PH-Physics

PH 502. Instructional Physical Science. 4 Hours.
Modern Physics for Teachers.

PH 502L. Instructional Physical Science Laboratory. 0 Hours.
Design of Physical Science Labs and Detailed Instructional Plans.

PH 505. Studies in Physics Teaching II. 3 Hours.
Development of new curricula, apparatus, and techniques of presentation of concepts in physics. Prerequisite: Permission of instructor.

PH 507. Physical Science for Teachers I. 3 Hours.
Concepts of physical science. Laboratory includes evaluation of experiments and equipment for lecture demonstrations. Prerequisite: Permission of instructor.

PH 508. Physical Science for Teachers II. 3 Hours.
Concepts of physical science. Laboratory includes evaluation of experiments and equipment for lecture demonstrations. Prerequisite: Permission of instructor.

PH 510. Physics of Fluids and Polymer Solutions. 3 Hours.
This course provides an overview of fluid mechanics and polymer physics appropriate for physics, engineering, chemistry, and biology majors. Topics include the concept of a fluid, the fluid as a continuum, properties of the velocity field, thermodynamic properties of a fluid, viscosity, pressure distribution in a fluid, basic physical laws of fluid mechanics, the Reynolds transport theorem, differential relations for a fluid particle, viscous flow, polymer solutions and thermodynamics, Brownian motion, diffusion equation, Fick's law, Stokes-Einstein equation and hydrodynamic radius of a polymer chain, and viscosity of polymer solutions.
Prerequisites: PH 221 [Min Grade: C] and MA 252 [Min Grade: C]

PH 518. Machine Learning Applications in Physics and Materials Science. 3 Hours.
This course covers interdisciplinary topics in material physics, computer science, and data science, with a focus on introducing first-principles software based on density-functional theory and data-driven machine-learning discoveries for applications in materials science and other physics domains.

PH 520. Introduction to Methods in Theoretical Physics I. 3 Hours.
Vector calculus. Curvilinear coordinate systems; commonly encountered ordinary differential equations and special functions; complex variables and contour integration partial differential equations, including solutions by Green function methods. Prerequisite: Permission of instructor.
Prerequisites: PH 222 [Min Grade: C] and MA 252 [Min Grade: C]

PH 524. Biomedical Optics. 3 Hours.
The objective of this class is to present an overview of applied optics, with an emphasis on biomedical optics.
Prerequisites: PH 222 [Min Grade: C]

PH 525. Applications of Contemporary Optics I. 3 Hours.
Applied geometrical optics. Refraction and reflection, paraxial optics, thick lens, matrix theory, optical aberrations, optical systems, and optical design using computer simulations.
Prerequisites: PH 222 [Min Grade: C]

PH 526. Applications of Contemporary Optics II. 3 Hours.
Applied wave optics. Fresnel equations, optical interference, optical interferometry, coherence, diffraction, lasers, and Gaussian beam propagation.
Prerequisites: PH 525 [Min Grade: C]

PH 527. Geometrical Optics. 4 Hours.
Properties of optical systems. Lenses, mirrors, and stops; aberrations; rays and wave fronts, optical instruments; aspheric components.
Prerequisites: PH 222 [Min Grade: C]

PH 527L. Geometrical Optics Lab. 0 Hours.
Geometrical Optics Lab.

PH 528. Physical Optics. 4 Hours.
Interference and diffraction phenomena; emission, propagation, and absorption of radiation; polarization and dispersion; stimulated emission.
Prerequisites: PH 527 [Min Grade: C]

PH 528L. Physical Optics Lab. 0 Hours.
Physical Optics Lab.

PH 529. Applications of Contemporary Optics III. 3 Hours.
Applied optical interactions with materials linear and nonlinear polarization phenomena, optical properties of materials, anisotropic optics, electro-optics, and nonlinear optics.
Prerequisites: PH 526 [Min Grade: C]

PH 532. Statistical Thermodynamics I. 3 Hours.
Statistical basis of laws of thermodynamics; ensembles and partition functions; quantum statistics of ideal gases, including photons and electrons; applications to solids, real gases, liquids, and magnetic systems; transport theory.
Prerequisites: PH 351 [Min Grade: C]

PH 533. Statistical Thermodynamics II. 3 Hours.
Statistical basis of laws of thermodynamics; ensembles and partition functions; quantum statistics of ideal gases, including photons and electrons; applications to solids, real gases, liquids, and magnetic systems; transport theory.
Prerequisites: PH 532 [Min Grade: C]

PH 545. Electromagnetic Theory I. 3 Hours.
Electromagnetic theory approached from standpoint of fields and using Maxwell's equations.
Prerequisites: PH 420 [Min Grade: C] or MA 444 [Min Grade: C]

PH 546. Electromagnetic Theory II. 3 Hours.
Electromagnetic theory approached from standpoint of fields and using Maxwell's equations.
Prerequisites: PH 545 [Min Grade: C]

PH 550. Introduction to Quantum Mechanics I. 3 Hours.
Principles of quantum mechanics; their application to particle waves, angular momentum, tunneling, radiation, and selection rules; perturbation and variational methods.
Prerequisites: PH 351 [Min Grade: C] and PH 562 [Min Grade: C]

PH 551. Introductory Quantum Mechanics II. 3 Hours.
Principles of quantum mechanics; their application to particle waves, angular momentum, tunneling, radiation, and selection rules; perturbation and variational methods.
Prerequisites: PH 550 [Min Grade: C]

PH 552. Introduction to Quantum Mechanics III. 2 Hours.

PH 553. Solid State Physics I. 3 Hours.
Properties of crystal lattices, lattice dynamics, lattice imperfections, and bonding energies; electronic properties of dielectrics, semiconductors, and metals; ferroelectric, magnetic, and optical properties of solids.
Prerequisites: PH 551 [Min Grade: C]

PH 554. Solid State Physics II. 3 Hours.
Properties of crystal lattices, lattice dynamics, lattice imperfections, and bonding energies; electronic properties of dielectrics, semiconductors, and metals; ferroelectric, magnetic, and optical properties of solids.
Prerequisites: PH 553 [Min Grade: C]

PH 557. Directed Reading in Quantum Physics. 3 Hours.
Tutorial studies in quantum physics offered by special arrangement.
Prerequisites: PH 351 [Min Grade: C] and PH 562 [Min Grade: C]

PH 558. Directed Reading in Physics. 3 Hours.
Directed Reading in Physics I. Tutorial studies in physics offered by special arrangement.

PH 561. Classical Mechanics I. 3 Hours.
Kinematics and dynamics, including central forces, rotating coordinate systems, and generalized coordinates; Lagrangian and Hamiltonian.
Prerequisites: PH 222 [Min Grade: C] and MA 252 [Min Grade: C]

PH 562. Classical Mechanics II. 3 Hours.
Kinematics and dynamics, including central forces, rotating coordinate systems, and generalized coordinates; Lagrangian and Hamiltonian.
Prerequisites: PH 561 [Min Grade: C]

PH 571. Atomic and Molecular Physics. 3 Hours.
Applications of quantum mechanics to structure and spectra of atoms and small molecules; use of symmetry in understanding and describing molecular vibrations and bonding.
Prerequisites: PH 551 [Min Grade: C]

PH 575. Intro to Biophysics I. 3 Hours.
Application of physical techniques and analytical methods of selected biological problems. Permission of instructor.
Prerequisites: PH 352 [Min Grade: C]

PH 576. Intro to Biophysics II. 3 Hours.
Application of physical techniques and analytical methods of selected biological problems. Permission of instructor.
Prerequisites: PH 575 [Min Grade: C]

PH 580. Directed Reading in Classical Physics. 3 Hours.
Tutorial studies in classical physics offered by special arrangement.
Prerequisites: PH 222 [Min Grade: C] and MA 252 [Min Grade: C]

PH 581. Laser Physics I. 3 Hours.
Physical principles of laser operation and design. Spontaneous and stimulated emission, population inversion, light amplification, laser resonators, Q-switching, mode-locking, pulse shortening techniques, spectral narrowing, and tunable lasers. Individual types of lasers will be considered. Practical applications of lasers will be treated in detail.
Prerequisites: PH 222 [Min Grade: C]

PH 582. Laser Physics II. 3 Hours.
Physical principles of laser operation and design. Spontaneous and stimulated emission, population inversion, light amplification, laser resonators, Q-switching, mode-locking, pulse shortening techniques, spectral narrowing, and tunable lasers. Individual types of lasers will be considered. Practical applications of lasers will be treated in detail.
Prerequisites: PH 581 [Min Grade: C]

PH 583. Atomic and Nuclear Physics. 3 Hours.
Prerequisites: PH 352 [Min Grade: C]

PH 584. Atomic and Nuclear Physics. 3 Hours.
Prerequisites: PH 583 [Min Grade: C]

PH 585. Laser Spectroscopy. 3 Hours.
Practical applications of lasers and modern techniques and instrumentation in laser spectroscopy.
Prerequisites: PH 222 [Min Grade: D]

PH 586. Semiconductor Materials in Modern Technology. 3 Hours.
Brief review of electronic materials with emphasis on traditional and cutting edge Si technology. Competing and complementary semiconductors covered in standard lecture and seminar style. Materials: compound and tertiary semiconductors, organic semiconductors, wide bandgap semiconductors. Applications: optical and chemical sensors, microwave electronics, high power electronics, lasers. Specific applications/ materials determined by student interest.
Prerequisites: PH 352 [Min Grade: C] or EE 351 [Min Grade: C] or CH 326 [Min Grade: C]

PH 587. Nanoscale Science and Applications. 3 Hours.
Nanoscale Science and Applications. Physics of electronic, mechanical, and biological properties of materials at the nanoscale level approaching one billionth of a meter. The applications of nanoscale materials in electronic, mechanical, and biomedical systems will be emphasized. Special tools in synthesis and characterization of nanomaterials will be discussed.

PH 589. Applications of Modern Physics. 3 Hours.

PH 590. Preparations for Teaching. 1-3 Hour.
This class is intended to help teaching assistants prepare for successful teaching experiences. The course will emphasize a foundation of practical knowledge related to expectations and duites shared by teachers in higher education, as well as an opportunity to read, reflect, and discuss current research related to teaching and learning at the university level.

PH 591. Advanced Physics Laboratory I. 1-4 Hour.
Laboratory investigation of topics of modern physics. Permission of instructor.

PH 592. Advanced Physics Laboratory II. 1-4 Hour.
Laboratory investigation of topics of modern physics. Permission of instructor.

PH 593. Advanced Physics Laboratory III. 1-4 Hour.
Laboratory investigation of topics of modern physics. Permission of instructor.

PH 594. Computers in Physics. 3 Hours.

PH 595. Computers in Physics. 3 Hours.

PH 597. Special Topics in Physics. 1-3 Hour.

PH 610. Classical Mechanics I. 3 Hours.
Applications of methods of LaGrange, Hamilton, Poisson, and Hamilton-Jacobi to such classical problems as central force, small oscillation, and rigid body motions.
Prerequisites: PH 562 [Min Grade: C]

PH 618. Computational Solid State Physics. 3 Hours.
This course covers interdisciplinary topics in material physics, computer science, and data science, with a focus on introducing first-principles software based on density-functional theory and data-driven machine-learning discoveries for applications in materials science and other physics domains.

PH 635. Advanced Statistical Mechanics. 3 Hours.
Applications of statistical laws to modern topics such as quantum fluids, critical phenomena, and nonequilibrium systems.
Prerequisites: PH 551 [Min Grade: B]

PH 650. Electromagnetic Theory I. 3 Hours.
Boundary value and Green function methods for solving potential problems; fields in dielectric, magnetic media, and radiation fields.
Prerequisites: PH 546 [Min Grade: B]

PH 651. Electromagnetic Theory II. 3 Hours.
Boundary value and Green function methods for solving potential problems; fields in dielectric, magnetic media, and radiation fields.
Prerequisites: PH 650 [Min Grade: C]

PH 652. Electromagnetic Theory III. 3 Hours.
Electromagnetic Theory.

PH 653. Solid State Physics I. 3 Hours.
Structure and dynamics of solids; optical, magnetic, and transport properties.
Prerequisites: PH 551 [Min Grade: C]

PH 654. Solid State Physics II. 3 Hours.
Structure and dynamics of solids; optical, magnetic, and transport properties.
Prerequisites: PH 653 [Min Grade: C]

PH 655. Advanced Solid State Laboratory. 1-3 Hour.
Thin film X-ray diffraction, Raman spectroscopy in materials characterization, electron paramagnetic resonance, and thin film deposition.
Prerequisites: PH 653 [Min Grade: C] and PH 654 [Min Grade: C]

PH 660. Methods of Mathematical Physics. 3 Hours.
Vector and tensor analysis; differential and integral equations; Green functions; variational techniques; linear operator theory; Fourier and Laplace transforms.
Prerequisites: PH 520 [Min Grade: B]

PH 671. Quantum Mechanics I. 3 Hours.
Discrete and continuous spectra; central force problems; angular momentum and spin; systems of identical particles; perturbation theory; scattering theory.
Prerequisites: PH 546 [Min Grade: B] and PH 551 [Min Grade: B]

PH 672. Quantum Mechanics II. 3 Hours.
Discrete and continuous spectra; central force problems; angular momentum and spin; systems of identical particles; perturbation theory; scattering theory.
Prerequisites: PH 671 [Min Grade: C]

PH 673. Applications of Quantum Mechanics. 3 Hours.
Scattering theory, density matrix, and polarization; applications to atomic and nuclear reactions.
Prerequisites: PH 671 [Min Grade: C] and PH 672 [Min Grade: C]

PH 695. Directed Reading. 2-3 Hours.
Tutorial studies in physics offered by special arrangement. Permission of instructor.

PH 696. Directed Reading in Classical Physics. 3 Hours.
Tutorial studies in classical physics offered by special arrangement.
Prerequisites: PH 562 [Min Grade: C]

PH 697. Special Topics in Physics. 1-12 Hour.
Topics of current interest, such as theoretical physics, computational physics, experimental techniques. May be repeated for credit. 1-12 hours.

PH 698. Nonthesis Research. 1-12 Hour.
May be repeated for credit.

PH 699. Research for Thesis. 1-12 Hour.
May be repeated for credit. Prerequisite: Admission to candidacy. 1-12 hours.
Prerequisites: GAC M

PH 710. Advanced Classical Mechanics I. 3 Hours.
Analysis of dynamics, including rigid body motion, featuring the LaGrange formulation, introduction to the Hamiltonian, formulation, Poisson brackets, analyses in nonrelativistic applications.
Prerequisites: PH 562 [Min Grade: C]

PH 711. Advanced Classical Mechanics II. 3 Hours.
Analysis of dynamics, including rigid body motion, featuring the LaGrange formulation, introduction to the Hamiltonian, formulation, Poisson brackets, analyses in nonrelativistic applications.
Prerequisites: PH 710 [Min Grade: C]

PH 715. Advanced Statistical Mechanics. 3 Hours.
Applications of statistical laws to modern topics such as quantum fluids, critical phenomena, and nonequilibrium systems.
Prerequisites: PH 532 [Min Grade: B] and PH 551 [Min Grade: B]

PH 716. Advanced Statistical Mechanics. 3 Hours.
Applications of statistical laws to modern topics such as quantum fluids, critical phenomena, and nonequilibrium systems.
Prerequisites: PH 715 [Min Grade: C]

PH 718. Machine Learning Applications in Physics and Materials Science. 3 Hours.
This course covers interdisciplinary topics in material physics, computer science, and data science, with a focus on introducing first-principles software based on density-functional theory and data-driven machine-learning discoveries for applications in materials science and other physics domains.

PH 732. Growth and Characterization of Thin Films I. 3 Hours.
Basics of vacuum science. Methods of thin film deposition. Nucleation, evolution of microstructure and surface morphology of thin films. Simulation of growth processes. Thin film characterization techniques (SEM/SIM, TEM, SPM, SPS/AES, XRD, optical and and mechanical measurements). Demonstrations on thin-film deposition and basic characterization of tilm microstructure and properties. Prerequisites: PH 553/653 and PH554/654 or permission of instructor. Lecture and demonstration. 3 semester hours.
Prerequisites: (PH 453 [Min Grade: C] or PH 553 [Min Grade: C]) and (PH 454 [Min Grade: C] or PH 554 [Min Grade: C])

PH 733. Growth and Characterization of Thin Films II. 3 Hours.
Basics of vacuum science. Methods of thin film deposition. Nucleation, evolution of microstructure and surface morphology of thin films. Simulation of growth processes. Thin film characterization techniques (SEM/SIM, TEM, SPM, XPS/AES, XRD, optical and mechanical measurements). Demonstrations on thin-film deposition and basic characterization of film microstructure and properties. Prerequisites: PH553/653 and PH554/654 or permission of instructor. Lecture and demonstrations. 3 semester hours.
Prerequisites: (PH 453 [Min Grade: C] or PH 553 [Min Grade: C]) and (PH 454 [Min Grade: C] or PH 554 [Min Grade: C])

PH 745. Molecular Spectroscopy. 3 Hours.
Infrared, Raman, and ultraviolet techniques applied to study of molecular properties, including rotation-vibration spectra and spectra of crystalline solids.

PH 746. Applied Physics Internship. 3 Hours.
Practical research outside UAB or, upon approval of the graduate program director, at a UAB laboratory other than that of the student's advisor. The internship is intended to supplement proposed or ongoing dissertation research.

PH 747. Theoretical Nuclear Physics. 3 Hours.

PH 750. Classical Electrodynamics I. 3 Hours.
Static and time-varying fields in vacuum and in matter, radiation fields, solutions and implications of Maxwell's equation utilizing advanced mathematical methods.
Prerequisites: PH 546 [Min Grade: B] and PH 760 [Min Grade: B]

PH 751. Classical Electrodynamics II. 3 Hours.
Static and time-varying fields in vacuum and in matter, radiation fields, solutions and implications of Maxwell's equation utilizing advanced mathematical methods.
Prerequisites: PH 750 [Min Grade: C]

PH 752. Light-Matter Interactions. 3 Hours.
Quantized Electromagnetic Fields; Photons; Quantum Optics; Coherence; Nonlinear optics; Quantum excitations in solids.
Prerequisites: PH 750 [Min Grade: B] and PH 771 [Min Grade: B]

PH 753. Solid State Physics I. 3 Hours.
Properties of electrons and photons in crystal lattices; electromagnetic interactions with solids; lattice defects.

PH 754. Solid State Physics II. 3 Hours.
Properties of electrons and photons in crystal lattices; electromagnetic interactions with solids; lattice defects.
Prerequisites: PH 753 [Min Grade: C]

PH 755. Advanced Solid State Physics III. 2 Hours.
Advanced Solid State Physics II.
Prerequisites: PH 753 [Min Grade: C] and PH 754 [Min Grade: C]

PH 760. Methods of Mathematical Physics I. 3 Hours.
Vector and tensor analysis; differential and integral equations; Green functions; variational techniques; linear operator theory; Fourier and Laplace transforms.
Prerequisites: PH 520 [Min Grade: B]

PH 761. Methods of Mathematical Physics II. 3 Hours.
Vector and tensor analysis; differential and integral equations; Green functions; variational techniques; linear operator theory; Fourier and Laplace transforms.

PH 762. Computational Physics I. 3 Hours.
Numerical techniques for solution of differential, integral, and matrix equations of physics; computer simulations of physical phenomena; optimization problems.
Prerequisites: PH 545 [Min Grade: C] and PH 551 [Min Grade: C] and PH 561 [Min Grade: C]

PH 771. Quantum Mechanics I. 3 Hours.
Discrete and continuous spectra; central force problems; angular momentum and spin; systems of identical particles; perturbation theory; scattering theory.
Prerequisites: PH 546 [Min Grade: B] and PH 551 [Min Grade: B]

PH 772. Quantum Mechanics II. 3 Hours.
Discrete and continuous spectra; central force problems; angular momentum and spin; systems of identical particles; perturbation theory; scattering theory.
Prerequisites: PH 771 [Min Grade: C]

PH 773. Applications of Quantum Mechanics. 3 Hours.
Scattering theory, density matrix, and polarization; applications to atomic and nuclear reactions.
Prerequisites: PH 771 [Min Grade: C] and PH 772 [Min Grade: C]

PH 791. Physics Seminar I. 1 Hour.
Topics of current interest in physics, presented by graduate students, faculty, and visitors. Required each term of all full-time graduate students.

PH 792. Physics Seminar II. 1 Hour.
Topics of current interest in physics, presented by graduate students, faculty, and visitors. Required each term of all full-time graduate students.

PH 793. Scientific Communications I. 1 Hour.
Scientific writing exercises and recent topics in physics presented by graduate students in order to provide experience in written and oral scientific communication.

PH 794. Scientific Communications II. 1 Hour.
Scientific writing exercises and recent topics in physics presented by graduate students in order to provide experience in written and oral scientific communication.
Prerequisites: PH 793 [Min Grade: C]

PH 795. Directed Reading. 2-3 Hours.
Tutorial studies in physics offered by special arrangement. Permission of instructor.

PH 797. Special Topics in Physics. 1-12 Hour.
Topics of current interest, such as group theory, medical physics, computational methods, biological physics, materials physics, optics, and space physics. May be repeated for credit.

PH 798. Non-Dissertation Research. 1-12 Hour.
Permission of instructor.

PH 799. Research for Dissertation. 1-12 Hour.
Admission to candidacy.
Prerequisites: GAC Z