

PHYSICS

Physics is the study of the fundamental structure of matter and the interactions of its constituents. Physicists are concerned with the development of concepts needed for a precise description of nature and with experiments to test such concepts.

For students of science and engineering, the study of physics provides the basic foundation needed to understand the complex workings of the material world, from the forces that build atoms to those that build bridges. For students of the liberal arts, the study of physics provides an introduction to modern ideas about the most fundamental and elemental aspects of nature and how those ideas developed in their cultural and historical context. Physics is a basic and indispensable tool in all technical fields, and its development figures prominently in any discussion of the intellectual history of our civilization.

Undergraduate Degree Programs

The department offers several programs leading to degrees in physics. A basic physics curriculum in the College of Science stresses the detailed and advanced preparation needed for graduate work or employment in physics.

Options are available within the physics degree program that prepare students for graduate work or employment in an allied field, such as applied physics, biophysics, chemical physics, geophysics, mathematical physics, optical physics, and physics teaching.

Other programs are offered that train students for careers in physics teaching. A Physics minor is available for students majoring in other areas of science and engineering.

The Department of Physics offers the upper-division curriculum, Paradigms in Physics. Many of the junior-year courses are taught in 2-credit intensive modules, meeting seven hours a week for about three weeks.

Graduate Degrees

Graduate programs leading to the MA, MS, and PhD are offered, emphasizing theoretical or experimental studies in the areas of atomic physics, computational physics, nuclear physics, optical physics, particle physics, and solid state physics. The MS degree has both thesis and nonthesis options. Comprehensive written and oral examinations must be passed before the student can become a candidate for an advanced degree.

Careers

A multitude of opportunities exists for students who complete undergraduate degrees in physics. They include employment in technological industries, including electronics, computers, optics, materials science, and aerospace; graduate study leading to an advanced degree in physics or a related area such as mathematics, Earth sciences, computer science, engineering, or astronomy; and degree programs leading to professions such as law or medicine, with specialties in areas in which a physics background is essential.

Preparation

Recommended high school preparation for students who plan to major in physics includes one year each of chemistry and physics and four years of mathematics through analytic geometry. Mathematics preparation

is especially important; students who are not ready to start calculus (MTH 251 *DIFFERENTIAL CALCULUS) upon entering may be delayed in their progress toward a degree. Students anticipating transfer to OSU from another institution are encouraged to contact the Department of Physics as early as possible to discuss their placement in the course curricula.

Advising

Each undergraduate student is assigned an advisor who helps select the most appropriate degree program and assists in planning the curriculum. Minor variations in the requirements for degrees are possible, but must be discussed with the advisor and approved at an early stage in curriculum planning. Near the end of the degree program, the advisor can help the student to apply for employment or admission to graduate programs.

Options

Students desiring to combine the study of physics with that of another related subject should consider the options below, or should consult with a Department of Physics advisor about substituting upper-division work in a related field for certain of the upper-division physics requirements. All such substitutions must constitute a coherent program in related areas and must be approved in advance by the Department of Physics. In each case, the program must include at least 3 credits of PH 403 *THESIS to satisfy the university's writing intensive course (WIC) requirements.

Astronomy

The Department of Physics offers an introductory course, PH 104 *DESCRIPTIVE ASTRONOMY. Three online courses (PH 205 *SOLAR SYSTEM ASTRONOMY, PH 206 *STARS AND STELLAR EVOLUTION, PH 207 *GALAXIES, QUASARS, AND COSMOLOGY) and several on-campus special topics courses also are offered. Students who desire careers in astronomy can design a curriculum under the Geophysics option, which includes related course work in geology and in atmospheric sciences. This curriculum would qualify the student for graduate work in astronomy.

Graduation Requirements

All undergraduate students must satisfy the university requirements for graduation (see the description of the **OSU Baccalaureate Core** in this catalog) and the college requirements (see the description in the College of Science section).

Grades of C– or better must be attained in all courses required for the Physics major. Courses in which a lower grade is received must be repeated until a satisfactory grade is received.

Undergraduate Programs

Major

- Physics (<http://catalog.oregonstate.edu/college-departments/science/physics/physics-ba-bs-hba-hbs>)

Options

- *Applied Physics*
- *Biological Physics*
- *Chemical Physics*
- *Computational Physics*
- *Geophysics*
- *Mathematical Physics*

- Optical Physics
- Physics Teaching/Physics

Minor

- Physics (<http://catalog.oregonstate.edu/college-departments/science/physics/physics-minor>)

Graduate Programs

Majors

- Applied Physics (<http://catalog.oregonstate.edu/college-departments/science/physics/applied-physics-ms-psm>) **[To be terminated pending approval.]**
- Physics (<http://catalog.oregonstate.edu/college-departments/science/physics/physics-ma-ms-phd-mais>)

Minor

- Physics (<http://catalog.oregonstate.edu/college-departments/science/physics/physics-graduate-minor>)

Heidi Schellman, Head

301 Weniger Hall

Oregon State University

Corvallis, OR 97331-6507

541-737-4631

Email: heidi.schellman@oregonstate.edu

Website: <http://www.physics.oregonstate.edu/>

Faculty

Professors Jansen, Lee, Manogue, McIntyre, Schellman, Tate

Associate Professors Giebultowicz, Lazzati, Minot, Ostroverkhova, Roundy, Schneider

Assistant Professors Gire, Graham, Qiu, Sun

Instructor Bannon, Coffin, Hadley, Ketter, Milstein, Walsh

Adjunct Faculty

Herman, Keszler, Kornilovich

Physics

PH 104. *DESCRIPTIVE ASTRONOMY. (4 Credits)

Historical and cultural context of discoveries concerning planets and stars and their motions. Topics include the solar system, the constellations, birth and death of stars, pulsars and black holes. An accompanying laboratory is used for demonstrations, experiments, and projects, as well as for outdoor observations. Lec/lab. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

Equivalent to: PH 104H

PH 104H. *DESCRIPTIVE ASTRONOMY. (4 Credits)

Historical and cultural context of discoveries concerning planets and stars and their motions. Topics include the solar system, the constellations, birth and death of stars, pulsars and black holes. An accompanying laboratory is used for demonstrations, experiments, and projects, as well as for outdoor observations. Lec/lab. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science; HNRS – Honors Course Designator

Equivalent to: PH 104

PH 106. *PERSPECTIVES IN PHYSICS. (4 Credits)

A descriptive and non-mathematical study of the development of physical concepts and their historical and philosophical context. The emphasis is on the origin, meaning, significance, and limitations of these concepts and their role in the evolution of current understanding of the universe. Concepts to be covered include Copernican astronomy, Newtonian mechanics, energy, electricity and magnetism, relativity, and quantum theory. Intended primarily for non-science students. Lec/lab. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

PH 111. *INQUIRING INTO PHYSICAL PHENOMENA. (4 Credits)

Development of conceptual understandings through investigation of everyday phenomena. Emphasis is on questioning, predicting, exploring, observing, discussing, and writing in physical science contexts. Students document their initial thinking, record their evolving understandings, and write reflections upon how their thinking changed and what fostered their learning. Lec/lab. (Baccalaureate Core Course)

Attributes: CPPS – Core, Pers, Physical Science

PH 199. SPECIAL STUDIES. (1-16 Credits)

One-credit sections are graded pass/no pass.

This course is repeatable for 99 credits.

PH 201. *GENERAL PHYSICS. (5 Credits)

Introductory survey course covering a broad spectrum of classical and modern physics with applications. Topics include dynamics, vibrations and waves, electricity and magnetism, optics, and modern physics. Laboratory and recitation sections accompany the lectures. Mathematical preparation should include college algebra and trigonometry. Lec/lab/rec. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

Recommended: MTH 111 and MTH 112

PH 202. *GENERAL PHYSICS. (5 Credits)

Introductory survey course covering broad spectrum of classical and modern physics with applications. Topics include dynamics, vibrations and waves, electricity and magnetism, optics, and modern physics. Laboratory and recitation sections accompany the lectures. Mathematical preparation should include college algebra and trigonometry. Lec/lab/rec. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

Recommended: MTH 111 and MTH 112 and PH 201

PH 203. *GENERAL PHYSICS. (5 Credits)

Introductory survey course covering broad spectrum of classical and modern physics with applications. Topics include dynamics, vibrations and waves, electricity and magnetism, optics, and modern physics. Laboratory and recitation sections accompany the lectures. Mathematical preparation should include college algebra and trigonometry. Lec/lab/rec. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

Recommended: MTH 111 and MTH 112 and PH 202

PH 205. *SOLAR SYSTEM ASTRONOMY. (4 Credits)

History, laws, and tools of astronomy. Composition, motion, and origin of the sun, planets, moons, asteroids, and comets. An accompanying laboratory is used for demonstrations, experiments, and projects, as well as for outdoor observations. The courses in the astronomy sequence (PH 205, PH 206, PH 207) can be taken in any order. Lec/lab. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

PH 206. *STARS AND STELLAR EVOLUTION. (4 Credits)

Properties of stars; star formation, evolution, and death; supernovae, pulsars, and black holes. An accompanying laboratory is used for demonstrations, experiments, and projects, as well as for outdoor observations. The courses in the astronomy sequence (PH 205, PH 206, PH 207) can be taken in any order. Lec/lab. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

PH 207. *GALAXIES, QUASARS, AND COSMOLOGY. (4 Credits)

Nature and content of galaxies, properties of quasars, and the cosmic background radiation. Emphasis on the Big-Bang model and its features. An accompanying laboratory is used for demonstrations, experiments, and projects, as well as for outdoor observations. The courses in the astronomy sequence (PH 205, PH 206, PH 207) can be taken in any order. Lec/lab. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

PH 211. *GENERAL PHYSICS WITH CALCULUS. (4 Credits)

A comprehensive introductory survey course intended primarily for students in the sciences and engineering. Topics include mechanics, wave motion, thermal physics, electromagnetism, and optics. Elementary calculus is used. Laboratory work accompanies the lectures. Lec/lab/rec. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

Equivalent to: PH 211H

Recommended: MTH 251 and concurrent enrollment in MTH 252 and a PH 221 recitation section

PH 211H. *GENERAL PHYSICS WITH CALCULUS. (4 Credits)

A comprehensive introductory survey course intended primarily for students in the sciences and engineering. Topics include mechanics, wave motion, thermal physics, electromagnetism, and optics. Elementary calculus is used. Laboratory work accompanies the lectures. Lec/lab/rec. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science; HNRS – Honors Course Designator

Equivalent to: PH 211

Recommended: MTH 251 and concurrent enrollment in MTH 252 and a PH 211 recitation section

PH 212. *GENERAL PHYSICS WITH CALCULUS. (4 Credits)

A comprehensive introductory survey course intended primarily for students in the sciences and engineering. Topics include mechanics, wave motion, thermal physics, electromagnetism, and optics. Elementary calculus is used. Laboratory work accompanies the lectures. Lec/lab. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

Prerequisites: PH 211 with D- or better

Recommended: MTH 252 and concurrent enrollment in PH 222 and MTH 254

PH 213. *GENERAL PHYSICS WITH CALCULUS. (4 Credits)

A comprehensive introductory survey course intended primarily for students in the sciences and engineering. Topics include mechanics, wave motion, thermal physics, electromagnetism, and optics. Elementary calculus is used. Laboratory work accompanies the lectures. Lec/lab/rec. (Bacc Core Course)

Attributes: CPPS – Core, Pers, Physical Science

Recommended: MTH 254 and PH 212. Concurrent enrollment in a recitation section is strongly recommended.

PH 221. RECITATION FOR PHYSICS 211. (1 Credit)

One-hour weekly session for the development of problem-solving skills in calculus-based general physics. Lec/rec. Graded P/N.

Corequisites: PH 211

Equivalent to: PH 221H

PH 221H. RECITATION FOR PHYSICS 211. (1 Credit)

One-hour weekly session for the development of problem-solving skills in calculus-based general physics. Lec/rec. Graded P/N.

Attributes: HNRS – Honors Course Designator

Equivalent to: PH 221

Recommended: Concurrent enrollment in PH 211 or PH 211H

PH 222. RECITATION FOR PHYSICS 212. (1 Credit)

One-hour weekly session for the development of problem-solving skills in calculus-based general physics. Graded P/N.

Corequisites: PH 212

Equivalent to: PH 222H

PH 222H. RECITATION FOR PHYSICS 212. (1 Credit)

One-hour weekly session for the development of problem-solving skills in calculus-based general physics. Lec/rec. Graded P/N.

Attributes: HNRS – Honors Course Designator

Equivalent to: PH 222

Recommended: Concurrent enrollment in PH 212 or PH 212H

PH 223. RECITATION FOR PHYSICS 213. (1 Credit)

One-hour weekly session for the development of problem-solving skills in calculus-based general physics. Lec/rec. Graded P/N.

Corequisites: PH 213

Equivalent to: PH 223H

PH 223H. RECITATION FOR PHYSICS 213. (1 Credit)

One-hour weekly session for the development of problem-solving skills in calculus-based general physics. Lec/rec. Graded P/N.

Attributes: HNRS – Honors Course Designator

Corequisites: PH 213

Equivalent to: PH 223

Recommended: Concurrent enrollment in PH 213

PH 265. SCIENTIFIC COMPUTING. (3 Credits)

Basic computational tools and techniques for courses in science and engineering. Project approach to problem solving using symbolic and compiled languages with visualization. Basic computer literacy assumed.

Recommended: Concurrent enrollment in MTH 251

PH 299. SPECIAL TOPICS. (1-16 Credits)

This course is repeatable for 16 credits.

PH 313. *ENERGY ALTERNATIVES. (3 Credits)

Exploration of the challenges and opportunities posed by dwindling resources; physical and technological basis of our current energy alternatives; new or controversial technologies such as nuclear or solar power; overview of resource availability, patterns of energy consumption, and current governmental policies. (Bacc Core Course)

Attributes: CSST – Core, Synthesis, Science/Technology/Society

Equivalent to: PH 313H

Recommended: Upper-division standing and 12 credits of introductory science.

PH 313H. *ENERGY ALTERNATIVES. (3 Credits)

Exploration of the challenges and opportunities posed by dwindling resources; physical and technological basis of our current energy alternatives; new or controversial technologies such as nuclear or solar power; overview of resource availability, patterns of energy consumption, and current governmental policies. (Bacc Core Course)

Attributes: CSST – Core, Synthesis, Science/Technology/Society; HNRS – Honors Course Designator

Equivalent to: PH 313

Recommended: Upper-division standing and 12 credits of introductory science

PH 315. PHYSICS OF CONTEMPORARY CHALLENGES. (3 Credits)

An introduction to thermal and quantum physics in the context of contemporary challenges faced by our society, such as power generation, energy efficiency, and global warming.

Recommended: PH 211

PH 331. *SOUND, HEARING, AND MUSIC. (3 Credits)

Basic course in the physics, technology, and societal implications of sound. Intended for students in nontechnical majors. Topics include wave motion, hearing and the perception of sound, noise pollution, music and musical instruments, architectural acoustics, and sound recording and reproduction. (Bacc Core Course)

Attributes: CSST – Core, Synthesis, Science/Technology/Society

Recommended: Upper-division standing and one year of university science

PH 332. *LIGHT, VISION, AND COLOR. (3 Credits)

Basic physics of light, optical instruments (lenses, telescopes, microscopes), the eye and visual perception, colors, photography, environmental lighting, lasers and holography. For nontechnical majors. (Bacc Core Course)

Attributes: CSST – Core, Synthesis, Science/Technology/Society

Recommended: Upper-division standing and one year of university science

PH 335. TECHNIQUES OF THEORETICAL MECHANICS. (3 Credits)

Newtonian, Lagrangian, and Hamiltonian classical mechanics. Special relativity with relativistic mechanics.

Recommended: PH 212 and MTH 254

PH 365. COMPUTATIONAL PHYSICS LAB. (1 Credit)

A project-driven laboratory experience in computational physics. Includes the use of basic mathematical and numerical techniques in computer calculations leading to solutions for typical physical problems. Topics to be covered will coordinate with the Paradigms in Physics course sequence.

Prerequisites: PH 213 with C- or better

Recommended: Concurrent enrollment in Paradigms

PH 366. COMPUTATIONAL PHYSICS LAB. (1 Credit)

A project-driven laboratory experience in computational physics. Includes the use of basic mathematical and numerical techniques in computer calculations leading to solutions for typical physical problems. Topics to be covered will coordinate with the Paradigms in Physics course sequence.

Prerequisites: PH 213 with C- or better

Recommended: Concurrent enrollment in Paradigms

PH 367. COMPUTATIONAL PHYSICS LAB. (1 Credit)

A project-driven laboratory experience in computational physics. Includes the use of basic mathematical and numerical techniques in computer calculations leading to solutions for typical physical problems. Topics to be covered will coordinate with the Paradigms in Physics course sequence.

Prerequisites: PH 213 with C- or better

Recommended: Concurrent enrollment in Paradigms

PH 399. SPECIAL TOPICS. (1-16 Credits)

Equivalent to: PH 399H

This course is repeatable for 16 credits.

PH 399H. SPECIAL TOPICS. (1-16 Credits)

Attributes: HNRS – Honors Course Designator

Equivalent to: PH 399

This course is repeatable for 16 credits.

PH 401. RESEARCH. (1-16 Credits)

A research project under the supervision of a faculty member, whose approval must be arranged by the student in advance of registration.

This course is repeatable for 16 credits.

PH 403. ^THESIS. (1-16 Credits)

A research project leading to a thesis under the supervision of a faculty member, whose approval must be arranged by the student in advance of registration. (Writing Intensive Course)

Attributes: CWIC – Core, Skills, WIC

This course is repeatable for 16 credits.

PH 405. READING AND CONFERENCE. (1-16 Credits)

An independent study project under the supervision of a faculty member, whose approval must be arranged by the student in advance of registration.

This course is repeatable for 16 credits.

PH 407. SEMINAR. (1-16 Credits)

Departmental seminars or colloquium. Graded P/N.

Equivalent to: PH 407H

This course is repeatable for 16 credits.

PH 407H. SEMINAR. (1-16 Credits)

Departmental seminars or colloquium.

Attributes: HNRS – Honors Course Designator

Equivalent to: PH 407

This course is repeatable for 16 credits.

PH 409. PHYSICS TEACHING PRACTICUM. (1-6 Credits)

Physics practicum experience for students assisting in Physics courses. Includes training in course content and development of instructional materials. Admission is by application. See the department office in Weniger 301 for details.

This course is repeatable for 6 credits.

PH 410. INTERNSHIP. (1-16 Credits)

This course is repeatable for 16 credits.

PH 411. ELECTRONICS. (3 Credits)

Covers how to build and analyze basic circuits. Topics include passive dc and ac circuits including filters, complex impedance, Fourier analysis, operational amplifiers, semiconductor diodes, and transistors.

Recommended: PH 213

PH 415. COMPUTER INTERFACING AND INSTRUMENTATION. (3 Credits)

Applications of computers as scientific instruments, with emphasis on hardware and instrumentation, online data acquisition, and computer control of experiments.

Recommended: Upper-division and PH 412/PH 512 or equivalent background in electronics

PH 422. PARADIGMS IN PHYSICS: STATIC FIELDS. (3 Credits)

Theory of static electric, magnetic, and gravitational potentials and fields using the techniques of vector calculus in three dimensions.

Recommended: PH 213 and MTH 255

PH 423. PARADIGMS IN PHYSICS: ENERGY AND ENTROPY. (3 Credits)

Thermodynamics and canonical statistical mechanics.

Recommended: PH 213

PH 424. PARADIGMS IN PHYSICS: OSCILLATIONS AND WAVES. (3 Credits)

Dynamics of mechanical and electrical oscillation using Fourier series and integrals; time and frequency representations for driven damped oscillators, resonance; one-dimensional waves in classical mechanics and electromagnetism; normal modes.

Recommended: PH 213 and PH 411 and MTH 256

PH 425. PARADIGMS IN PHYSICS: QUANTUM FUNDAMENTALS. (3 Credits)

Introduction to quantum mechanics through Stern-Gerlach spin measurements. Probability, eigenvalues, operators, measurement, state reduction, Dirac notation, matrix mechanics, time evolution. Quantum behavior of a one-dimensional well.

Recommended: PH 213 and concurrent enrollment in MTH 341

PH 426. PARADIGMS IN PHYSICS: CENTRAL FORCES. (3 Credits)

Gravitational and electrostatic forces; angular momentum and spherical harmonics, separation of variables in classical and quantum mechanics, hydrogen atom.

Recommended: PH 213 and PH 422 and PH 425 and concurrent enrollment in PH 335

PH 427. PARADIGMS IN PHYSICS: PERIODIC SYSTEMS. (3 Credits)

Quantum waves in position and momentum space; Bloch waves in one-dimensional periodic systems, and the reciprocal lattice; coupled harmonic oscillators; phonons.

Recommended: PH 424 and PH 425 and concurrent enrollment in PH 315

PH 431. CAPSTONES IN PHYSICS: ELECTROMAGNETISM. (3 Credits)

Static electric and magnetic fields in matter, electrodynamics, Maxwell equations, electromagnetic waves, wave guides, dipole radiation.

Recommended: (PH 424 or 524) and (PH 426 or PH 526)

PH 441. CAPSTONES IN PHYSICS: THERMAL AND STATISTICAL PHYSICS. (3 Credits)

Entropy and quantum mechanics; canonical Gibbs probability; ideal gas; thermal radiation; Einstein and Debye lattices; grand canonical Gibbs probability; ideal Fermi and Bose gases; chemical reactions and phase transformations.

Recommended: (PH 423 or PH 523) and (PH 451 or PH 551)

PH 451. CAPSTONES IN PHYSICS: QUANTUM MECHANICS. (3 Credits)

Wave mechanics, Schrodinger equation, operators, harmonic oscillator, identical particles, atomic fine structure, approximation methods and applications.

Recommended: (PH 424 or PH 524) and (PH 425 or PH 525) and (PH 426 or PH 526)

PH 455. ASTROPHYSICS. (3 Credits)

Physics of stars and the cosmos.

Recommended: PH 213; PH 315 or equivalent junior-level background in modern physics and thermodynamics.

PH 461. CAPSTONES IN PHYSICS: MATHEMATICAL METHODS. (3 Credits)

Complex algebra, special functions, partial differential equations, series solutions, complex integration, calculus of residues.

Recommended: (PH 424 or PH 524) and (PH 426 or PH 526) and MTH 256

PH 464. SCIENTIFIC COMPUTING II. (3 Credits)

Mathematical, numerical, and conceptual elements forming foundations of scientific computing: computer hardware, algorithms, precision, efficiency, verification, numerical analysis, algorithm scaling, profiling, and tuning. Lec/lab.

PH 465. COMPUTATIONAL PHYSICS. (3 Credits)

The use of basic mathematical and numerical techniques in computer calculations leading to solutions for typical physical problems. Topics to be covered include models and applications ranging from classical mechanics and electromagnetism to modern solid state and particle physics.

Recommended: PH 464 or PH 564

PH 481. PHYSICAL OPTICS. (4 Credits)

Wave propagation, polarization, interference, diffraction, and selected topics in modern optics.

Recommended: PH 431 or PH 531

PH 482. OPTICAL ELECTRONIC SYSTEMS. (4 Credits)

Photodetectors, laser theory, and laser systems. Lec/lab. CROSSLISTED as ECE 482/ECE 582.

Equivalent to: ECE 482

Recommended: ECE 391 or (PH 481 or PH 581)

PH 483. GUIDED WAVE OPTICS. (4 Credits)

Optical fibers, fiber mode structure and polarization effects, fiber interferometry, fiber sensors, optical communication systems. Lec/lab. CROSSLISTED as ECE 483/ECE 583.

Equivalent to: ECE 483

Recommended: Completion or concurrent enrollment in ECE 391 or PH 481

PH 495. INTRODUCTION TO PARTICLE AND NUCLEAR PHYSICS. (3 Credits)

Elementary particles and forces, nuclear structure and reactions.

Recommended: PH 451 or PH 551

PH 499. SPECIAL TOPICS. (1-16 Credits)

Topics vary from year to year. May be repeated for credit. Not offered every year.

This course is repeatable for 16 credits.

PH 501. RESEARCH. (1-16 Credits)

Graded P/N.

This course is repeatable for 16 credits.

PH 503. THESIS. (1-16 Credits)

This course is repeatable for 999 credits.

PH 505. READING AND CONFERENCE. (1-16 Credits)

This course is repeatable for 16 credits.

PH 507. SEMINAR. (1-16 Credits)

Section 1: Departmental Colloquium. Section 3: Nuclear and Particle Physics. Section 5: Atomic, Molecular, and Optical Physics. Section 7: Solid State Physics. Section 9: Computational Physics. One-credit options are graded P/N.

This course is repeatable for 16 credits.

PH 510. INTERNSHIP. (1-16 Credits)

This course is repeatable for 16 credits.

PH 511. ELECTRONICS. (3 Credits)

Covers how to build and analyze basic circuits. Topics include passive dc and ac circuits including filters, complex impedance, Fourier analysis, operational amplifiers, semiconductor diodes, and transistors.

Recommended: PH 213

PH 512. ANALOG AND DIGITAL ELECTRONICS. (3 Credits)

Circuit theory. Passive dc and ac circuits including filters, resonance, complex impedance and Fourier analysis. Operational amplifiers, gates and combinational logic. Semiconductor principles, diodes, transistors, BJTs and FETs. Multiplexing, flip-flops and sequential logic, 555 timer, registers and memory, DAC, ADC.

Recommended: PH 511 and completion or concurrent enrollment in PH 314

PH 515. COMPUTER INTERFACING AND INSTRUMENTATION. (3 Credits)

Applications of computers as scientific instruments, with emphasis on hardware and instrumentation, online data acquisition, and computer control of experiments.

Recommended: PH 412 or PH 512 or equivalent background in electronics

PH 531. CAPSTONES IN PHYSICS: ELECTROMAGNETISM. (3 Credits)

Static electric and magnetic fields in matter, electrodynamics, Maxwell equations, electromagnetic waves, wave guides, dipole radiation.

Recommended: (PH 424 or PH 524) and (PH 426 or PH 526)

PH 541. CAPSTONES IN PHYSICS: THERMAL AND STATISTICAL PHYSICS. (3 Credits)

Entropy and quantum mechanics; canonical Gibbs probability; ideal gas; thermal radiation; Einstein and Debye lattices; grand canonical Gibbs probability; ideal Fermi and Bose gases; chemical reactions and phase transformations.

Recommended: (PH 423 or PH 523) and (PH 451 or PH 551)

PH 551. CAPSTONES IN PHYSICS: QUANTUM MECHANICS. (3 Credits)

Wave mechanics, Schroedinger equation, operators, harmonic oscillator, identical particles, atomic fine structure, approximation methods and applications.

Recommended: (PH 424 or PH 524) and (PH 425 or PH 525) and (PH 426 or PH 526)

PH 555. ASTROPHYSICS. (3 Credits)

Physics of stars and the cosmos.

Recommended: PH 213; PH 315 or equivalent junior-level background in modern physics and thermodynamics.

PH 561. MATHEMATICAL PHYSICS. (3 Credits)

Fundamental mathematical techniques needed for graduate students in physics. Topics include vector spaces and operators; fourier series, integrals, and transforms; partial differential equations; special functions, distributions, and delta functions; Green's functions; complex analysis.

PH 562. MATHEMATICAL PHYSICS. (3 Credits)

Fundamental mathematical techniques needed for graduate students in physics. Topics include vector spaces and operators; fourier series, integrals, and transforms; partial differential equations; special functions, distributions, and delta functions; Green's functions; complex analysis.

PH 564. SCIENTIFIC COMPUTING II. (3 Credits)

Mathematical, numerical, and conceptual elements forming foundations of scientific computing: computer hardware, algorithms, precision, efficiency, verification, numerical analysis, algorithm scaling, profiling, and tuning. Lec/lab.

PH 575. INTRODUCTION TO SOLID STATE PHYSICS. (3 Credits)

Introduction to condensed matter physics for majors in physics, chemistry, and engineering. Topics include band structure, free electron behavior, optical properties, magnetism, and lattice excitations.

Recommended: (PH 451 or PH 551) and concurrent enrollment in PH 427 or PH 527

PH 581. PHYSICAL OPTICS. (4 Credits)

Wave propagation, polarization, interference, diffraction, and selected topics in modern optics.

Recommended: PH 431 or PH 531

PH 582. OPTICAL ELECTRONIC SYSTEMS. (4 Credits)

Photodetectors, laser theory, and laser systems. Lec/lab. CROSSLISTED as ECE 482/ECE 582.

Equivalent to: ECE 582

Recommended: PH 481 or PH 581

PH 583. GUIDED WAVE OPTICS. (4 Credits)

Optical fibers, fiber mode structure and polarization effects, fiber interferometry, fiber sensors, optical communication systems. Lec/lab. CROSSLISTED as ECE 483/ECE 583.

Equivalent to: ECE 583

Recommended: Completion or concurrent enrollment in ECE 391 or PH 481/581

PH 585. ATOMIC, MOLECULAR, AND OPTICAL PHYSICS. (3 Credits)

Atomic and molecular structure, interaction with electromagnetic fields, atomic and molecular spectra, spectroscopic techniques, laser theory, nonlinear optics.

Recommended: (PH 431 or PH 531) or (PH 451 or PH 551)

PH 591. BIOLOGICAL PHYSICS. (3 Credits)

Basic physics principles applied to the kinetics and dynamics of molecular and cellular processes. Ion channels, two-state systems, dynamics of molecular motors, cell signalling, and multicellular phenomena.

Recommended: PH 320, PH 421, PH 422 and PH 423 or junior-level background in classical mechanics, electromagnetism, and thermodynamics

PH 595. INTRODUCTION TO PARTICLE AND NUCLEAR PHYSICS. (3 Credits)

Elementary particles and forces, nuclear structure and reactions.

Recommended: PH 451 or PH 551

PH 599. SPECIAL TOPICS. (1-16 Credits)

(See PH 499 for description.)

This course is repeatable for 16 credits.

PH 601. RESEARCH. (1-16 Credits)

This course is repeatable for 16 credits.

PH 603. THESIS. (1-16 Credits)

This course is repeatable for 999 credits.

PH 605. READING AND CONFERENCE. (1-16 Credits)

This course is repeatable for 16 credits.

PH 607. SEMINAR. (1-16 Credits)

Section 1: Departmental Colloquium. Section 3: Nuclear and Particle Physics. Section 5: Atomic, Molecular, and Optical Physics. Section 7: Solid State Physics. Section 9: Computational Physics. One-credit options are graded P/N.

This course is repeatable for 16 credits.

PH 621. DYNAMICS OF SINGLE- AND MULTI-PARTICLE SYSTEMS. (3 Credits)

Introduction to theory of non-linear systems. Chaos in Hamiltonian and dissipative systems. Lyapunov exponents, fractal geometries.

Recommended: PH 435 or PH 535

PH 631. ELECTROMAGNETIC THEORY. (3 Credits)

Electrostatics; multipole expansion; magnetostatics; radiation fields; dynamics of relativistic particles and electromagnetic fields.

Recommended: PH 431 or PH 531

PH 632. ELECTROMAGNETIC THEORY. (3 Credits)

Electrostatics; multipole expansion; magnetostatics; radiation fields; dynamics of relativistic particles and electromagnetic fields.

Recommended: PH 631 and (PH 431 or PH 531)

PH 633. ELECTROMAGNETIC THEORY. (3 Credits)

Electrostatics; multipole expansion; magnetostatics; radiation fields; dynamics of relativistic particles and electromagnetic fields.

Recommended: PH 632 and (PH 431 or PH 531)

PH 641. STATISTICAL THERMOPHYSICS. (3 Credits)

Macroscopic thermodynamics and kinetic theory. Classical and quantum statistical ensembles; partition functions. Applications to atoms and molecules, clustering, solids, radiation.

Recommended: PH 435 or PH 535

PH 642. STATISTICAL THERMOPHYSICS. (3 Credits)

Macroscopic thermodynamics and kinetic theory. Classical and quantum statistical ensembles; partition functions. Applications to atoms and molecules, clustering, solids, radiation.

Recommended: PH 641

PH 651. QUANTUM MECHANICS. (3 Credits)

Basic principles of nonrelativistic quantum theory and applications. Schrodinger theory, quantum theory of angular momentum, matrix mechanics, perturbation theory, identical particles, scattering.

Recommended: (PH 435 or PH 535) and (PH 451 or PH 551)

PH 652. QUANTUM MECHANICS. (3 Credits)

Basic principles of nonrelativistic quantum theory and applications. Schrodinger theory, quantum theory of angular momentum, matrix mechanics, perturbation theory, identical particles, scattering.

Recommended: (PH 435 or PH 535) and (PH 451 or PH 551) and PH 651

PH 653. QUANTUM MECHANICS. (3 Credits)

Basic principles of nonrelativistic quantum theory and applications. Schrodinger theory, quantum theory of angular momentum, matrix mechanics, perturbation theory, identical particles, scattering.

Recommended: (PH 435 or PH 535) and (PH 451 or PH 551) and PH 652

PH 654. ADVANCED QUANTUM THEORY. (3 Credits)

Scattering theory, second quantization and many body theory, relativistic quantum mechanics, quantization of fields, quantum electrodynamics, and elementary particles.

Recommended: PH 653

PH 671. SOLID STATE PHYSICS, ELECTRON TRANSPORT. (2 Credits)

Fundamentals of solid state physics, Boltzmann transport, phonon and defect scattering, quantum transport, transport in magnetic field, localization, Mott-insulator transition, electron tunneling, superconductivity. Offered in alternate years.

Recommended: Basic knowledge of electromagnetism and quantum mechanics.

PH 672. SOLID STATE PHYSICS, THEORY. (2 Credits)

The many-body problem, density functional theory, excited states properties, BCS theory of superconductivity. Offered in alternate years.

Recommended: PH 575 and PH 654 and basic knowledge of electromagnetism and quantum mechanics.

PH 673. SOLID STATE PHYSICS, NANOSCIENCE AND NANOTECHNOLOGY. (2 Credits)

Introduction to nanoscience and nanotechnology; semiconductor quantum wells, wires, and dots; bulk metals vs nanoparticles; molecular ensembles vs single molecules; fabrication of nanoparticles and nanostructured materials; scanning probe microscopy; advanced optical imaging and manipulation. Offered in alternate years.

Recommended: Basic knowledge of electromagnetism and quantum mechanics.

PH 674. SOLID STATE PHYSICS, MAGNETISM. (2 Credits)

Magnetism of atoms; interaction between magnetic atoms, magnetic ordering in crystalline solids; excitations in magnetic solids; temperature dependent phenomena in magnetic solids; magnetism of metals, alloys, insulators and semiconductors; topics of considerable interest in contemporary research.

Recommended: Basic knowledge of electromagnetism and quantum mechanics.

PH 681. ATOMIC, MOLECULAR AND OPTICAL PHYSICS, MODERN OPTICS. (2 Credits)

Maxwell's equations in matter; refraction, phase and group indices; material and geometry dispersion; effective-medium regime. Not offered every year.

Recommended: Basic knowledge of electromagnetism and quantum mechanics.

PH 682. ATOMIC, MOLECULAR, OPTICAL PHYSICS, SEMICONDUCTOR OPTICS. (2 Credits)

Linear response theory; polarization effects; interband excitations and emissions; low dimensional systems; excitons; phonons; semiconductor lasers; photovoltaics. Offered alternate years.

Recommended: Basic knowledge of electromagnetism and quantum mechanics.

PH 683. ATOMIC, MOLECULAR AND OPTICAL PHYSICS, NONLINEAR OPTICS. (2 Credits)

Coherent nonlinear electromagnetic phenomena; harmonic generation and parametric mixing; quantum mechanical description of multi-photon interactions; incoherent multi-photon interactions; coherent nonlinear optical phenomena and spectroscopies. Offered in alternate years.

Recommended: Basic knowledge of electromagnetism and quantum mechanics.

PH 684. ATOMIC, MOLECULAR AND OPTICAL PHYSICS, ULTRAFAST OPTICS. (2 Credits)

Introduction of ultrafast optical science; short pulse propagation in linear media; pulse stretching and compressing; Q-switching and mode-locking; characterization of femtosecond lasers; coherent optical effects. Offered in alternate years.

Recommended: Basic knowledge of electromagnetism and quantum mechanics.

PH 699. SPECIAL TOPICS: BIOLOGICAL PHYSICS. (3 Credits)

Topics vary from year to year. Not offered every year.

This course is repeatable for 9 credits.