COURSES FOR PHYSICS AND ASTRONOMY

Astronomy Courses

AY101 Intro To Astronomy
N

Hours 3

This course surveys the development of our current understanding of the Universe, including our Solar System, exoplanets, stars and stellar evolution (including white dwarfs, neutron stars, black holes, and supernovae), galaxies and cosmology (dark matter, dark energy, the Big Bang, the accelerating universe, supermassive black holes), and life in the Universe. NOTE: If the student plans to apply AY 101 toward satisfaction of the N requirement of the University Core Curriculum, AY 102 must also be taken.

Natural Science

AY102 Intro Astronomy Lab
N

Hours 1

This laboratory course involves indoor hands-on activities interpreting stellar spectra, stellar luminosity-temperature diagrams, celestial spheres, and astronomical imagery of the Moon, stars (including the Sun), star clusters, nebulae, galaxies, and galaxy clusters. NOTE: If the student plans to apply AY 102 toward satisfaction of the N requirement of the University Core Curriculum, AY 101 must also be taken.

Prerequisite(s) with concurrency: AY 101

Natural Science

AY155 Life in the Universe
Hours 3

This course is a survey of the new and rapidly-developing interdisciplinary science of astrobiology, accessible to the non-science major. Using the tools of astronomy, biology, geology, and chemistry, we will explore some of the biggest questions ever asked: How did life start on the Earth? Did life start elsewhere in our solar system, and elsewhere in our galaxy? Are we alone in the Universe? If there is life on other planets, how would we recognize it? Using the example of the history of life on Earth, we will explore locations in our solar system to gather evidence of whether life could have started, and could currently thrive in those locations. We will then broaden our scope to explore possibilities of life on planets orbiting other stars in our galaxy (and beyond) by summarizing what has been learned recently from surveys of planets orbiting other stars, in the Search for Extra Terrestrial Intelligence.

AY203 Observational Astronomy
N

Hours 2

In this course students learn to observe and record images and spectra of planets, stars, nebulae, and galaxies using portable telescopes on campus, the 16-inch telescope of the campus observatory, telescopes located in the darker skies at Moundville, and observatory telescopes in Arizona and Chile by internet control. Both indoor exercises and observing projects are undertaken. Students should normally have already completed an introductory or advanced astronomy course. NOTE: If the student plans to apply AY 203 toward satisfaction of the N requirement of the University Core Curriculum, AY 204 or AY 206 must also be taken.

Prerequisite(s): MATH 113 or MATH 115 or MATH 125 or MATH 145

Natural Science

AY204 Solar System Astronomy
N

Hours 3

This course provides (1) a discussion of orbital mechanics and of the interior structure, surface features, atmosphere, and origin of the sun, planets, and solar system; (2) an understanding of the detection techniques and current census of extrasolar planets; and (3) a discourse on the possibility of life on other planets. NOTE: If the student plans to apply AY 204 toward satisfaction of the N requirement of the University Core Curriculum, AY 203 must also be taken.

Prerequisite(s): MATH 113 or MATH 115 or MATH 125 or MATH 145

Natural Science

AY206 Astron Beyond Solar Syst
N

Hours 3

This course: (1) connects the observed properties of stars (including our Sun) to their physical structure and evolution, up to their final endpoints as white dwarfs, neutron stars, or black holes; (2) surveys the properties of galaxies (including our Milky Way), their baryonic and dark matter content, their dynamics and evolution (star formation history, feedback, secular processes, mergers, growth of central supermassive black holes) and galaxy clustering; and (3) presents modern cosmology, including the Big Bang, the Cosmic Microwave Background, the accelerating expansion of the Universe, dark energy, inflation, and the formation of the lightest elements. NOTE: If the student plans to apply AY 206 toward satisfaction of the N requirement of the University Core Curriculum, AY 203 must also be taken.

Prerequisite(s): MATH 113 or MATH 115 or MATH 125 or MATH 145

Natural Science

AY421 Theoretical Astrophysics
Hours 3

This course provides a broad introduction to the theoretical foundations of astrophysical phenomena, demonstrating how fundamental phenomenology arises from physical laws. Several broad domains of astrophysics are covered, including planetary and stellar orbits, radiation, radiative transfer, ionization, star and planet formation, stellar evolution, binary stars, special and general relativity (including black holes), galactic structure and dynamics (including dark matter), active galaxies, spacetime structure, formation of large scale matter structure, and cosmology (including the accelerating expansion of the Universe, dark energy, and Grand Unification of forces in the early Universe).

Prerequisite(s): PH 253

AY433 Techniques of Observational Astronomy
W

Hours 3

Students will learn to perform astronomical observations with eye, telescope, and modern detectors, using techniques of digital imaging, photometry, and spectroscopy. Wavelength ranges from radio to gamma-ray will be addressed. Students will gain familiarity with current software tools for data analysis, model fitting, and error analysis. Students will carry out and report on all components of observational research, from concept and data collection to analysis and presentation of conclusions. Writing proficiency is required for a passing grade in this course. A student who does not write with the skill normally required of an upper-division student will not earn a passing grade, no matter how well the student performs in other areas of the course.

Prerequisite(s): AY 204 or AY 206 PH 253 or permission of instructor

Writing

AY450 Stars & Stellar Evolution
Hours 3

This course is intended to facilitate a fairly complete understanding of stars, including their structure, evolution (formation, stages of burning, end states), synthesis of elements, and the physical processes involved in each of these, as well as introduce the modern computational modeling techniques used to apply stellar physics to stars. For astronomy students, this course will provide the background necessary to understand the underlying principles of stellar processes and modelling as they are used both in ongoing research into stellar physics and phenomena and in support of other areas of astronomical research where stellar populations, products and processes are important. In a broader context, relevant for any physics student, this course will discuss how understanding the physical principles in fluid dynamics, high-density materials, heat transfer, plasma physics, nuclear structure, and nuclear processes are assembled into our modern understanding of how stellar objects behave, and how the study of stars pushes the frontier of understanding in these areas of physics.

Prerequisite(s): MATH 238

AY482 Selected Topics in Astronomy
Hours 1-3

This course may deal with any astronomy topic not covered by existing courses. The course title is added at the time the course is taught. Repeat credit is allowed for different course titles.

AY491 Independent Study I
Hours 1-3

No description available

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AY492 Independent Study II
Hours 1-3

No description available

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AY521 Theoretical Astrophysics
Hours 3

This course provides a broad introduction to the theoretical foundations of astrophysical phenomena, demonstrating how fundamental phenomenology arises from physical laws. Several broad domains of astrophysics are covered, including planetary and stellar orbits, radiation, radiative transfer, ionization, star and planet formation, stellar evolution, binary stars, special and general relativity (including black holes), galactic structure and dynamics (including dark matter), active galaxies, spacetime structure, formation of large scale matter structure, and cosmology (including the accelerating expansion of the Universe, dark energy, and Grand Unification of forces in the early Universe).

AY533 Observational Techniques
Hours 3

Theoretical and practical aspects of modern astronomical observational techniques. Photometry, spectroscopy, interferometry, and optical and radio data reduction and image processing.

AY550 Stars & Stellar Evolution
Hours 3

This course is intended to facilitate a fairly complete understanding of stars, including their structure, evolution (formation, stages of burning, end states), synthesis of elements, and the physical processes involved in each of these, as well as introduce the modern computational modeling techniques used to apply stellar physics to stars. For astronomy students, this course will provide the background necessary to understand the underlying principles of stellar processes and modelling as they are used both in ongoing research into stellar physics and phenomena and in support of other areas of astronomical research where stellar populations, products and processes are important. In a broader context, relevant for any physics student, this course will discuss how understanding the physical principles in fluid dynamics, high-density materials, heat transfer, plasma physics, nuclear structure, and nuclear processes are assembled into our modern understanding of how stellar objects behave, and how the study of stars pushes the frontier of understanding in these areas of physics.

AY580 Cosmology
Hours 3

This course surveys the evolution of the universe, including discussion of general relativity, the Standard Big Bang Cosmology, cosmological inflation, the cosmic microwave background, large scale structure, baryogenesis, dark matter and dark energy.

AY582 Selected Topics in Astronomy
Hours 1-3

This course may deal with any astronomy topic not covered by existing courses. The course title is added at the time the course is taught. Repeat credit is allowed for different course titles.

AY590 Research Techniques
Hours 3

This course provides graduate students with domain-specific skills and knowledge in their research specialty. This training is expected to be undertaken in the context of active engagement by the student in an ongoing or semester-long research project. Alternatively, if formal preparation beyond the available courses is necessary for a student's success within their specialty, such formal preparation (reading, assignments, etc) will be performed under the direction and supervision of the instructor. Any combination of active research and additional specialty formal preparation may be specified by the instructor, as is necessary to advance the student's knowledge and skill toward that necessary to plan and perform successful research in their specialty.

Prerequisite(s): Permission of instructor is required. Core courses must be completed before taking this Research Techniques course.

AY597 Astrophysics Seminar
Hours 1

Required of all full-time physics graduate students specializing in astronomy each semester in residence. Students must attend weekly seminars and make one oral presentation.

AY620 Extragalactic Astronomy
Hours 3

This course surveys the observational and physical aspects of galaxies, clusters of galaxies, active galaxies, quasars, and astrophysical cosmology. The cosmic distance scale and galaxy evolution will be addressed. On successful completion of this course, a student will be prepared to understand the relevant research literature and be ready to embark on independent research in these topics.

AY630 Stellar and Galactic Dynamics
Hours 3

The subject of this course is the dynamics of collisionless objects (stars and dark matter) within self-gravitating systems, i.e. within galaxies and star clusters. The course is primarily theoretical, but there will be considerable discussion of the connections to observations. The approach will combine rigorous mathematical analysis with computational experiments.

AY640 Radiation Processes in Astrophysics
Hours 3

This course covers radiative transfer, blackbody radiation, and non-relativistic and relativistic electromagnetic radiation processes, including bremsstrahlung, synchrotron and Compton radiation, as well as atomic and molecular transitions.

AY682 Selected Topics in Astronomy
Hours 1-3

This course may deal with any astronomy topic not covered by existing courses. The course title is added at the time the course is taught. Repeat credit is allowed for different course titles.

Physics Courses

PH101 General Physics I
N

Hours 4

Lectures and laboratory. An algebra-based introductory course including classical mechanics and thermodynamics. Topics include: kinematics, Newtonian dynamics, conservation of energy and momentum, rotational motion, oscillations and waves, kinetic theory of gases, and thermodynamics. Degree credit can only be awarded for one of the following: PH 101, PH 105, or PH 125.

Prerequisite(s): MATH 113 or MATH 115 or MATH 125 or MATH 145

Natural Science

PH102 General Physics II
N

Hours 4

Lectures and laboratory. An algebra-based introductory course including electricity and magnetism, optics, and modern physics. Topics include: electrostatic force and fields, electrical energy, capacitance, resistance, dc circuits, magnetism, induction, ac circuits, electromagnetic waves, geometric optics, wave optics, relativity, quantum mechanics, atomic physics, and nuclear physics. Degree credit can only be awarded for one of the following: PH 102, PH 106, or PH 126.

Prerequisite(s): PH 101 or PH 105 or PH 125

Natural Science

PH105 General Physics W/Calc I
N

Hours 4

Lectures and laboratory. This is an introductory calculus-based course covering classical mechanics, conservation laws, oscillations, waves, and thermal phenomena. Two course format options may be offered: a studio format with integrated lectures and laboratories and a non-studio format in which lectures and laboratories meet separately. Degree credit can only be awarded for one of the following: PH 101, PH 105, or PH 125.

Prerequisite(s): MATH 125 or MATH 145

Natural Science

PH106 General Physics W/Calc II
N

Hours 4

Lecture and laboratory. Introductory calculus-based course in classical physics, including electricity, magnetism, and optics. Degree credit can only be awarded for one of the following: PH 102, PH 106, or PH 126.

Prerequisite(s): MATH 126 or MATH 146; and PH 101 or PH 105 or PH 125

Natural Science

PH111 Intro Physics Seminar
Hours 1

Seminar on current topics in Physics, aimed at a level accessible to all undergraduates. A broad introduction to exciting recent developments in physics, current areas of interest, and ongoing research at UA. Multiple faculty will present seminars, including some based on student suggestions.

PH115 Descriptive Physics for Non-Science Majors
N

Hours 4

A non-technical course designed for non-science majors intended to give an introduction to physics with no math prerequisites. Demonstrations and lectures on the chief topics of classical and modern physics and how they relate to everyday life. Credit earned in this course may not be counted toward fulfillment of the requirements for the major or minor in physics. Credit will not be granted for both PH 101 and PH 115. Three lecture hours and one laboratory period.

Natural Science

PH125 Honors Gen Ph W/Calculus
N, UH

Hours 4

This is an Honors version of PH 105, primarily intended for Physics majors and Honors students. This is an introductory calculus-based course covering classical mechanics, conservation laws, oscillations, waves, and thermal phenomena. This course is usually offered in the studio format (integrated lectures and labs). Degree credit can only be awarded for one of the following: PH 101, PH 105, or PH 125.

Prerequisite(s): MATH 125 or MATH 145

Natural Science, University Honors

PH126 Honors Gen Ph W/Calculus II
N, UH

Hours 4

Lecture, discussion, and laboratory. This is an Honors version of PH 106, primarily intended for Physics majors and Honors students. Introductory calculus-based course in classical physics, including electricity, magnetism, and optics. Degree credit can only be awarded for one of the following: PH 102, PH 106, or PH 126.

Prerequisite(s): MATH 126 or MATH 146; and PH 105 or PH 125

Natural Science, University Honors

PH253 Intro Modern Physics
N

Hours 3

Study of topics in modern physics, including special relativity, quantum physics, atomic structure, solid state physics, and selected additional topics (e.g. lasers, molecular physics, the atomic nucleus). NOTE: If the student plans to apply PH 253 toward satisfaction of the N requirement of the University Core Curriculum, PH 255 must also be taken.

Prerequisite(s): MATH 126 or MATH 146; and PH 102 or PH 106 or PH 126

Natural Science

PH255 Modern Physics Lab
N

Hours 1

Experimental work in the topics that form the subject matter of PH 253, including special relativity, quantum physics, atomic and nuclear structure, and solid state physics. Successful students will develop their ability to collect and analyze experimental data, interpret the results, and present their findings in a clear, concise, and convincing way. NOTE: If the student plans to apply PH 255 toward satisfaction of the N requirement of the University Core Curriculum, PH 253 must also be taken.

Prerequisite(s): PH 253

Natural Science

PH301 Mechanics I
Hours 3

This course is a more rigorous and sophisticated treatment of the classical mechanics topics covered in the introductory courses PH 101/105/125. The treatment is based on differential equations. The list of topics includes vectors, Newtonian mechanics in 1, 2, and 3 dimensions, oscillations, Lagrangian mechanics, gravity and central forces, rotational motion of rigid bodies, non-inertial coordinate systems, and coupled oscillators and normal modes.

Prerequisite(s): MATH 238 and PH 102 or PH 106 or PH 126

Prerequisite(s) with concurrency: MATH 238

PH302 Intermediate Mechanics
Hours 3

This course is a more rigorous and sophisticated treatment of the classical mechanics topics covered in the introductory courses PH 101/105/125. The course is based on differential equations, and is particularly intended for students who plan to pursue graduate studies in physics or astronomy. The list of topics includes Newton's laws, projectile motion, energy, momentum and angular momentum conservation, oscillations, calculus of variations, Lagrangian formalism, two-body central forces, rotation of rigid bodies, coupled oscillators and normal modes. Some aspects of nonlinear motion and chaos, Hamiltonian mechanics, collisions, and special relativity may also be covered.

Prerequisite(s): PH 102 or PH 106 or PH 126

Prerequisite(s) with concurrency: MATH 238

PH331 Elect & Magnetism I
Hours 3

Vector analysis, electrostatics and magnetostatics, potential, and electric and magnetic fields in matter.

Prerequisite(s): PH 102 or PH 106 or PH 126; and MATH 238

Prerequisite(s) with concurrency: MATH 238

PH332 Elect & Magnetism II
Hours 3

Electrodynamics, conservation laws, electromagnetic waves, radiation, and relativity.

Prerequisite(s): PH 331

PH354 Intermediate Modern Physics
Hours 3

The course provides an introduction to the topics of modern physics based on a theoretical approach. Topics include: the theory of special and general relativity with applications to black holes and cosmological models; particle physics and basic aspects of the standard model; nuclear physics with applications; fundamental interactions and symmetries; astrophysics of stellar evolution and celestial objects.

Prerequisite(s): PH 253

PH405 Physics For Science Teachers
W

Hours 3

Selected topics in contemporary physics for high-school and post-secondary science teachers. Writing proficiency is required for a passing grade in this course. A student who does not write with the skill normally required of an upper-division student will not earn a passing grade, no matter how well the student performs in other areas of the course.

Writing

PH411 Biophysics
Hours 3

Physics of biological systems: proteins, lipids, nucleic acids, supramolecular structures, and molecular motors; structure, function, energetics, thermodynamics, bionanotechnology. Emphasis on systems that are best understood in physical and molecular detail.

PH412 Physics Pedagogy
Hours 1

This is a course in teaching methodologies for introductory physics, based on recent results from physics education research.

Prerequisite(s): None

Prerequisite(s) with concurrency: None

PH434 Digital Electronics
Hours 3

Two laboratory periods. Theory and practical application of digital integrated circuits, including gates, flip-flops, and counters. Computer data acquisition, D/A and A/D conversion, communication and instrument control fundamentals using LabView.

PH441 Quantum Structure of Matter I
Hours 3

Wave functions, time-independent Schroedinger equation, mathematical tools of quantum mechanics, quantum mechanics in three dimensions, identical particles. No graduate credit will be awarded for PH 441.

Prerequisite(s): PH 253 and PH 331 and PH 301 or PH 302

Prerequisite(s) with concurrency: MA 237

PH442 Quantum Structure of Matter II
W

Hours 3

Time-independent perturbation theory, variational principle, WKB approximation, time-dependent perturbation theory, adiabatic approximation, scattering theory. Writing proficiency is required for a passing grade in this course. A student who does not write with the skill normally required of an upper-division student will not earn a passing grade, no matter how well the student performs in other areas of the course. No graduate credit will be awarded for PH 442.

Prerequisite(s): PH 441

Writing

PH461 Nuclear and Particle Physics
Hours 3

An introduction to nuclear and elementary particle physics, this course will cover: nuclear properties, forces, structure and decays; experimental methods in nuclear and particle physics; introduction to the Standard Model of elementary particle physics; the quark model of hadrons; Quantum Electrodynamics; Quantum Chromodynamics and the strong interaction; the weak interaction; electroweak unification, gauge symmetries and the Higgs mechanism.

Prerequisite(s): PH 441

PH471 Thermal Physics
Hours 3

Introduction to thermal phenomena on a macroscopic and a statistical basis, and principles and laws governing them. Introduction to energy and entropy formalism and discussion of thermodynamic potentials (Helmholtz and Gibbs). Applications to systems in equilibrium.

Prerequisite(s): MATH 227 or MATH 247 and PH 253

PH481 Solid State Physics
Hours 3

This course covers the structure of crystals, the mechanical, thermal, electrical, and magnetic properties of solids, the free-electron model, and the band approximation.

Prerequisite(s): PH 253

PH482 Topics Physics & Astronomy
Hours 1-3

Topics in physics and astronomy not covered by existing courses. Repeat credit is allowed for different topics.

PH490 Honors Seminar In Physics
UH

Hours 1

A seminar course on current topics in physics and astronomy.

University Honors

PH491 Advanced Laboratory
W

Hours 3

Advanced experiments in modern physics. Research, analysis, and reporting of scientific results. Writing proficiency is required for a passing grade in this course. A student who does not write with the skill normally required of an upper-division student will not earn a passing grade, no matter how well the student performs in other areas of the course.

Prerequisite(s): PH 255

Writing

PH493 Intro To Research
Hours 1-3

Credit is by arrangement, but no graduate credit will be awarded for PH 493. Student performs research under supervision of a faculty member.

PH495 Independent Study I
Hours 1-3

No description available

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PH496 Independent Study II
Hours 1-3

No description available

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PH501 Classical Dynamics
Hours 3

Variational principles and Lagrange's equations; two-body central-force problems; kinematics of rigid-body motion; rigid-body equations of motion; special relativity; Hamilton's equations of motion; and canonical transformations.

PH505 Physics For Science Teachers
Hours 3

Selected topics in contemporary physics for high school and post-secondary science teachers.

PH511 Biophysics
Hours 3

Physics of biological systems: proteins, lipids, nucleic acids, supramolecular structures, and molecular motors; structure, function, energetics, thermodynamics, bionanotechnology. Emphasis on systems that are best understood in physical and molecular detail.

PH512 Physics Pedagogy
Hours 1

This is a course in teaching methodologies for introductory physics, based on recent results from physics education research.

Prerequisite(s): None

Prerequisite(s) with concurrency: None

PH523 Relativity
Hours 3

Special relativity, equivalence principle, tensor analysis, gravitational effects, curvature, Einstein's field equations, action principle, classic tests of Einstein's theory.

PH531 Electromagnetic Theory
Hours 3

Electric and magnetic fields, Green's functions, and Maxwell's equations.

PH532 Electromagnetic Theory
Hours 3

Electromagnetic waves, relativity, and selected topics.

Prerequisite(s): PH 531

PH534 Digtl Elect Comp Interfc
Hours 3

Theory and practical application of digital integrated circuits, including gates, flip flops, counters, latches, and displays. Computer data acquisition and control using LabView, A/D and D/A fundamentals. Digital communications.

PH541 Quantum Mechanics
Hours 3

Solution of the Schroedinger equation, matrix methods, angular momentum, and approximation methods.

PH542 Quantum Mechanics
Hours 3

Time-dependent perturbation theory, scattering theory, radiation, identical particles, and spin.

Prerequisite(s): PH 541

PH561 Nuclear Particle Physics
Hours 3

Structure and properties of nuclear and subnuclear matter; conservation laws; scattering and decay processes; and fundamental interactions.

PH571 Statistical Physics
Hours 3

Ensembles, partition function, quantum statistics, Bose and Fermi systems, phase transitions and critical phenomena, and applications.

PH581 Solid State Physics
Hours 3

Structure of simple crystals; thermal, electrical, and magnetic properties of solids; the free-electron model and the band approximation; and semiconductors.

PH582 Topics Physics & Astronomy
Hours 1-3

May deal with any physics or astronomy topic not covered by existing courses. The course title is added at the time the course is taught. Repeat credit is allowed for different course titles.

PH585 Magnetism: Fundamentals and Applications
Hours 3

PH585 is the first course of series of graduate level courses on magnetism (PH585, PH586 - Advanced Magnetism: Magnetic Materials, Phenomena and Devices), magnetic phenomena, magnetic materials with examples of magnetic devices for physical science and engineering students. The course is based on a combination of physical principles (materials physics, condensed mater, physics of magnetism) and examples their applications. Lecture examples, lecture and home work problems throughout the course will be based on applications (see list of applications in the topics list) with emphasize on impact of fundamental magnetism for advances in particular technology.

PH586 Advanced Magnetism: Phenomena, Materials, Devices
Hours 3

PH586 a graduate level course in magnetism, magnetic phenomena, magnetic materials with examples of magnetic devices for physical science and engineering students. The course is based on a combination of physical principles (condensed mater and physics of magnetism) and examples their applications to magnetization process and magneto-transport phenomena. The course material will include the following topics: • Review Principles of Magnetism: Fundamental Magnetic Properties • Magnetic domains and domain walls • Thermal Effects • Micromagnetics • Magnetization Processes • Landau-Lifshitz-Gilbert Equation • Hard and Soft Magnetic Materials , Permanent magnet applications • Overview of modern magnetic recording: magnetic recording media • Ferromagnetic Resonance • Interlayer and Interfacial Exchange and Exchange Bias • Review Principles of Electronic structure and Electronic transport • Magneto-transport Phenomena • Anisotropic Magnetoresistance • Giant Magnetoresistance • Tunneling Magnetoresistance • Overview of MagntoElectronic devices : HDD reader, MRAM • Special topics may be included, such as critical phenomena (Ising/Heisenberg model), magnetic and non-magnetic neutron scattering, or principles of VSM magnetometry, spin polarized electron characterization techniques.

PH590 Research Techniques
Hours 3

This course provides graduate students with domain-specific skills and knowledge in their research specialty. This training is expected to be undertaken in the context of active engagement by the student in an ongoing or semester-long research project. Alternatively, if formal preparation beyond the available courses is necessary for a student's success within their specialty, such formal preparation (reading, assignments, etc) will be performed under the direction and supervision of the instructor. Any combination of active research and additional specialty formal preparation may be specified by the instructor, as is necessary to advance the student's knowledge and skill toward that necessary to plan and perform successful research in their specialty.

Prerequisite(s): Permission of instructor is required. Core courses must be completed before taking this Research Techniques course.

PH591 Advanced Laboratory
Hours 3

Experimental work in modern physics at an advanced level.

PH595 Independent Study
Hours 3

No description available

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PH597 Physics Seminar
Hours 1

Required of all full-time physics graduate students each semester in residence. (Students specializing in astronomy must take AY 597.) Students are required to attend at least 10 department colloquia and/or specialty research seminars. Students in their second year and beyond are required to give one oral research presentation.

PH598 Non-Thesis Research
Hours 1-9

No description available

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PH599 Thesis Research
Hours 1-9

No description available

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PH641 Relativistic Quantum Mechanics
Hours 3

The Dirac equation, Lorentz covariance, free-particle solutions of the Dirac equation, Foldy-Wouthuysen transformation, propagator theory, and applications to quantum electrodynamics.

Prerequisite(s): PH 542

PH642 Quantum Field Theory
Hours 3

Classical field theory, quantization of free fields, interacting fields, the scattering matrix, Feynman rules and diagrams, evaluation of integrals and divergences, and electroweak and strong interactions. Offered according to demand.

Prerequisite(s): PH 641

PH661 High Energy Physics
Hours 3

Gauge invariance, non-Abelian gauge theories, hidden symmetries, electroweak interactions of leptons and quarks, strong interactions among quarks, string theories, and phenomenology of high-energy interactions. Offered according to demand.

Prerequisite(s): PH 642

PH662 High Energy Physics II
Hours 3

This course will review physics beyond the Standard Model, Grand Unified Theories, Supersymmetric Theories, Superstrings, and Exact Solutions in Quantum Field Theory.

Prerequisite(s): PH 661

PH681 Adv Solid State Physics
Hours 3

Computational methods in solid-state physics are explored in more detail than in PH 581. Band structure calculations, Green's functions, density-functional methods, superconductivity, and disordered materials. Offered according to demand.

Prerequisite(s): PH 581

PH682 Selected Topics Physics
Hours 1-6

May deal with any physics topic not covered by existing courses. The course title is added at the time each course is taught. Repeat credit is allowed for different course titles.

PH698 Non-Dissertat Research
Hours 1-9

Because this is non-dissertation research, students may repeat this course each semester for up to 18 credit hours.

PH699 Dissertation Research
Hours 1-12

No description available

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