PHYSICS AND ASTROPHYSICS (PHY)

PHY 104 | THE SUN & ITS PLANETS | 4 quarter hours
(Undergraduate)
This course focuses on the development of our knowledge about the Solar System with an emphasis on the origin, structure and motion of the planets and the Sun. Topics include both historical astronomy and our current understanding based on information from spacecraft sent to other planets. Cannot receive credit for both PHY 104 and PHY 114.
MAT 120 or HON 180 or (MAT 130 or above) or consent of instructor is a prerequisite for this course.

PHY 110 | BASIC ELECTRONICS: PRINCIPLES & TECHNIQUES | 4 quarter hours
(Undergraduate)
Introduction to analog electronics that develops the basic principles needed to understand consumer electronics. Emphasis is given to audio applications, but the same basic principles are the foundation of modern computer technology.
MAT 120 or HON 180 or (MAT 130 or above) or consent of instructor is a prerequisite for this course.

PHY 114 | EXPLORING OTHER WORLDS | 4 quarter hours
(Undergraduate)
Activity-based course that compares the local environment of Earth in the Solar System to worlds and environments elsewhere in the Universe. Cannot receive credit for both PHY 104 and PHY 114.
MAT 120 or HON 180 or (MAT 130 or above) or consent of instructor is a prerequisite for this course.

PHY 120 | HOW THINGS WORK | 4 quarter hours
(Undergraduate)
This course will develop an understanding of the physics of everyday objects, such as electric motors, solar cells (photovoltaics), or heat engines (e.g. car engines or refrigerators) . Each course will focus on three different objects, demonstrating principles from different sub-fields of physics. In addition to conceptual understanding, students will learn how scientific discoveries were necessary to make these devices, and how continued scientific exploration is related to their further development.
MAT 120 or HON 180 or (MAT 130 or above) or consent of instructor is a prerequisite for this course.

PHY 150 | GENERAL PHYSICS I | 4 quarter hours
(Undergraduate)
This course provides a comprehensive, non-calculus introduction to physics. Vectors, forces, Newtonia mechanics of translational and rotational motion. This course is intended for life science and health science majors.
MAT 131 or above is a prerequisite for this class.

PHY 151 | GENERAL PHYSICS II | 4 quarter hours
(Undergraduate)
Continuation of PHY 150. Topics include heat, thermodynamics, sound and light.
PHY 150 or PHY 170 is a prerequisite for this class

PHY 152 | GENERAL PHYSICS III | 4 quarter hours
(Undergraduate)
Continuation of PHY 151. Topics include electricity, magnetism and modern physics.
PHY 151 is a prerequisite for this course.

PHY 155 | GENERAL PHYSICS | 6 quarter hours
(Undergraduate)
A combination of Physics 150 plus half of 151. Summer only. (6 quarter hours)
MAT 131 or above is a prerequisite for this class.

PHY 156 | GENERAL PHYSICS | 6 quarter hours
(Undergraduate)
A combination of the last half of Physics 151 plus 152. Summer only. (6 quarter hours)
PHY 155, PHY 151, or PHY 171 is a prerequisite for this course.

PHY 170 | UNIVERSITY PHYSICS I | 4 quarter hours
(Undergraduate)
This course provides a comprehensive, calculus-based introduction to Newtonian mechanics. Topics include vectors, Newton's laws, linear and rotational motion. Course intended for majors in a physical science, required for the physics major. Offered in autumn quarter.
MAT 147 or MAT 150 or MAT 160 is a co-requisite for this class.

PHY 171 | UNIVERSITY PHYSICS II | 4 quarter hours
(Undergraduate)
A continuation of PHY 170. Topics include heat, sound and light. Offered in winter quarter.
MAT 148 or MAT 151 or MAT 161 is a co-requisite for this class.

PHY 172 | UNIVERSITY PHYSICS III | 4 quarter hours
(Undergraduate)
A continuation of PHY 171. Topics include electricity and magnetism. Offered spring quarter.
MAT 149 or MAT 152 or MAT 162 is a co-requisite for this class.

PHY 190 | MATLAB PROGRAMMING FOR SCIENTISTS AND MATHEMATICIANS | 2 quarter hours
(Undergraduate)
Introduction to the Matlab Programming environment with an emphasis on applications of interest to science and mathematics students. Topics include basic operations, functions and scripts, arguments and scope, and graphics. Applications include curve fitting, visualization of data, root finding, and solving systems of equations. (2 quarter hours)

PHY 200 | LIGHT AND ATOMS | 4 quarter hours
(Undergraduate)
A conceptual treatment of light and matter, which emphasizes the counter-intuitive behavior of atoms, electrons and photons. Topics covered include the electrical nature of matter, wave-particle duality, the uncertainty principle, and philosophical implications. Some applications to technology will also be discussed such as lasers, fiber optic communication, superconductivity, and magnetic storage of data.
MAT 120 or HON 180 or (MAT 130 or above) or consent of instructor is a prerequisite for this course.

PHY 204 | FRONTIERS OF THE UNIVERSE | 4 quarter hours
(Undergraduate)
Focuses on the tremendous increase in our understanding of the universe beyond the Solar System that has occurred in recent years. Topics include stellar evolution, the properties of stars, supernova explosions, black holes, galaxies, and the origin of the universe.
MAT 120 or HON 180 or (MAT 130 or above) or consent of instructor is a prerequisite for this course.

PHY 205 | EINSTEIN'S PECULIAR IDEAS | 4 quarter hours
(Undergraduate)
A conceptual treatment of Einstein's groundbreaking ideas about space, time, and the nature of reality. Topics covered include special relativity, Einstein's contributions to quantum physics, including his criticisms of its orthodox interpretation, and some aspects of his theory of gravity. Aspects of Einstein's thoughts on social issues will also be briefly discussed.
MAT 120 or HON 180 or (MAT 130 or above) or consent of instructor is a prerequisite for this course.

PHY 206 | SOUND AND ACOUSTICS | 4 quarter hours
(Undergraduate)
Sound waves, their production, transmission and detection; applications to music, acoustics and noise pollution.
MAT 120 or HON 180 or (MAT 130 or above) or consent of instructor is a prerequisite for this course.

PHY 220 | OCEANOGRAPHY | 4 quarter hours
(Undergraduate)
Develops the concepts of physical oceanography. Topics include the chemical and physical properties of seawater, the dynamics of ocean currents and circulations, the physics of water waves and tides, the interaction of the ocean with the atmosphere, the formation of coastlines, and the effects of pollution on the ocean. Cross-listed with GEO 220.
MAT 120 or HON 180 or (MAT 130 or above) or consent of instructor is a prerequisite for this course.

PHY 223 | LIGHT, COLOR, AND PHOTOGRAPHY | 4 quarter hours
(Undergraduate)
Principles of image formation with lenses and mirrors. Discussion of color, interference, polarization, and diffraction. Introduction to cameras and film, lasers and holography. Cross-listed with ART 223.
MAT 120 or HON 180 or (MAT 130 or above) or consent of instructor is a prerequisite for this course.

PHY 225 | EARTH'S CHANGING CLIMATE | 4 quarter hours
(Undergraduate)
Develops the physical concepts needed to understand the atmosphere, the oceans, and their interactions with the aim of building a conceptual model of weather and climate. Long-term climate variability and climate related environmental issues are also discussed. Cross-listed with GEO 225.
MAT 120 or HON 180 or (MAT 130 or above) or consent of instructor is a prerequisite for this course.

PHY 231 | LINEAR ELECTRIC CIRCUITS | 4 quarter hours
(Undergraduate)
Frequency response and feedback, operational amplifiers as linear amplifiers, active filters, oscillators, communication circuits and data conversion circuits.
PHY 110 is a prerequisite for this course.

PHY 232 | INTRODUCTION TO DIGITAL ELECTRONICS | 4 quarter hours
(Undergraduate)
Principles of combinational logic circuits. Boolean algebra and Boolean function simplification. State diagrams and sequential logic circuits, and MSI devices. Digital circuit prototyping using SSI components.
MAT 120 or HON 180 or (MAT 130 or above) or consent of instructor is a prerequisite for this course.

PHY 236 | THE SCIENCE OF DIGITAL AUDIO | 4 quarter hours
(Undergraduate)
Introduction to the physics and mathematics of digital audio, including the conversion of sound energy into electrical signals, the digitization of the signal, conversion of the signal to a standard format, storage of the signal on a hard disk or a CD, and manipulation of the digitized signal. Also includes a discussion of the ethics and legality of downloading digitized audio, in the context of intellectual property rights. This course assumes familiarity with trigonometric mathematical functions.
MAT 120 or HON 180 or (MAT 130 or above) or consent of instructor is a prerequisite for this course.

PHY 270 | UNIVERSITY PHYSICS IV | 4 quarter hours
(Undergraduate)
An introduction to 20th-century physics. Topics include special relativity, quantum mechanics, and statistical analysis of data.
PHY 172 is a prerequisite for this course.

PHY 300 | METHODS OF COMPUTATIONAL AND THEORETICAL PHYSICS I | 4 quarter hours
(Undergraduate)
Computational and theoretical methods in ordinary differential equations, complex numbers, systems of equations, phase plane analysis, bifurcations. Applications to damped, driven oscillators, electronics. COREQUISITE(S):MAT 261.

PHY 301 | METHODS OF COMPUTATIONAL AND THEORETICAL PHYSICS II | 4 quarter hours
(Undergraduate)
Fourier series, Fourier transforms, partial differential equations, Legendre polynomials, special functions. Applications to wave motion, electricity and magnetism, modern physics, optics. Spring.
PHY 300 is a prerequisite for this course.

PHY 310 | MECHANICS I | 4 quarter hours
(Undergraduate)
Newtonina motion in a one-, two-, and three-dimensional motion, conservative systems, variational principles, Lagrangian and Hamiltonian mechanics, central-force problems.
PHY 300 is a prerequisite for this course.

PHY 311 | MECHANICS II | 4 quarter hours
(Undergraduate)
Continuation of PHY 310. Topics include systems of particles, collisions and scattering, motion in rotating frames, rigid body motion.
PHY 310 is a prerequisite for this course.

PHY 315 | CHAOS IN PHYSICAL SYSTEMS | 4 quarter hours
(Undergraduate)
Motion in phase space, characteristics of chaotic systems, Lyapunov exponents, stability of equilibrium solutions, strange attractors, bifurcations, discrete dynamics, and applications to lasers, fluids, and other physical systems.
PHY 300 is a prerequisite for this course.

PHY 320 | ELECTRICITY AND MAGNETISM I | 4 quarter hours
(Undergraduate)
Solutions to electrostatic, magnetostatics, and boundary-value problems. Introduction to Coulumb's law, Gauss's law, Biot-Savart law, and electric and magnetic potentials.
PHY 301 is a prerequisite for this course.

PHY 321 | ELECTRICITY AND MAGNETISM II | 4 quarter hours
(Undergraduate)
A continuation of PHY 320. Topics include Maxwell's equations, time varying fields, electromagnetic waves, and radiation.
PHY 320 is a prerequisite for this course.

PHY 325 | LASER PHYSICS | 4 quarter hours
(Undergraduate)
Interaction of radiation and matter, pumping mechanisms for lasers, optical resonators, cw and transient laser behavior, laser types, current topics in optical physics. Cross-listed as PHY 425.
PHY 300 is a prerequisite for this course.

PHY 330 | SENIOR CAPSTONE PHYSICAL SCIENCE | 4 quarter hours
(Undergraduate)
Senior Capstone in the Physical Sciences. Topics in the physical sciences and their social, political, environmental and economic impact.
Student standing of at least junior level is a prerequisite for this course.

PHY 335 | NON-EQUILIBRIUM PHYSICS AND SELF-ORGANIZATION | 4 quarter hours
(Undergraduate)
The spontaneous formation of structure is one of the most interesting phenomenon in nature and arises in fields as diverse as physics, chemistry, biology, management, economics, and sociology. Many self-organizing systems show similarities in the way the structure arises, indicating that there are underlying general principles that govern these systems. This course will investigate these principles. PHY 340 or consent recommended.
PHY 301 is a prerequisite for this course.

PHY 340 | THERMAL PHYSICS | 4 quarter hours
(Undergraduate)
Statistical interpretation of the fundamental concepts of thermodynamics and its physical applications.
PHY 301 is a prerequisite for this course.

PHY 342 | COMPUTATIONAL PHYSICS | 4 quarter hours
(Undergraduate)
Computational solution and simulation of physical systems; applications chosen from nonlinear dynamics, optics, central-force motion, fluids, condensed matter.
PHY 301 is a prerequisite for this course.

PHY 350 | OPTICS | 4 quarter hours
(Undergraduate)
Matrix methods for image formation, diffraction, interferometry, coherence, scattering, polarization, holography, Fourier transform spectroscopy. PHY 320 recommended.
PHY 301 is a prerequisite for this course.

PHY 356 | FIBER OPTICS | 4 quarter hours
(Undergraduate)
Solution of Maxwell's equations for dielectric waveguides, optical communications, nonlinear effects in dielectric waveguides, and current research. PHY 321 recommended. Cross-listed with PHY 456.
PHY 301 is a prerequisite for this course.

PHY 360 | QUANTUM MECHANICS I | 4 quarter hours
(Undergraduate)
Introduction to quantum mechanics, including the solution of the Schrodinger equation in one and three dimensions for a variety of potentials. Applications to atomic systems and solids.
PHY 301 is a prerequisite for this course.

PHY 361 | QUANTUM MECHANICS II | 4 quarter hours
(Undergraduate)
Continuation of PHY 360. Applications of quantum mechanics, including time-independent and time-dependent perturbation theory, the variational principle, and an introduction to scattering theory.
PHY 360 is a prerequisite for this course.

PHY 365 | NUCLEAR PHYSICS | 4 quarter hours
(Undergraduate)
Theoretical and phenomenological approaches to nuclear structure and strong, electromagnetic, and weak interactions of nuclei. Topics of study include the theory of scattering and decay of nuclei, resonances, nuclear models.
PHY 360 is a prerequisite for this course.

PHY 366 | RADIATION PHYSICS | 4 quarter hours
(Undergraduate)
Radioactive decay processes, interactions of radiation with matter, general properties of radiation detectors, and applications to basic nuclear spectroscopy, health physics and medical physics. Cross-listed w/ PHY 466.
PHY 270 is a prerequisite for this course.

PHY 370 | ELECTRONICS | 4 quarter hours
(Undergraduate)
A laboratory course covering analysis and construction of analog and digital circuits used in experimental research.
PHY 301 is a prerequisite for this course.

PHY 373 | STAR FORMATION | 4 quarter hours
(Undergraduate)
This course will cover various topics related to Star Formation and the Interstellar Medium. Topics include: Molecular Line Radiation, Molecular Cloud Observations, Radiative Transfer, The Interstellar Medium, Physical Processes in Molecular Clouds, the Star Formation Rate: Galactic and Extragalactic, Magnetic Fields: Theory and Observations, Stages in Low Mass and High Mass Star Formation, Disks and Outflows.
PHY 301 is a prerequisite for this course.

PHY 374 | STELLAR ASTROPHYSICS | 4 quarter hours
(Undergraduate)
This course will cover the foundational concepts of the astrophysics of stars and stellar remnants. Topics include: Interaction of Radiation and Matter, Astronomical Instruments and Detectors, Solar Atmosphere and Magnetic Activity, Properties of Stars, Stellar Atmospheres, Stellar Interiors, Stellar Evolution and Stellar Remnants.
PHY 301 is a prerequisite for this course.

PHY 375 | INTRODUCTION TO COSMOLOGY | 4 quarter hours
(Undergraduate)
Provides a foundation to the core concepts of cosmology, with an emphasis on developing physical insight. Discusses recent major developments in cosmology, such as the cosmological constant and accelerating universe, and key future developments, including details of the cosmic microwave background and gravitational wave detection. PHY 310 recommended.
PHY 301 is a prerequisite for this course.

PHY 376 | ASTRONOMICAL DATA ANALYSIS | 4 quarter hours
(Undergraduate)
This course will cover various topics related to data analysis in astrophysics across a multitude of wavelengths. Topics include: Ground-based and space-based optical observations, infrared, and X-ray observations, single-dish and interferometric radio observations, multi-wavelength data processing.
PHY 301 is a prerequisite for this course.

PHY 378 | TOPICS IN PHYSICS | 4 quarter hours
(Undergraduate)
Current topics in applied physics, as determined by the interests of the instructor and students.
PHY 301 is a prerequisite for this course.

PHY 380 | EXPERIMENTAL PHYSICS I | 4 quarter hours
(Undergraduate)
Experimental techniques in optics, atomic and nuclear physics. Approved for Experiential Learning Credit.
PHY 270 and PHY 301 are a prerequisite for this course.

PHY 381 | EXPERIMENTAL PHYSICS II | 4 quarter hours
(Undergraduate)
Experimental techniques in solid-state and high-vacuum physics. Laboratory.
PHY 380 is a prerequisite for this course.

PHY 382 | EXPERIMENTAL PHYSICS III | 4 quarter hours
(Undergraduate)
Experimental Physics III (laboratory)
PHY 381 is a prerequisite for this course.

PHY 384 | ADVANCED LABORATORY | 4 quarter hours
(Undergraduate)
Variable credit Laboratory experience in techniques selected in consultation with instructor.

PHY 385 | INTRODUCTION TO PHYSICS EDUCATION RESEARCH | 4 quarter hours
(Undergraduate)
This course covers effective teaching methods for physics, findings from physics education research, and the use of technology in physics classrooms. Course is required to serve as a Teaching Assistant within the department. Cross listed with PHY 485.
PHY 301 is a prerequisite for this course.

PHY 390 | APPLIED COMPUTATIONAL PHYSICS LABORATORY | 4 quarter hours
(Undergraduate)
Project-based computational laboratory of problems in modern applied physics. Numerical modeling of experiments, computer interfacing of experiments, computational techniques in data analysis.
PHY 301 is a prerequisite for this course.

PHY 391 | ELECTRONIC PROPERTIES OF MATERIALS | 4 quarter hours
(Undergraduate)
The free-electron gas model, energy band theory, theory of metals and alloys, transport pheonomena, dia-and para-magnetism, ferromagnetism, and antiferomagnetism, superconductivity.
PHY 360 is a prerequisite for this course.

PHY 392 | STRUCTURAL PROPERTIES OF MATERIALS | 4 quarter hours
(Undergraduate)
Periodicity, symmetry and classification of crystal structure, X-ray diffraction, reciprocal lattice, crystal binding, Debye theory of heat capacity, anharmonic interactions, point defects, surfaces.
PHY 360 is a prerequisite for this course.

PHY 395 | METHODS OF THEORETICAL PHYSICS | 4 quarter hours
(Undergraduate)
Special functions, complex integration, calculus of variations, coordinate transformations.
PHY 301 is a prerequisite for this course.

PHY 398 | READING AND RESEARCH | 1-8 quarter hours
(Undergraduate)
Undergraduate research participation. (variable credit)
Student standing of at least junior level is a prerequisite for this course.

PHY 399 | INDEPENDENT STUDY | 1-4.5 quarter hours
(Undergraduate)
Independent Study. (variable credit)

PHY 400 | CLASSICAL MECHANICS FOR TEACHERS | 4 quarter hours
(Graduate)
Concepts and materials for teaching mechanics as part of high school physics. Only offered by arrangement.

PHY 401 | ELECTRICITY AND MAGNETISM FOR TEACHERS | 4 quarter hours
(Graduate)
The principles of electricity and magnetism, including electric circuits. This level is appropriate for regular and AP high school Physics teachers. Only offered by arrangement.

PHY 402 | ATOMIC AND NUCLEAR PHYSICS FOR TEACHERS | 4 quarter hours
(Graduate)
This course provides a broad perspective for teachers. It includes atomic, nuclear and some particle physics. Only offered by arrangement.

PHY 403 | TOPICS IN PHYSICS TEACHING | 4 quarter hours
(Graduate)
Selected topics for high school teachers. May be taken more than once. Only offered by arrangement.

PHY 404 | OPTICS FOR TEACHERS | 4 quarter hours
(Graduate)
Geometrical and physical optics from the perspective of high school teaching. Applications to photography and holography. Only offered by arrangement.

PHY 406 | VIBRATIONS, WAVES AND SOUND FOR TEACHERS | 4 quarter hours
(Graduate)
Techniques for teaching high school science including musical acoustics and sound reproduction. Only offered by arrangement.

PHY 410 | CHAOS IN PHYSICAL SYSTEMS | 4 quarter hours
(Graduate)
Motion in phasespace, characteristics of chaotic systems, Lyapunov exponents, stability of equilibria, strange attractors, bifurcations, discrete dynamics, applications to lasers, fluids, and other physical systems.

PHY 411 | ELECTRODYNAMICS I | 4 quarter hours
(Graduate)
Electrostatics and magnetostatics in vacuum and in media; electromagnetic induction; Maxwell's equations; the Poynting vector; electromagnetic wave propagation.

PHY 412 | QUANTUM MECHANICS I | 4 quarter hours
(Graduate)
Schroedinger equation, operators, eigenvalues; series of eigenfunctions; physical interpretation; one- and three-dimensional applications.

PHY 420 | ELECTRODYNAMICS II | 4 quarter hours
(Graduate)
Further studies of electromagnetic wave propagation; scattering; dispersion; bounded structures and guided waves; electromagnetic radiation, including multipole radiations and radiation from systems of radiators.
PHY 411 is a prerequisite for this course.

PHY 425 | LASER PHYSICS | 4 quarter hours
(Graduate)
Interaction of radiation and matter, pumping mechanisms for lasers, optical resonators, cw and transient laser behavior, laser types, current topics in optical physics. Cross-listed with PHY 325.

PHY 435 | NON-EQUILIBRIUM PHYSICS AND SELF-ORGANIZATION | 4 quarter hours
(Graduate)
The spontaneous formation of structure is one of the most interesting phenomenon in nature and arises in fields as diverse as physics, chemistry, biology, management, economics, and sociology. Many self-organizing systems show similarities in the way the structure arises, indicating that there are underlying general principles that govern these systems. This course will investigate these principles. PHY 340 or consent recommended.

PHY 440 | CLASSICAL MECHANICS | 4 quarter hours
(Graduate)
Variational principles; Lagrangian and Hamiltonian mechanics; small oscillations; canonical transformations; Hamilton-Jacobi theory.

PHY 442 | COMPUTATIONAL PHYSICS | 4 quarter hours
(Graduate)
Contemporary Topics in physics are examined via numerical solutions. Calculations using an interactive approach and graphical representation are used extensively.

PHY 445 | STATISTICAL MECHANICS | 4 quarter hours
(Graduate)
Principles of statistical mechanics; applications to weakly interacting systems such as the classical plasma and Fermi gas; strongly interacting systems; transport theory; fluctuations and irreversible processes, phase transitions.

PHY 450 | PHASE TRANSITIONS & CRITICAL PHENOMENON | 4 quarter hours
(Graduate)
Applications of equilibrium statistical mechanics to the study of phase transitions and critical phenomena. Topics include the Ising model of magnetism, critical phenomena in fluids, mean field theory, Landau-Ginzburg theory, and the renormalization group.
PHY 340 and PHY 445 are prerequisites for this course.

PHY 454 | FOURIER OPTICS | 4 quarter hours
(Graduate)
Fourier Optics and optical processing of information. Topics include diffraction theory, optical transfer functions and holography. The Fourier Transform and Fast Fourier Transform are used extensively.

PHY 456 | FIBER OPTICS | 4 quarter hours
(Graduate)
(Cross-listed as PHY 356) Solution of Maxwell's equations for dialectic wave guides, optical communications, nonlinear effect in dialectic wave guides, and current research.

PHY 460 | QUANTUM MECHANICS II | 4 quarter hours
(Graduate)
Review of basic quantum theory; vector spaces; linear operators; observables; commutators; projection operations; representations; angular momentum theory; systems of identical particles; invariance.
PHY 412 is a prerequisite for this course.

PHY 465 | NUCLEAR PHYSICS | 4 quarter hours
(Graduate)
Theoretical and phenomenological approaches to nuclear structure and strong, electromagnetic, and weak interactions of nuclei. Topics of study include the theory of scattering and decay of nuclei, resonances, nuclear models.
PHY 360 is a prerequisite for this course.

PHY 466 | RADIATION PHYSICS | 4 quarter hours
(Graduate)
Interactions of X-rays, nuclear radiations, etc. with matter; radiation detectors; dosimetry; shielding; applications to medical physics. Cross-listed with PHY 366.

PHY 470 | ADVANCED GRADUATE LABORATORY TECHNIQUES | 4 quarter hours
(Graduate)
Advance laboratory techniques and measuring devices are used to study optics, atomic and nuclear, and condensed matter physics. Advanced data analysis techniques are also introduced. Emphasis is on individual research projects. Physics Graduate standing is a prerequisite.

PHY 473 | STAR FORMATION | 4 quarter hours
(Graduate)
This course will cover various topics related to Star Formation and the Interstellar Medium. Topics include: Molecular Line Radiation, Molecular Cloud Observations, Radiative Transfer, The Interstellar Medium, Physical Processes in Molecular Clouds, the Star Formation Rate: Galactic and Extragalactic, Magnetic Fields: Theory and Observations, Stages in Low Mass and High Mass Star Formation, Disks and Outflows. (Cross-listed with PHY 373.)

PHY 474 | STELLAR ASTROPHYSICS | 4 quarter hours
(Graduate)
This course will cover the foundational concepts of the astrophysics of stars and stellar remnants. Topics include: Interaction of Radiation and Matter, Astronomical Instruments and Detectors, Solar Atmosphere and Magnetic Activity, Properties of Stars, Stellar Atmospheres, Stellar Interiors, Stellar Evolution and Stellar Remnants. (Cross-listed with PHY 374.)

PHY 475 | INTRODUCTION TO COSMOLOGY | 4 quarter hours
(Graduate)
Provides a foundation to the core concepts of cosmology, with an emphasis on developing physical insight. Discusses recent major developments in cosmology, such as the cosmological constant and accelerating universe, and key future developments, including details of the cosmic microwave background and gravitational wave detection.

PHY 476 | ASTRONOMICAL DATA ANALYSIS | 4 quarter hours
(Graduate)
This course will cover various topics related to data analysis in astrophysics across a multitude of wavelengths. Topics include: Ground-based and space-based optical observations, infrared, and X-ray observations, single-dish and interferometric radio observations, multi-wavelength data processing.

PHY 478 | TOPICS IN PHYSICS | 4 quarter hours
(Graduate)
This course number is reserved for Individual study at the graduate level. Special seminars organized from time to time to accommodate the needs of groups of students in specialized subjects of topical interest.

PHY 480 | THESIS RESEARCH | 1-8 quarter hours
(Graduate)
This course number designates research performed to gather thesis material. Up to two registrations are allowed. No less than four quarter hours; no more than eight quarter hours total credit.

PHY 481 | THESIS WRITING SEMINAR | 4 quarter hours
(Graduate)
First- and second-year Physics master's degree students will improve their skills in reading and interpreting scientific journal articles, creating and presenting scientific work, and offering, receiving, and incorporating peer reviews of scientific presentations. Some assignments and in-class activities are designed around common journal articles, but a majority of course work focuses on an individual student's thesis project. First-year students will produce their introductory thesis chapter, while second-year students will produce the final chapter(s) of their thesis.

PHY 485 | INTRODUCTION TO PHYSICS EDUCATION RESEARCH | 4 quarter hours
(Graduate)
This course covers effective teaching methods for physics, findings from physics education research, and the use of technology in physics classrooms. Course is required to serve as a Teaching Assistant within the department. Cross listed with PHY 385.

PHY 490 | STRUCTURAL PROPERTIES OF MATERIALS | 4 quarter hours
(Graduate)
Periodicity, symmetry and classification of crystal structure; X-ray diffraction; reciprocal lattice; crystal binding. Debye theory of heat capacity; anharmonic interactions; point defects; surfaces.
PHY 360 is a prerequisite for this course.

PHY 491 | ELECTONIC PROPERTIES OF MATERIALS | 4 quarter hours
(Graduate)
The free-electron gas model; energy band theory; theory of metals and alloys; transport pheonomena; dia- and para-magnetism, ferromagnetism, and antiferromagnetism; superconductivity.
PHY 360 is a prerequisite for this course.

PHY 495 | METHODS OF THEORETICAL PHYSICS | 4 quarter hours
(Graduate)
Special functions, complex integration, calculus of variations, coordinate transformations. Cross-listed with PHY 395.

PHY 701 | CANDIDACY CONTINUATION | 0 quarter hours
(Graduate)
Students who have completed their coursework and are actively working on the requirements for the Master's thesis must enroll in candidacy continuation each quarter of the academic year until the Master's requirement has been completed. This course carries the equivalent of half-time student enrollment status. Course requires graduate program director approval and proof of work each quarter. Pass/No Pass grading. (0 credit hours)

PHY 702 | CANDIDACY MAINTENANCE | 0 quarter hours
(Graduate)
This course is meant for Master's students not actively working on their thesis. It is only used to maintain active student status. It will not give the student full- or half-time enrollment status and will not permit deferment of student loans. Course requires graduate program director approval each quarter. (0 credit hours)