628.

PHYS 627. Optical Materials and Devices. 4 Credits.
Principles of quantum mechanics and solid-state physics relating to material properties of optoelectronic devices with corresponding laboratories teaching how to operate and characterize these devices. Sequence with PHYS 626, PHYS 628.
Requisites: Prereq: PHYS 626.

PHYS 631. Quantum Mechanics. 4 Credits.
Review of fundamentals, central force problems, matrix mechanics. Sequence.

PHYS 632. Quantum Mechanics. 4 Credits.
Approximation methods, scattering. Sequence.
Requisites: Prereq: PHYS 631.

PHYS 633. Quantum Mechanics. 4 Credits.
Rotation symmetry, spin, identical particles. Sequence.
Requisites: Prereq: PHYS 632.

PHYS 661. Particle Physics I. 4 Credits.
Theory, phenomenology, and experimental basis of the standard model of particle physics: fundamentals; symmetries; quantum electrodynamics; R; quarks and leptons; chirality; flavor symmetry; mesons; baryons; form factors; deep inelastic scattering. Sequence.

PHYS 662. Particle Physics II. 4 Credits.
Theory, phenomenology, and experimental basis of the standard model of particle physics: quantum chromodynamics; parton distribution functions; hadron-hadron collisions; particle interactions in matter; collider detectors; experimental methodologies to analyze data; statistical thresholds and significance. Sequence with PHYS 661, PHYS 663.
Requisites: Prereq: PHYS 661.

PHYS 663. Particle Physics III. 4 Credits.
Theory, phenomenology, and experimental basis of the standard model of particle physics: electroweak symmetry breaking; CKM mixing; Higgs couplings; early universe cosmology; Friedmann expansion; entropy; freeze-out; impact of neutrinos on cosmology; dark matter evidence and candidates. Sequence with PHYS 661, PHYS 662.
Requisites: Prereq: PHYS 662.

PHYS 664. Quantum Field Theory. 4 Credits.
Canonical quantization, path integral formulation of quantum field theory, Feynman rules for perturbation theory, quantum electrodynamics, renormalization, gauge theory of the strong and electroweak interactions. Sequence with PHYS 665, PHYS 666.

PHYS 665. Quantum Field Theory II. 4 Credits.
The purpose of this course is to apply the methodology established in QFT I to theories of charged fermions coupled to a photon. Then we will begin to explore QFT beyond leading order. Sequence with PHYSS 664, PHYS 666.
Requisites: Prereq: PHYS 664.

PHYS 666. Quantum Field Theory III. 4 Credits.
The purpose of this course is to understand QFT at loop level, and to extend the formalism to non-Abelian gauge bosons. In addition, we will cover a variety of special topics. This course is designed to be the last quarter of a full year sequence. Sequence with PHYS 664, PHYS 665.
Requisites: Prereq: PHYS 665.

PHYS 671. Solid State Physics. 4 Credits.
Crystallography; thermal, electrical, optical, and magnetic properties of solids; band theory; metals, semiconductors, and insulators; defects in solids. Sequence.
Requisites: Prereq: PHYS 633.

PHYS 672. Solid State Physics. 4 Credits.
Crystallography; thermal, electrical, optical, and magnetic properties of solids; band theory; metals, semiconductors, and insulators; defects in solids. Sequence.
Requisites: Prereq: PHYS 671.

PHYS 674. Theory of Condensed Matter. 4 Credits.
Advanced topics include quantum and statistical description of many-particle systems, electronic structure, elementary excitations in solids and fluids, critical phenomena, statics and dynamics of soft condensed matter. Topics and emphasis vary.
Requisites: Prereq: PHYS 673.

PHYS 677M. Semiconductor Device Physics. 4 Credits.
Introduction to the theory behind semiconductors. Elementary theory of inorganic solids; electronic structures and transport properties. Basic theory of devices including diodes, transistors, mosfets, and optoelectronic devices. Offered only in summer. Sequence with PHYS 678M, PHYS 679M. Multilisted with CH 677M.

PHYS 678M. Semiconductor Processing and Characterization Technology. 4 Credits.
Introduction to the techniques required to make semiconductors and test their properties. Solid-state and surface chemistry of inorganic semiconductors as it pertains to microelectronic devices. Offered only in summer. Multilisted with CH 678M. Sequence with PHYS 677M, PHYS 679M.
Requisites: Prereq: PHYS 677M.

PHYS 679M. Device Processing and Characterization Laboratory. 4 Credits.
Students use theory and techniques learned to design, fabricate, and test a device that performs a specific function, with an emphasis on wafer processing and device realization. Offered only in summer. Sequence with PHYS 677M, PHYS 678M. Multilisted with CH 679M.
Requisites: Prereq: CH 678M.

PHYS 681. Cryogenic and Quantum Measurements. 4 Credits.
This course introduces cryogenic and quantum measurements, emphasizing ultra-low-temperature physics and superconducting qubit characterization. Students gain hands-on experience with dilution cryostats, learning their operation, control, and measurement hardware. Through practical lab sessions, they conduct experiments on superconducting qubits, bridging theory with real-world quantum computing applications. Ideal for those in quantum technologies, condensed matter physics, or cryogenic engineering. Concurrent registration in PHYS 682 and PHYS 691 required.
Requisites: Prereq: PHYS 533, PHYS 595. Coreq: PHYS 682, PHYS 691.

PHYS 682. Optical Quantum Lab. 4 Credits.
This hands-on laboratory course trains students in optical physics and experimental techniques central to quantum information science. Covering optical alignment, fiber optics, and acousto-optic modulation, students build a confocal microscope to image single spin qubits, such as atomic defects in diamond. They implement quantum state preparation, optical spin readout, single-qubit gates, and antibunching measurements. Advanced topics include Ramsey interferometry to study qubit dynamics. The course equips students with practical skills for careers in quantum engineering, photonics, and computing, providing a strong foundation for research or industry roles in the rapidly advancing quantum technology sector.
Requisites: Prereq: PHYS 533, PHYS 595. Coreq: PHYS 681, PHYS 691.

PHYS 684. Quantum Optics and Laser Physics. 4 Credits.
Nonlinear optical processes and quantum statistical properties of light produced by such processes, laser theory, wave mixing processes, optical Bloch equations, field quantization, photon statistics, cooperative emissions. Sequence.
Requisites: Prereq: PHYS 354 or equivalent.

PHYS 685. Quantum Optics and Laser Physics. 4 Credits.
Nonlinear optical processes and quantum statistical properties of light produced by such processes, laser theory, wave mixing processes, optical Bloch equations, field quantization, photon statistics, cooperative emissions. Sequence.
Requisites: Prereq: PHYS 684; coreq PHYS 631.

PHYS 686. Quantum Optics and Laser Physics. 4 Credits.
Nonlinear optical processes and quantum statistical properties of light produced by such processes, laser theory, wave mixing processes, optical Bloch equations, field quantization, photon statistics, cooperative emissions. Sequence.
Requisites: Prereq: PHYS 685; coreq: PHYS 632.

PHYS 691. Industry Projects in Quantum and Nanotechnology. 4 Credits.
This hands-on course trains students in designing, building, and testing integrated quantum and nanotechnology devices. Working in teams, students take projects from concept to completion, developing plug-and-play systems through design and fabrication. Projects involve nanofabricating mechanical, photonic, electronic, or superconducting micro- and nanodevices using advanced tools like e-beam lithography, scanning electron microscopy, and atomic force microscopy. Students gain skills in technical communication, design, fabrication, measurement, simulation, analysis, and industry collaboration. By course end, they will have built a functional system, developed industry-relevant expertise, and gained experience in teamwork, innovation, and advanced nanofabrication techniques.
Requisites: Prereq: PHYS 533, PHYS 595. Coreq: PHYS 681, PHYS 682.