PHYS-PHYSICS

PHYS 1114 General Physics for Non-Science Majors 4 Credit Hours
Prerequisite: high school algebra II. Not open to students who intend to do major work in mathematics or physical science. Concepts of force, energy, matter, atomic physics, electricity, light, presented as a part of a liberal education. A student may not receive credit for this course and PHYS 1205, PHYS 2414 or PHYS 2514. (F, Sp, Su) [II-NS].

PHYS 1205 Introductory Physics I for Physics Majors 5 Credit Hours
Prerequisite: enrollment in Mathematics 1823 or 1914 or permission of instructor. To be taken by physics, astronomy and engineering physics majors during the first semester of their freshman year. Kinematics, dynamics, work and energy, many-particle systems, rigid body rotation, simple harmonic motion. Laboratory is an integral part of the course. Laboratory (F) [II-NSL].

PHYS 1215 Introductory Physics II for Physics Majors 5 Credit Hours
Prerequisite: 1205 or permission of instructor. Electricity and magnetism: static fields and forces, circuits, electromagnetic induction. Thermodynamics: the First and Second Laws, temperature, heat, work and entropy. Laboratory is an integral part of the course. Laboratory (Sp)

PHYS 1311 General Physics Lab I 1 Credit Hour
Prerequisite: Corequisite: 2414 or 2514. Experiments in basic law of mechanics and thermodynamics. (F, Sp, Su) [II-NSL] .

PHYS 1321 General Physics Lab II 1 Credit Hour
Prerequisite: Corequisite: 2424 or 2524. Experiments in basic laws of electricity, magnetism, and optics. (F, Sp, Su) [II-NSL] .

PHYS 1453 Musical Acoustics 3 Credit Hours
An introduction to the science of sound and its propagation with special emphasis on the production of sound by musical instruments and the voice, psychological aspects of sound perception, and room acoustics. Topics are explored through lectures, demonstrations, and discussions. No previous musical experience or proficiency is required. Not for major credit. (F) [II-NS] .

PHYS 2203 Introductory Physics III: Modern Physics 3 Credit Hours
Prerequisite: 1215 or 2524 (or concurrent enrollment), or permission of instructor. An introduction to and overview of key concepts in contemporary physics, with emphasis on the contrast between classical and modern ways of thinking about the physical universe. Includes an introduction to selected major subject areas, which might include light and optics, relativity, atoms and molecules, the solid state, nuclei, elementary particles, fundamental interactions, cosmology and/or chaos. Students will also explore selected topics in current physics research. (F)

PHYS 2222 Computational Physics 2 Credit Hours
Prerequisite: MATH 2433 and PHYS 2203. Students will learn basic skills in programming in the context of solving physics problems. It is assumed that the student has no computer programming experience, and only modest understanding of physics. Through a variety of projects, the students are to obtain a deeper understanding of physical principles by implementing computer simulations. (Sp)

PHYS 2303 Electronics 3 Credit Hours
Prerequisite: 1215 or 2524 (or concurrent enrollment), or permission of instructor. An introduction to the characteristics of semiconductor electronic components and their use in the design and operation of practical analog and digital electronic circuits. The emphasis will be on gaining a working knowledge of basic circuits and preparation for understanding and building electronic circuits encountered by experimental research physicists. (F)

PHYS 2414 General Physics for Life Science Oriented Majors 4 Credit Hours
Prerequisite: Mathematics 1523 or 1743. Kinematics and dynamics of particles and rigid bodies, gravitation, equilibrium, momentum, energy, static and flowing fluids, kinetic theory, heat and thermodynamics, vibrations, waves and sound. A student may not receive credit for this course and PHYS 1205 or PHYS 2514. (F, Sp, Su) [II-NS].

PHYS 2424 General Physics for Life Science Oriented Majors 4 Credit Hours
Prerequisite: PHYS 2414 or PHYS 2514. Electric charge, electric field, electric potential, energy, DC and AC currents, magnetic fields, electromagnetic induction, geometrical optics, wave nature of light, optical instruments, early quantum theory, models of the atom, the nucleus, radioactivity, nuclear reactions and nuclear energy. A student may not receive credit for this course and PHYS 1215 or PHYS 2524. (F, Sp, Su)

PHYS 2514 General Physics for Engineering and Science Majors 4 Credit Hours
Prerequisite: MATH 1823 or MATH 1914 with grade of C or better. Vectors, kinematics and dynamics of particles, work and energy systems of particles, rotational kinematics and dynamics, oscillations, gravitation, fluid mechanics, waves. A student may not receive credit for this course and PHYS 1205. (F, Sp, Su) [II-NS].

PHYS 2524 General Physics for Engineering and Science Majors 4 Credit Hours
Prerequisite: PHYS 2514 and MATH 2423 or MATH 2924 with grade of C or better. Temperature, heat, thermodynamics, electricity, magnetism, optics. A student may not receive credit for this course and PHYS 1215. (F, Sp, Su)

PHYS 2970 Selected Topics in Physics 1-3 Credit Hours
1 to 3 hours. Prerequisite: sophomore standing or permission of instructor. May be repeated; maximum credit six hours. Special topics or seminar course for content not currently offered in regularly scheduled courses. May include library and/or laboratory research and field projects. (Irreg.)

PHYS 3043 Physical Mechanics I 3 Credit Hours
Prerequisite: 1205 or 2514, and Mathematics 3113 or 3413 (or concurrent enrollment); or permission of instructor. Differential equations based continuum mechanics: Newtonian particle mechanics, driven and damped oscillations, vibrations and waves, and their application to other linear systems, non-linear oscillations, introduction to Lagrange's equations. (Sp)

PHYS 3053 Physical Mechanics II 3 Credit Hours
Prerequisite: 3043 or permission of instructor. Lagrangian and Hamiltonian dynamics. Non-inertial reference frames. Rigid body motion. Central forces and collisions. Special relativity. (F)

PHYS 3183 Electricity and Magnetism I 3 Credit Hours
Prerequisite: 2203, Mathematics 3413 or concurrent enrollment; or permission of instructor. Electrostatics, dielectrics, continuity conditions, magnetic forces and fields, magnetic induction, magnetization, Maxwell's equations. (F)

PHYS 3223 Modern Physics for Engineers 3 Credit Hours
Prerequisite: Mathematics 3113 or equivalent. Relativity, atomic structure, nuclear theory, wave mechanics, statistical physics, solid state physics. (F)

PHYS 3302 Advanced Lab I 2 Credit Hours
Prerequisite: 2303 or permission of instructor. Junior-level experiments in physics. (F, Sp)

PHYS 3312 Advanced Lab II 2 Credit Hours
Prerequisite: 3302 or permission of instructor. Junior-level experiments in physics. (F, Sp)

PHYS 3440 Mentored Research Experience 3 Credit Hours
0 to 3 hours. Prerequisites: ENGL 1113 or equivalent, and permission of instructor. May be repeated; maximum credit 12 hours. For the inquisitive student to apply the scholarly processes of the discipline to a research or creative project under the mentorship of a faculty member. Student and instructor should complete an Undergraduate Research & Creative Projects (URCP) Mentoring Agreement and file it with the URCP office. Not for honors credit. (F, Sp, Su)

PHYS 3803 Introduction to Quantum Mechanics I 3 Credit Hours
Prerequisite: PHYS 3043 and MATH 3413 or permission of instructor. Fundamental ideas of quantum physics. Postulates of quantum theory, wave functions, operators, the Schrodinger equation, one-dimensional systems. Mathematical tools of quantum mechanics. Theory of measurement. Stationary and nonstationary states. (Sp)

PHYS 3960 Honors Reading 1-3 Credit Hours
1 to 3 hours. Prerequisite: admission to Honors Program. May be repeated; maximum credit six hours. Will consist of topics designated by the instructor in keeping with the student's major program. Covers materials not usually presented in the regular courses. (F, Sp, Su)

PHYS 3970 Honors Seminar 1-3 Credit Hours
1 to 3 hours. Prerequisite: admission to Honors Program. May be repeated; maximum credit six hours. The projects covered will vary. Deals with concepts not usually presented in regular coursework. (Su)

PHYS 3980 Honors Research 1-3 Credit Hours
1 to 3 hours. Prerequisite: admission to Honors Program. May be repeated; maximum credit six hours. Provides an opportunity for the gifted Honors candidate to work at a special project in the student's field. (F, Sp, Su)

PHYS 3990 Independent Study 1-3 Credit Hours
1 to 3 hours. Prerequisite: one course in general area to be studied; permission of instructor and department. May be repeated; maximum credit six hours. Contracted independent study for topic not currently offered in regularly scheduled courses. Independent study may include library and/or laboratory research and field projects. (F, Sp, Su)

PHYS G4153 Statistical Physics and Thermodynamics 3 Credit Hours
Prerequisite: 3803. Statistical properties of physical systems. Entropy and temperature, the Boltzmann distribution, Fermi-Dirac and Bose-Einstein gases. Thermodynamic functions. Statistical interpretation of thermodynamics. (F)

PHYS G4183 Electricity and Magnetism II 3 Credit Hours
Prerequisite: 3183. Maxwell's equations, electromagnetic wave equations, propagation of electromagnetic waves, reflection and refraction, radiation. (Sp)

PHYS 4213 Nuclear and Particle Physics 3 Credit Hours
(Slashlisted with 5213) Prerequisite: 3803. Basic nuclear structure, nuclear models, radioactivity, nuclear reactions. Particle interactions and families, quark model, weak decays of quarks and leptons. No student may earn credit for both 4213 and 5213. (F)

PHYS 4223 Optics 3 Credit Hours
(Slashlisted with PHYS 5223) Prerequisite: Junior standing. Geometrical optics; optical systems; optical aberrations; electromagnetic optics; diffraction theory; Fourier optics; interference; optical coherence and statistical properties of light; advanced topics such as, e.g., lasers and fiber optics. No student may earn credit for both 4223 and 5223. (Irreg.)

PHYS 4243 Solid State Physics 3 Credit Hours
(Slashlisted with 5243) Prerequisite: 3803. Crystal structure, electrons in simple metals, electron band theory, semiconductors, superconductivity, phonons. No student may earn credit for both 4243 and 5243. (Sp)

PHYS 4300 Senior Research Project 1-3 Credit Hours
1 to 3 hours. Prerequisite: senior standing in major and permission of instructor. May be repeated once. Research project, experimental or theoretical, to be arranged with individual faculty, leading to a senior thesis. Group seminars to discuss projects and other topics of current interest in physics and astronomy. Total of four hours required for general education capstone. (F, Sp) [V] .

PHYS 4310 Senior Research Project I 1-3 Credit Hours
1 to 3 hours. Prerequisite: Senior standing or permission of instructor. Research project, experimental or theoretical, to be arranged with individual faculty, leading to a senior thesis. Group seminars to discuss projects and other topics of current interest in physics and astronomy. Total of four hours between PHYS 4310 and PHYS 4320 are required. (F, Sp) [V].

PHYS 4320 Senior Research Project II 1-3 Credit Hours
1 to 3 hours. Prerequisite: PHYS 4310. A continuation of the research project, experimental or theoretical, arranged with individual faculty, producing a senior thesis. Group seminars to discuss projects and other topics of current interest in physics and astronomy. Total of four hours between PHYS 4310 and PHYS 4320 are required. (F, Sp) [V].

PHYS G4803 Introduction to Quantum Mechanics II 3 Credit Hours
Prerequisite: 3803 or permission of instructor. Quantum mechanics of three-dimensional systems. Angular momentum. Approximation methods: perturbation theory, variational methods. Time-dependent perturbations: transition rates, selection rules. Interaction of radiation with matter. Applications. Quantum mechanics of atoms and molecules. (F)

PHYS 4813 Atomic Physics 3 Credit Hours
(Slashlisted with PHYS 5813) Prerequisite: PHYS 4803. Hydrogen atom: fine structure, hyperfine structure, and external field effects; helium and many-electron atoms; two-level atom: rotating wave approximation, Rabi oscillation, and Bloch sphere; atom interferometry; broadening mechanisms; saturation spectroscopy; photon echoes. No student may earn credit for both 4813 and 5813. (Sp)

PHYS 4960 Directed Readings 1-4 Credit Hours
1 to 4 hours. Prerequisite: good standing in University; permission of instructor and dean. May be repeated; maximum credit four hours. Designed for upper-division students who need opportunity to study a specific problem in greater depth than formal course content permits. (Irreg.)

PHYS 4970 Seminar-Selected Topics in Physics 1-3 Credit Hours
1 to 3 hours. Prerequisite: permission of instructor. May be repeated with change of subject; maximum credit six hours. (Irreg.)

PHYS 4990 Independent Study 1-3 Credit Hours
1 to 3 hours. Prerequisite: three courses in general area to be studied,permission of instructor and department. May be repeated; maximum credit six hours. Contracted independent study for topic not currently offered in regularly scheduled courses. Independent study may include library and/or laboratory research and field projects. (F, Sp, Su)

PHYS 5000 Introduction to Graduate Studies in Physics 0 Credit Hours
Prerequisite: Graduate standing. The course is an introduction to research in general as well as specific research done within the department. It will familiarize students with departmental procedures, improve their teaching of Physics, and convey the expectations and demands of a career in Physics or Astronomy. (F)

PHYS 5013 Mathematical Methods in Physics 3 Credit Hours
Prerequisite: graduate standing. Orthogonal transformations and tensor analysis; partial differential equations and special functions; Green's functions; perturbation theory; calculus of variations; theory of complex variables; integral definition of special functions. (F)

PHYS 5153 Classical Mechanics 3 Credit Hours
Prerequisite: PHYS 3053 or equivalent. Hamilton's principle, Lagrange's equations, mechanics of particles and rigid bodies, Hamilton's equations, canonical transformations, Poisson brackets, action-angle variables. (F)

PHYS 5163 Statistical Mechanics 3 Credit Hours
Prerequisite: PHYS 4153 or equivalent. Classical and quantum statistical mechanics, fluctuations, thermodynamics, ideal gases, phase equilibrium and transitions, Bose-Einstein and Fermi-Dirac statistics, blackbody radiation, Einstein-Debye model, electrons in metals, critical exponents, spin models. (Sp)

PHYS 5213 Nuclear and Particle Physics 3 Credit Hours
(Slashlisted with 4213) Prerequisite: 4803; graduate standing. Basic nuclear structure, nuclear models, radioactivity, nuclear reactions. Particle interactions and families, quark model, weak decays of quarks and leptons. No student may earn credit for both 4213 and 5213. (F)

PHYS 5223 Optics 3 Credit Hours
(Slashlisted with PHYS 4223) Prerequisite: Graduate standing. Geometrical optics; optical systems; optical aberrations; electromagnetic optics; diffraction theory; Fourier optics; interference; optical coherence and statistical properties of light; advanced topics such as, e.g., lasers and fiber optics. No student may earn credit for both 4223 and 5223. (Irreg.)

PHYS 5243 Solid State Physics 3 Credit Hours
(Slashlisted with 4243) Prerequisite: 4803; graduate standing. Crystal structure, electrons in simple metals, electron band theory, semiconductors, superconductivity, phonons. No student may earn credit for both 4243 and 5243. (Sp)

PHYS 5293 Electronic, Optical and Magnetic Properties of Materials 3 Credit Hours
Prerequisite: Graduate standing and permission of instructor. This course surveys the electronic, optical and magnetic properties of materials and how these properties can be designed for specific applications. Topics include: forces, energies and timescales in condensed matter, electrons in crystalline semiconductors, electromagnetic waves in matter, optical and transport properties of polymers and small molecules, origins of magnetization in materials, structural and magnetic order/disorder phase transitions. (Irreg.)

PHYS 5393 Quantum Mechanics I 3 Credit Hours
Prerequisite: PHYS 4803 or equivalent. Topics in nonrelativistic quantum mechanics including the Heisenberg and Schrodinger pictures, Dirac formalism, angular momentum, bound states of spherically symmetric potentials, spin and angular momentum coupling, density matrix, 1d potential scattering. (Sp)

PHYS 5403 Quantum Mechanics II 3 Credit Hours
Prerequisite: PHYS 5393. Time-independent perturbation theory, time-dependent perturbation theory, electromagnetic interactions, potential scattering, symmetry and statistics, multiparticle systems, relativistic quantum mechanics including Klein-Gordon and Dirac equation. (F)

PHYS 5573 Electrodynamics I 3 Credit Hours
Prerequisite: PHYS 4183 or equivalent. Electrostatics; Poisson equation; solution via Green's functions; ponderable media; magnetism and Ampere's law; Faraday's law; Maxwell equations, solution via potentials; gauge fixing; advanced and retarded Green's functions; causality. (Sp)

PHYS 5583 Electrodynamics II 3 Credit Hours
Prerequisite: PHYS 5573. Electromagnetic waves and radiation; scattering and diffraction; special relativity and relativistic electrodynamics; radiation by moving charges. (F)

PHYS 5813 Atomic Physics 3 Credit Hours
(Slashlisted with PHYS 4813) Prerequisite: Graduate standing and PHYS 4803. Hydrogen atom: fine structure, hyperfine structure, and external field effects; helium and many-electron atoms; two-level atom: rotating wave approximation, Rabi oscillation, and Bloch sphere; atom interferometry; broadening mechanisms; saturation spectroscopy; photon echoes. No student may earn credit for both 4813 and 5813. (Sp)

PHYS 5910 Problems in Natural Science 1-2 Credit Hours
1 to 2 hours. Prerequisite: admission to candidacy for degree of Master of Natural Science. (F, Sp, Su)

PHYS 5960 Directed Readings 1-3 Credit Hours
1 to 3 hours. Prerequisite: graduate standing and permission of department. May be repeated; maximum credit twelve hours. Directed readings and/or literature reviews under the direction of a faculty member. (F, Sp, Su)

PHYS 5970 Seminar--Selected Topics in Modern Physics 1-3 Credit Hours
1 to 3 hours. Prerequisite: permission. May be repeated with change of subject matter; maximum credit for master's degree six hours, for doctor's degree 12 hours. (F, Sp, Su)

PHYS 5980 Research for Master's Thesis 2-9 Credit Hours
Variable enrollment, two to nine hours; maximum credit applicable toward degree, four hours. (F, Sp, Su)

PHYS 5990 Special Studies 1-4 Credit Hours
Prerequisite: 12 hours of physics, permission. May be repeated with change of subject matter; maximum credit for a master's degree four hours, for a doctor's degree ten hours. (F, Sp, Su)

PHYS 6213 Advanced Particle Physics 3 Credit Hours
Prerequisite: 5213, 5403 or equivalents. The theory and phenomenology of the "standard model" of particle physics which encompasses the electro-weak and strong interactions. Topics will include: symmetries, groups and conservation laws; bound states, quarkonium; Feynman diagrams, QED; QCD; weak interactions; gauge theories. (Irreg.)

PHYS 6243 Advanced Solid State Physics 3 Credit Hours
Prerequisite: 4243, 5403, or equivalents. The physics of metals, semiconductors and insulators. Free electron theory, crystal structure and phonons, electron band theory, semiclassical model, applications to electronic and optical properties of solids, effects of magnetic fields. (Irreg.)

PHYS 6283 Advanced Atomic/Molecular Physics 3 Credit Hours
Prerequisite: Graduate standing and PHYS 5403 (QMII), PHYS 5813 (AMOI), or equivalent. Beyond the two-level atom approximation: effects such as lambda system, STIRAP, dark states, and slow light; Doppler-free spectroscopy; optical pumping; collective atomic effects; laser cooling; Bose-Einstein condensates; electronic wave functions of atoms and molecules: variational principle, Hartee-Fock, and configuration interaction; molecular interaction potentials; interaction of light and molecules. (Irreg.)

PHYS 6333 General Relativity 3 Credit Hours
Prerequisite: 5013, 5583. The mathematical and physical basis for the relativistic theory of gravitation; the principle of equivalence; tensor analysis; Einstein's field equations; tests of general relativity; gravitational collapse; cosmology; toward a quantum theory of gravity. (Irreg.)

PHYS 6433 Quantum Field Theory 3 Credit Hours
Prerequisite: 5403. Canonical quantization of scalar and spinor fields; perturbation theory and Feynman diagrams; renormalization; path integral formulation; renormalization group; gauge fields with selected applications to QED, electro-weak theory and QCD. (Irreg.)

PHYS 6443 Advanced Quantum Field Theory 3 Credit Hours
Prerequisite: graduate standing and 6433. Path integral quantization; renormalization; renormalization group equations; gauge theories of strong and electroweak interactions. (F)

PHYS 6543 Advanced Quantum Optics 3 Credit Hours
Prerequisite: Graduate standing, PHYS 5393, PHYS 5403, PHYS 5573, and PHYS 5813, or equivalent; Recommended - PHYS 5223. This course introduces students to advanced topics in quantum optics, with reference to both historic and current state-of-the-art developments. Students will be introduced to core concepts such as quantum noise, phase-space, atom-light interactions, entanglement, and open systems. Students will learn how to apply these theoretical concepts to experimental systems that study the generation and manipulation of quantum states of light. (Irreg.)

PHYS 6663 Non-Relativistic Many Body Theory 3 Credit Hours
Prerequisite: Graduate standing, PHYS 5393 (QMI), PHYS 5403 (QMII), PHYS 5573 (EMI), PHYS 5153 (Class Mech), and PHYS 5163 (Stat Mech), or equivalent. This course introduces students to several many-body treatments and illustrates the techniques on a variety of examples, focusing on applications of historical importance and recent modern developments. The course focuses on non-relativistic (as opposed to relativistic) quantum many-body techniques and applications. Students will be introduced to mean-field theory, Green's functions, broken symmetries and transformations, path integrals, and diagrammatic techniques. (Irreg.)

PHYS 6860 Advanced Topics in Mathematical Methods in Physics 1-3 Credit Hours
1 to 3 hours. Prerequisite: 5013 or permission. May be repeated with change of content; maximum credit nine hours. Topics covered will be selected by instructor and announced prior to the term in which it will be offered. The course is intended to offer material currently used in theoretical physics. (Irreg.)

PHYS 6960 Directed Readings 1-3 Credit Hours
1 to 3 hours. Prerequisite: graduate standing or permission of instructor. May be repeated; maximum credit six hours. Directed readings and/or literature review under the direction of a faculty member. (Irreg.)

PHYS 6970 Special Topics/Seminar 1-3 Credit Hours
1 to 3 hours. Prerequisite: graduate standing or permission of instructor. May be repeated; maximum credit 12 hours. Special topics or seminar course for content not currently offered in regularly scheduled courses. May include library and/or research and field projects. (Irreg.)

PHYS 6980 Research for Doctoral Dissertation 2-16 Credit Hours
2 to 16 hours. Prerequisite: Graduate standing and permission of instructor; may be repeated. Directed research culminating in the completion of the doctoral dissertation. (F, Sp, Su)

PHYS 6990 Independent Study 1-3 Credit Hours
1 to 3 hours. Prerequisite: Graduate standing and permission of instructor. May be repeated; maximum credit nine hours. Contracted independent study for a topic not currently offered in regularly scheduled courses. Independent study may include library and/or laboratory research and field projects. (Irreg.)